AUERBACH STANDARD EDP REPORTS

An Analytical Reference Service
for the Electronic Data Processing Field

Prepared and Edited by
AUERBACH Corporation
Philadelphia, Penna.

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The information contained herein has been obtained from reliable sources and has been evaluated by technical teams with extensive working experience in computer design, selection and application. The information, however, is not guaranteed.

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WHAT IT IS--HOW TO USE IT

AUERBACH®

STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

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STANDARD EDP REPORTS AUERBACH

SEPTEMBER 1966

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PACKING LIST

The enclosed September supplement for your AUERBACH Standard EDP Reports features:

- An incisive Summary Report on the new Sigma computer systems from Scientific Data Systems (SDS).
- A reformatted and expanded edition of the 110-page Comparison Charts section.
- A revised edition of the 39-page General Index to AUERBACH Standard EDP Reports.

The Summary Report on the new SDS computers reviews the small-scale Sigma 2 system and analyzes in depth the medium-scale Sigma 7 system. Sigma 7 is the archetype system of the gradually expanding family of Sigma systems, and is the first SDS computer with noteworthy capabilities for business data processing. The announcement of Sigma 7 raised industry eyebrows with the promise that it "performs three times as much work as other machines in its price class and sells for half the price of computers with comparable capability." Continuing a definite trend among new computer systems, Sigma 7 is largely compatible with the IBM System/360.

The AUERBACH Standard EDP Reports Comparison Charts are the most comprehensive and up-to-date quick reference guide to computer characteristics available anywhere. The enclosed revised edition includes comparative information on the newest Burroughs "500 Systems" — the B 2500 and B 3500 — and on the industry's latest computer family — the UNIVAC 9000 Series. The Comparison Charts are divided into three basic categories:

- Configuration Rentals (page 11:010.101). These charts show the prime-shift monthly rental prices for more than 90 U. S.-manufactured digital computer systems in various standardized equipment configurations. The specifications for each of the standard configurations are described on page 4:030.100 of the Users' Guide. These charts enable you to make direct, meaningful comparisons of the costs of competitive systems with similar capabilities.

- Hardware Characteristics (page 11:210.101). These charts list, in a standardized format, the important characteristics of the central processor, internal storage, and standard peripheral devices for each computer system. The entries in these charts are designed to be largely self-explanatory and to facilitate valid comparisons, but we urge you to turn to the individual Computer System Reports in Binders 2 through 8 for more detailed analyses of the information summarized in the charts. Because of the physical limitations upon the amount of information that a printed page can hold, the Hardware Characteristics charts are divided into four subsections covering different classes of equipment; the Quick Reference Index on page 11:001.002 will direct you to all the entries pertaining to any particular computer system.
- System Performance (page 11:400.101). These unique charts summarize the total processing times for our standard "benchmark" problems, which are representative of computer workloads in both business and scientific applications. Each of the 280 lines shows the cost and calculated performance of a particular computer system arranged in a particular standard configuration. The System Performance charts will help you to determine quickly which computer systems may be able to meet your performance requirements and your budget, enabling you to weed out the inapplicable computers and concentrate on the detailed Computer System Reports on the systems which appear to be suitable for your needs.

The expanded edition of the General Index includes entries for every device, program, and concept covered in your eight-volume service through September 1966. The first page of the General Index contains concise instructions to make it easier than ever to find the information you need.

Please file the enclosed material promptly and carefully in accordance with the filing instructions below. Then we suggest routing this cover sheet to the others in your organization who should be informed of the important new material being added to AUERBACH Standard EDP Reports.

FILING INSTRUCTIONS

Binder 1

Behind Tab 1: WHAT IT IS — HOW TO USE IT:

- Remove existing pages 1:001.100 thru 1:001.102 (Summary Table of Contents), and insert revised pages 1:001.100 thru 1:001.102.

Behind Tab 2: INDEX:

- Remove existing pages 2:050.001 thru 2:100.037 (Supplement Index and General Index), and insert revised pages 2:100.001 thru 2:100.039.

Behind Tab 11: COMPARISON CHARTS:

- Remove existing pages 11:001.001 thru 11:400.111 (entire Comparison Charts section), and insert new pages 11:001.001 thru 11:400.111.

Binder 7

Behind Tab 716: Spectra 70/55:

- Insert new Tab 740: SDS SIGMA 7 and pages 740:001.010 thru 740:221.101 immediately behind existing page 716:201.400.

> The October supplement to AUERBACH Standard EDP Reports will bring you an up-to-date, expanded report on the GE-600 Series systems, analyzing their hardware, software, and compatibility features. The November supplement will feature a revised and penetrating analysis of the IBM System/360.

AUERBACH STANDARD EDP REPORTS: WHAT IT IS — HOW TO USE IT

.1 WHAT IT IS

AUERBACH Standard EDP Reports is an analytical reference service designed to satisfy the need for accurate, effective data to aid in the selection and utilization of computer systems for business and scientific applications. This service can save you countless hours by providing the facts you need, when you need them, in standardized formats that permit rapid references and facilitate objective comparisons. Regular supplements keep the service up to date and keep you informed of significant new developments in the EDP field.

AUERBACH Standard EDP Reports is a uniquely useful tool for every user and potential user of digital computer systems. Like most tools, it will be of some value to nearly everyone who uses it, but it will be of far greater value to those who are willing to invest a little time and effort in learning how to use it most effectively. To ensure that all of the information in AUERBACH Standard EDP Reports can be effectively employed in solving your data processing problems, we strongly recommend a thorough reading of the remainder of this "What It Is — How to Use It" section.

.2 STRUCTURE AND CONTENTS

AUERBACH Standard EDP Reports has a looseleaf format and an open-ended numbering system to facilitate additions and revisions. The service currently fills eight large binders. Binders 2 thru 8 contain the detailed Computer System Reports, while Binder 1 holds all of the other material described in the paragraphs that follow. Numbered divider tabs make it easy to locate individual reports. The Summary Table of Contents, immediately behind Tab 1, provides an up-to-date summary of the overall structure and contents of the service.

.21 Computer System Reports

These detailed technical reports on the hardware, software, and overall performance of individual computer systems are the principal component of AUERBACH Standard EDP Reports.

Every Computer System Report has the same basic format. Each report is divided into a number of logical sections, and each section is devoted to a specific category of information. For example, Section :021 of each Computer System Report describes the system's Data Structure, Section :051 describes its Central Processor, Section :171 describes its Machine Oriented Language (assembler), and Section :191 describes its Operating Environment. Section :201 of each Computer System Report is particularly significant; it contains the results of a series of standard "benchmark" problems which measure the system's overall performance in typical business and scientific applications.

A single Computer System Report may contain two or more sections of a particular type. For example, there will usually be several Internal Storage sections — one describing each type of storage device (core, drum, disc, etc.) that is available for the system. To facilitate comparisons, all of the Internal Storage sections have the same format, and they are numbered :041, :042, :043, etc. The first page of every Computer System Report is a Contents page that summarizes the structure and content of the report by listing each section.

.22 Users' Guide

The Users' Guide (behind Tab 4) explains the basis and significance of each of the standardized entries in the Computer System Reports. Keyed to the Computer System Reports through corresponding section and paragraph numbers, the Users' Guide provides the background you need to derive maximum value from the facts and evaluations in the individual reports. The Users' Guide constitutes an encyclopedia of computer terms and characteristics, and it can serve as a checklist to ensure that no important item is overlooked in computer system evaluations. Regular references to the appropriate Users' Guide entries will help you get the most out of AUERBACH Standard EDP Reports.

.23 Index

The Index (behind Tab 2) is the natural starting point for most references. It is arranged in straightforward alphabetical order to lead you quickly to all the information about any specific device, program, or concept. The first page of the Index, Page 2:100.001, contains brief instructions for using the Index effectively.

.24 Glossary

The rapid, unregimented growth of the computer industry has led to significant differences in the meanings and usages of many technical terms. A prerequisite for the preparation of standardized Computer System Reports is the adoption of a consistent set of terms, each of which has a single clearly-defined meaning. The Glossary (behind Tab 7) defines the precise meaning of each technical term as used throughout AUERBACH Standard EDP Reports.

.25 Comparison Charts

The Comparison Charts (behind Tab 11) summarize the key data from the Computer System Reports in formats designed to permit quick, objective comparisons. The charts are divided into three main categories:

- Configuration Rentals (Page 11:010.101). These charts show the prime-shift monthly rental prices for individual computer systems arranged in various standardized equipment configurations; the specifications for each of the standard configurations are described on Page 4:030.100 of the Users' Guide. These charts enable you to make direct, meaningful comparisons of the costs of competitive systems with similar capabilities.

- Hardware Characteristics (Page 11:210.101). These charts list, in a standardized format, the important characteristics of the central processor, internal storage, and standard peripheral devices for each computer system. The Hardware Characteristics charts are divided into four subcategories covering different classes of equipment.

- System Performance (Page 11:400.101). These unique charts summarize the total processing times for our standard "benchmark" problems, which are representative of computer workloads in both business and scientific applications. Each line shows the cost and calculated performance of a particular computer system arranged in a particular standard configuration. The System Performance charts will help you to determine quickly which computer systems may be able to meet your performance requirements and your budget.

The Quick Reference Index to the Comparison Charts on Page 11:001.002 will direct you to all the latest entries pertaining to any particular computer system. Although the Comparison Charts are quite comprehensive and largely self-explanatory, the serious user is urged to turn to the individual Computer System Reports in Binders 2 thru 8 for more detailed information.

.26 Directories

The Directories (behind Tab 21) provide detailed listings of manufacturers and suppliers of computing equipment and services — a handy compilation of likely sources of the products and services you need.

.27 Special Reports

A series of Special Reports (behind Tab 23) rounds out the service by providing facts and guidelines on individual topics of special interest to many of our subscribers. Recent reports, for example, have intensively examined optical character recognition, computer rental terms, random-access storage, and data collection systems.

.3 REGULAR SUPPLEMENTS

Your copy of AUERBACH Standard EDP Reports will be kept comprehensive and up to date by means of regular supplements. Each supplement contains new reports on recently-announced equipment and/or revised versions of previously-published reports that reflect changes in equipment characteristics and in the state of the art. A blue cover sheet containing a summary of the new information and easy-to-follow filing instructions accompanies each supplement. We recommend that you set up a standard procedure to ensure that each new supplement will be filed promptly and that the cover sheet will be routed to everyone who may profit from the new material in AUERBACH Standard EDP Reports.

(Contd.)

.4 THE NUMBERING SYSTEM

The page numbers in AUERBACH Standard EDP Reports, which look rather formidable at first glance, are part of a numbering system that has been specifically designed to facilitate rapid references and meaningful comparisons. The basic unit of reference is not the page, but the paragraph. Referencing by paragraph number rather than by page number permits standardized report structures, ease of cross-referencing, simplicity of indexing, and convenient supplementation.

Each major component of the service is identified by a separate divider tab and is called a report. Report numbers consist of one, two, or three digits — the digits to the left of the colon in every page number or index reference. For example, Report 203 (behind Tab 203 in Binder 2) is the Computer System Report on the Burroughs B 5500.

Each report is, in general, divided into a number of logical sections. Section numbers consist of the three digits to the right of the colon in every page number or index reference. For example, Section :051 of every Computer System Report describes the system's Central Processor. The Central Processor section of the Burroughs B 5500 report, therefore, is Section 203:051, and it begins on Page 203:051.100.

Each section is further divided into numbered paragraphs, which constitute the basic unit of reference in AUERBACH Standard EDP Reports. Every paragraph number consists of from one to four digits preceded by a decimal point. For example, Paragraph .232 of every Central Processor section shows the processor's "Instruction layout."

To find the Burroughs B 5500's instruction layout, you simply turn to Paragraph 203:051.232; that is, the "Instruction layout" entry (Paragraph .232) of the Central Processor section (Section :051) of the B 5500 report (behind Tab 203). You will find this entry on Page 203:051.215. The page is so designated because the first entry on it is Paragraph .215. Thus, every page number is composed of a report number (the digits to the left of the colon), a section number (the three digits to the right of the colon), and the number of the first paragraph on the page (the three digits to the right of the decimal point, with zeros added to one-digit or two-digit paragraph numbers). For guidance in finding specific information, turn to the concise instructions for using the Index on Page 2:100.001.

All report numbers, paragraph numbers, and page numbers throughout AUERBACH Standard EDP Reports are strictly sequential, although there are many "gaps," or omitted numbers. These gaps help to keep the service "open-ended" by facilitating the insertion of new material in the most appropriate places.

Note that although individual Computer System Reports may contain two or more sections of a particular type, a single Users' Guide section applies to all sections of that type. Therefore, although section numbers in the Computer System Reports end with the digits 1, 2, 3, etc., the corresponding Users' Guide section numbers end with 0. Thus, Section 4:040 of the Users' Guide applies to all of the Internal Storage sections which are numbered :041, :042, :043, etc. in the various Computer System Reports.

.5 DERIVATION AND RELIABILITY

AUERBACH Standard EDP Reports is prepared and edited by experienced computer system analysts, all of whom are members of the Technical Staff of AUERBACH Corporation.

In gathering, analyzing, and evaluating material for these reports, our staff starts with the specifications and manuals issued by the equipment manufacturers and other reliable sources. Advance information from the manufacturers frequently enables us to publish a detailed analysis immediately after the official announcement of a new computer system. Extensive amplification and clarification of the generally-available specifications are usually obtained through visits to or correspondence with the manufacturers. Users of the equipment are also interviewed whenever practical. The comprehensive, systematic structure of the Computer System Reports helps us to identify and resolve the errors and inconsistencies that are common in manufacturers' specifications. The procedures that are involved in deriving certain standardized report entries from the manufacturers' specifications are clearly explained in the corresponding Users' Guide entries.

Throughout AUERBACH Standard EDP Reports, every effort is made to adhere to a consistent set of technical terms, as defined in the Glossary. Therefore, some of the terms used in our reports on a given manufacturer's equipment may, of necessity, differ from the terms used in the manufacturer's own literature.

.5 DERIVATION AND RELIABILITY (Contd.)

Every report describing a specific manufacturer's equipment or services is sent to the manufacturer for review prior to publication. We invite the manufacturer's comments regarding the completeness and accuracy of the report. Where differences of opinion exist between a manufacturer and our staff, however, AUERBACH Standard EDP Reports always reflects the opinion of our staff.

Where insufficient specific data is available, estimates may be used. All estimates or approximations are clearly identified as such. Where specific data is unavailable and an estimate is considered impractical, a question mark (?) is inserted in the published report to indicate that the manufacturer was unable or unwilling to supply the requested data.

Comments and suggestions from our subscribers are always welcome because they help us to make AUERBACH Standard EDP Reports even more effective in meeting the needs of its users. We welcome notification of any errors or omissions, as well as suggestions for additions to the service or improvements in its clarity or balance. Extensions and improvements are frequently made to ensure proper coverage of new developments in the EDP field; but the general format, content, and style of the service will remain stable so that straightforward comparisons can be made between reports issued at different times.

.6 HOW TO USE THIS SERVICE EFFECTIVELY

The information in AUERBACH Standard EDP Reports can meet many different needs, and you will probably discover new applications nearly every time you use it. A thorough reading of the Users' Guide and the Computer System Reports on a few of the newer systems amounts to a concentrated course in data processing technology. The possibilities for casual yet rewarding "browsing" are virtually unlimited. Most of your EDP information needs, however, will probably fall within one of four general classes:

(1) Information about a specific device, program, or concept is needed. How can it be located quickly?

(2) The characteristics of hardware or software items of a particular type must be surveyed and compared. How can the necessary data be compiled?

(3) The throughput of an existing data processing system must be increased. How can this be accomplished most economically?

(4) A new computer system must be selected. How can the most suitable equipment be chosen and justified?

Recommended procedures — though by no means the only ones — for using AUERBACH Standard EDP Reports to help you solve each of these four types of problems are outlined in the following paragraphs.

.61 Locating Specific Information

To locate the information pertaining to any specific device or concept, the Index should always be your starting point. Arranged in straightforward alphabetical order, the Index will guide you quickly to the exact report, section, and paragraph that contains the information you need. The instructions on Page 2:100.001 explain how to use the Index effectively.

.62 Comparing Hardware or Software

The standardized format of AUERBACH Standard EDP Reports is especially valuable when the characteristics of hardware or software items of a particular type must be surveyed and compared. In fact, you are likely to find that the job has already been done for you. To survey the characteristics of Central Processors, for example, you need only turn to Section :051 of each Computer System Report. There, Paragraph .237 discusses each processor's indexing capabilities, Paragraph .42 lists its processing speeds for numerous standardized tasks, and so forth. (Much of the same information, in more abbreviated form, can be found in the Comparison Charts, which make comparisons of key characteristics even easier.)

A unique feature of AUERBACH Standard EDP Reports is that software comparisons can be made in the same straightforward, objective manner as hardware comparisons.

(Contd.)

.62 Comparing Hardware or Software (Contd.)

To survey the language facilities of the various COBOL or FORTRAN compilers, for example, simply turn to the Process Oriented Language sections (:161, :162, etc.) of each Computer System Report. There, each implementation of COBOL or FORTRAN is compared to a clearly-defined standard version of the language. In a similar manner, you can compare the capabilities and limitations of the highly-publicized new operating systems by referring to Section :191 of each Computer System Report.

.63 Improving an Existing System

When expanding workloads make it necessary to increase the throughput of your present data processing system, turn to the Computer System Report that describes it. Chances are that a careful reading of our objective analysis will disclose numerous ways in which you can increase, or more fully utilize, the processing power of your system.

Maybe the use of an integrated operating system (Section :191) can save several minutes of set-up time on every job. Maybe most of your main runs are tape-limited, so that the installation of faster magnetic tape units or another controller (Section :091) can double your throughput. Maybe your programmers and/or your equipment configuration are not taking full advantage of the system's capabilities for simultaneous operations (Section :111). Maybe an optical or magnetic character reader (Sections :101, :102, etc.) can remove your input bottlenecks. Maybe the addition of optional features to your central processor (Section :051) can significantly increase your processing speeds. Maybe a faster, cheaper random-access storage device (Sections :042, :043, etc.) is now available. Maybe there's a compiler, assembler, sort routine, or application package (Sections :151 thru :191) that can simultaneously cut your programming costs and improve performance.

These are just a few of the possible ways in which AUERBACH Standard EDP Reports can help you to get more out of your present system; the possibilities are really limited only by your own imagination. Furthermore, you'll want to read the Introductions and other descriptive portions of the Computer System Reports on all the new systems. They will help you to keep up with the advances in data processing technology, find out about new concepts and equipment that can be adapted for use with your present system, and decide when it's time to trade up to one of the newer computer systems.

.64 Selecting a Computer System

When the time comes to select and justify a new computer system, you can utilize the full power of the facts and evaluations in AUERBACH Standard EDP Reports. The Selection Procedure Report on Analysis Techniques (Tab 15) will guide you in analyzing your requirements. Next, you can use the Comparison Charts (Tab 11) to "weed out" the computer systems that are clearly too slow, too expensive, or otherwise unsuitable.

The characteristics and capabilities of the systems that survive this preliminary screening process can now be investigated in detail by turning to the appropriate Computer System Reports. In each report you will find: a descriptive Introduction (Section :011) that highlights the system's overall characteristics and limitations, several representative equipment configurations and their prices (Section :031), detailed reports on each item of hardware and software, a complete price list (Section :221), and a uniquely useful evaluation of the system's overall performance on a group of standard "benchmark" problems that you can readily relate to your own applications (Section :201).

The format and contents of these reports (and of the supporting Users' Guide) have been especially designed to provide the information you need to pinpoint each system's advantages and limitations, to make objective comparisons, to write realistic procurement specifications, to evaluate manufacturers' proposals, and to measure the system's effectiveness after installation. AUERBACH Standard EDP Reports frees you from the frustrating, time-consuming job of collecting, correlating, and analyzing manufacturers' specifications that otherwise complicates every computer selection task — and it provides authoritative documentary evidence to support your recommendations.

INDEX

STANDARD EDP REPORTS

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GENERAL INDEX

This Index, arranged in straightforward alphabetical order, is designed to lead you quickly to all the information in AUERBACH Standard EDP Reports about any specific device, program, or concept. It is the natural starting point for most references. All index entries are expressed in terms of Report (or Tab) numbers (the digits to the left of the colon), Section numbers (the three digits immediately to the right of the colon), and Paragraph numbers (the digits, if any, to the right of the decimal point); e.g.:

710:051.237
— Paragraph .237, "Address indexing."
— Section :051, "Central Processors."
— Report 710, "RCA Spectra 70" (behind Tab 710).

Where no Paragraph number is shown, the entire indicated Section is devoted to the subject device, program, or concept. Where no Report (or Tab) number is shown, the entry refers to a general concept which is described in the indicated Paragraph of the indicated series of Sections in each of the Computer System Reports in Binders 2 through 8, as well as in the Users' Guide. For example, the Index entry for "reserved storage, internal storage" is ":040.16". This means that: (1) a general discussion of the purposes and implications of reserved storage areas in internal storage devices will be found in Paragraph 4:040.16 of the Users' Guide; and (2) the reserved storage in specific internal storage devices is described in numerous correspondingly-numbered Paragraphs such as 420:041.16, 420:042.16, and 420:043.16 (for the IBM System/360), 340:041.16, 340:042.16, and 340:043.16 (for the GE 400 Series), etc.

For a more detailed explanation of the structure and numbering system of AUERBACH Standard EDP Reports, please turn to "What It Is — How to Use It," beginning on page 1:010.100.

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USERS' GUIDE

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DETAILED TABLE OF CONTENTS

USERS' GUIDE AND ALL COMPUTER SYSTEM REPORTS

Following is the complete plan of organization for the Users' Guide and each Computer System Report

DATA STRUCTURE

§ 020.

.1 STORAGE LOCATIONS

A list is given of the major sizes and types of location that are used for instructions and data in all parts of the computer system, internal and external storage, working and auxiliary storage. The list is arranged in order of increasing size within hierarchy.

.11 Name of location

The names used are, wherever possible, standard terminology for the types of location used; otherwise, the manufacturer's terminology is used.

.12 Size

The size of each location is specified in terms of its major parts so that the hierarchy of location structures is emphasized.

.13 Purpose or Use

Notes are made of any special use or purpose, of particular types of location, usually in terms of their intended contents, or the special unit with which they are associated.

.2 DATA FORMATS

This is a list of the different types of data and instructions that may be referenced as operands and held in the various types of locations. They are listed in order of increasing size.

.21 Type of Data

The types range from bits through numerals, letters, instructions and words, to blocks of data.

.22 Representation

The representation of each type of data is specified in terms of the location or locations it occupies in storage.

SYSTEM CONFIGURATION

§ 030.

.1 GENERAL

The capabilities and price of a computer system can vary considerably depending on the specific configuration of equipment. Throughout each computer system report, certain specific configurations are defined as standard and are used as bases for illustrating capabilities and prices. These configurations are typical points in the range of actual installations which might be ordered. Standard configurations are specified below. A standard configuration table is given for each group of machines - grouped by general capability and application-orientation.

The standard configurations have been chosen to give a good sample of the variations possible within a system. The configurations illustrate variations in capacity, speed, simultaneity of operations, logical functions, etc., which can be obtained by appropriate selections of units and optional features. These configurations are similar to ones that should be used in specific applications.

The configurations shown for a specific computer system are those which most nearly meet the specifications. They are shown by means of block diagrams, appropriately annotated.

The standard configurations are:

I Card Configuration

The specifications for the card configuration are typical of an average card installation. This may have more features than a card configuration quoted by a manufacturer, which is often chosen to minimize price. Configuration I, however, represents the equipment which a user is most likely to need when he has his installation in full operation.

II 4-Tape Business Configuration (Minimum Tape)

This is a minimum arrangement of equipment which permits reasonable use of magnetic tapes for files and input-output operations.

III 6-Tape Business Configuration (Average Tape)

This is a basic magnetic tape configuration useful for a wide range of data processing applications. It makes use of facilities that provide good performance, such as simultaneous operations and high-speed magnetic tapes.

IV 12-Tape Business Configuration (Expanded Tape, Small System)

This represents the largest reasonable configuration of a small to medium system that takes advantage of extra units and the optional features available to extend the system's performance.

V 6-Tape Auxiliary Storage Configuration

This is the same as III, with the addition of random access auxiliary storage. It represents a configuration oriented to batch processing problems as well as those requiring random access facilities.

§ 030.

VI 6-Tape Business/Scientific Configuration

This is the same as III, with the addition of internal storage and floating point arithmetic, to facilitate scientific and engineering computations.

VII 10-Tape General Configuration

This is a configuration in which the Central Processor and the input-output units have been logically separated so that both can be used intensively. This arrangement is available either by providing a separate computer or special purpose units to process the input-output transcription; or by providing a powerful controller which, by use of multi-running facilities, controls the transcription separately. These two arrangements of hardware are referred to as:

VII A Integrated Configuration

VII B Paired Configuration.

VIII 20-Tape General Configuration

This is a configuration for large volume intensive operation, and is otherwise similar to VII. It has two versions: VIII A and VIII B.

IX Desk Size Scientific Configuration

This is a minimum configuration for use by an operator at the console. It has provision for manual input and, at least, typed output of results. It includes facilities to punch and read programs.

X Punched Tape/Card Scientific Configuration

This is a small configuration with moderate input-output equipment included to provide an increased volume of throughput. In addition, it can perform floating point operations. It may also be used for limited business applications.

XI 4-Tape Scientific Configuration

This is the same as configuration X, but expanded to include magnetic tape and a line printer, in order to cover applications in which moderately large volumes of data and intermediate results are involved.

The configurations are standard throughout a report and are referred to by their numbers, I, II, etc.

Each standard configuration has been defined as representing a system capable of performing a typical type and level of application. The size of the working storage is chosen to hold a certain number of instructions plus a certain amount of data. For example, in Configuration III, the working storage is required to hold the equivalent of 2,000 one-address instructions (a reasonable program for an average tape system) and 8,000 characters of data (a generous amount for input and output areas as well as for working areas). The following assumptions are made: two-address instructions are approximately equivalent to 1.5 one-address instructions and three-address instructions to 2 one-address instructions. Where variable-sized instructions are allowed, the average number of addresses per instruction for the more common instructions is used.

The magnetic tape requirements for a configuration are stated as a number of possible simultaneous transfers, a number of magnetic tape units, and a peak input-output speed.

Peripheral input-output devices are specified by a peak operating speed.

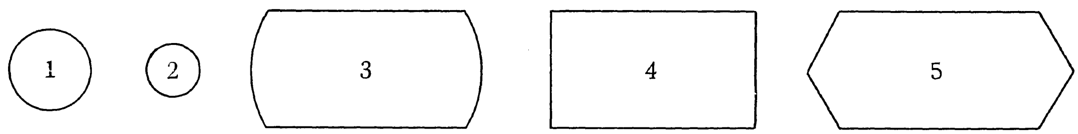
The inclusion of specific hardware options is standardized. The degree of simultaneous operations required is specified. For lower-speed systems, it is assumed that no off-

§ 030.

line equipment is used in any configuration. Wherever a system does not provide a unit which meets standard requirements, the unit or option with the closest specifications is selected.

.11 Configuration Diagram Symbols

Arrows on the diagrams indicate the possible direction of the data flow, which may be uni- or bi-directional. The conventional symbol shapes used in the diagrams are given below. Where two functions are performed by a single unit (cabinet) of equipment, the symbols are abutted.



1 is used for peripheral units which perform a storage function.
2 is used for peripheral units which perform an input-output function.
3 is a controller capable of dealing with one transfer at a time.
4 is a controller capable of dealing with several operations at a time, by multiplexing or multiway switching.
5 is a processor of data and/or instructions.

In general, the configuration diagram is arranged in the following conventional way:

- The central processor is on the left near the center of the diagram.
- Storage units are above the central processor.
- Input-output equipment is shown in a vertical list to the right, with controllers on the left.
- The sequence of peripheral devices is, in general, from top to bottom: consoles and inquiry stations; punched tape; punched card; printers; magnetic tape; others.

If necessary, these conventions are relaxed to make a presentation clearer.

.12 Annotations

At the top of each configuration diagram in a report, a list is given of any significant deviations from the standard configuration resulting from the non-availability of a unit or feature, or because certain features are not separable and must be included although not required by the standard. If a size or speed requirement cannot be met exactly, the unit with the closest specification is selected. These deviations may account for significant differences in rentals for some systems' configurations.

The monthly rental for the configuration, derived from standard price lists, is stated.

At the foot of the diagram is a list of those optional features that have been included in the system but which are not obvious in the diagram.

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STANDARD CONFIGURATIONS FOR SMALL BUSINESS-ORIENTED SYSTEMS

	I	II	III	IV	V	VI
	Card	4-Tape Business	6-Tape Business	12-Tape Business	6-Tape Auxiliary Storage	6-Tape Business/ Scientific
WORKING STORAGE						
One-address instructions (or equiv.)	1,000	1,000	2,000	4,000	2,000	8,000
Characters	4,000	4,000	8,000	16,000	8,000	32,000
AUXILIARY STORAGE						
Characters	0	0	0	0	20,000,000	0
MAGNETIC TAPE						
Simultaneous transfers while computing	-	0	1	2	1	1
Units	0	4	6	12	6	6
Nominal speed, char/sec.	-	15,000	30,000	60,000	30,000	30,000
PRINTER						
Lines per minute	1,000	500	500	1,000	500	500
CARD READER						
Cards per minute	1,000	500	500	1,000	500	500
CARD PUNCH						
Cards per minute	200	100	100	200	100	100
OTHER FEATURES						
Simultaneous transfers (not magnetic tape)	1	0	1	2	1	1
Floating Point	No	No	No	No	No	Yes
Index registers	1	No	3	10	3	3
Multiply-Divide	Yes	No	Yes	Yes	Yes	Yes
Console Typewriter Input	No	No	No	No	No	No
Console Typewriter Output	No	No	Yes	Yes	Yes	Yes

INTERNAL STORAGE

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.1 GENERAL

Internal Storage covers working storage and auxiliary storage and all locations which have a unique identity that can be used as an instruction's address. Working storage is all the storage that can be accessed directly for operands used in the arithmetic and logical operations of the central processor, and the storage that can be accessed directly for instructions. Auxiliary storage is all internal storage except for working storage and input-output buffers, which only serve as a link between working storage and input-output units. The internal storage of a computer may consist of several different stores. A store is one unit of a particular type of storage. The stores may also be arranged in a hierarchy of levels of increasing access time. Each store of a different type is described in a separate part of a computer report, but different sizes of one form of storage which may be separate stores are covered jointly in one part of a report.

In some special cases, a storage facility may be considered both an internal and an external store. Such units are covered in both sections of a computer report from the appropriate viewpoint of internal or external storage. The external storage is covered in the input-output section: for example, a system such as the magnetic card CRAM unit (made by NCR), considered as an internal store and described in this section, would also be considered as an input-output unit. Where a unit is described in more than one place, it is cross-referenced.

.11 Identity

The identity of the device may take several forms: its full name; its model number; an abbreviated name used throughout the report; and perhaps a nickname by which it is widely known. All of these are included in the contents for the individual system and in the general index. Where several versions of the unit have similar characteristics, they are jointly described in one part. The different versions are distinguished by their abbreviated names.

.12 Basic Use

The basic use of each store is normally stated as either working storage or auxiliary storage. Working storage is that which can be accessed directly by the central processor for instructions or operands used in arithmetic and logical operations. Auxiliary storage is all other internal storage, except for input-output buffers. In some cases, there may be special-purpose stores used to hold special working registers, fixed subroutines or arithmetic and control registers.

.13 Description

This paragraph states the general characteristics of all the versions available, notes the differences between them and any novel or outstanding features. It states whether the unit is an adaptation of a well-known unit or has other interesting antecedents. It also makes clear whether the unit is an auxiliary or working store or some combination of the two. When a unit is arranged in such a way that its different uses cannot be separated, they are covered jointly in one section of the report. If any optional features are available, their official names, abbreviations, and associated advantages are stated. The description states the basic speeds and any important drawbacks.

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.14 Availability

The first available date quoted is preferably a fully-operational date; otherwise, a date for first pilot operation or field tests is given. In the intervening period, both dates may be given.

.15 First Delivery

This is the date of first delivery to, and acceptance by, a customer.

.16 Reserved Storage

In many computer systems, particularly those in which the central processor has sophisticated facilities or in which special input-output controllers are provided, certain areas of internal storage are conventionally reserved for their use, although the storage areas can be addressed in the normal way by ordinary instructions. Different sets of reserved storage are listed, with the purposes for which they are used. The volume or number of locations reserved for each set is stated.

Where locks can be applied to prevent inadvertent or deliberate misuse of the areas by routines, the methods of providing the locks are also stated. The locks may be control bits or indicators set by supervisor routines or by facilities built into the hardware, or by switches on the console.

.2 PHYSICAL FORM

This paragraph states the type, size, structure, recording methods, packing densities, access techniques and potential performance of the store.

.21 Storage Medium

Internal storage media vary widely from computer to computer and even within a computer system. The more common media are magnetic cores, drums, discs, delay lines, magnetic cards, magnetic tapes and thin magnetic films.

.22 Physical Dimensions

The physical dimensions, such as diameter, thickness, length, or width of drums or tapes, and the number of items in a store are stated. The degree of details given depends upon the relative importance and interest of the various dimensions to an analyst. The exterior dimensions of the cabinets which house the stores are stated in Section 23.

.23 Storage Phenomenon

Storage phenomenon is the way in which the storage medium is used to hold data. The most common form is the direction of magnetization in either magnetic cores, discs, or drums.

.24 Recording Permanence

Different varieties of stores vary widely in the degree to which they are able to retain data once it has been recorded, even among stores which use the same storage medium and the same storage phenomenon.

.241 Data erasable by instructions

Erasable storage is that whose recording can be erased by instructions and replaced by other data; therefore, it is a suitable form of storage for a working store. If recordings cannot be erased by instructions, the storage, provided that it is not volatile, is a suitable form for a fixed store.

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.242 Data regenerated constantly

Many forms of storage are dynamic, and unless the data in them is constantly regenerated, as is necessary in a delay line, the recording will, more or less, rapidly deteriorate. Such a store is invariably volatile. This paragraph does not include the case of a core store which may need regeneration only when read.

.243 Data volatile

Volatile storage is that in which the recording is lost when its power supply is switched off or is otherwise disconnected. There are different degrees of volatile stores. In some, the recording is not lost if the power supply is switched off in the normal way, but may be lost if the supply is improperly disconnected.

.244 Data permanent

Permanent data is that held in storage which is fixed and unalterable by the computer system itself either by instructions or control operations of the central processor. The permanent data may be in a changeable store.

.245 Storage changeable

Changeable storage is that in which cartridges of the storage medium can be removed from the store while retaining the data recorded upon them, and can be replaced by others. It is used for both permanent stores and for stores such as magnetic cards or magnetic tapes, where a potentially large library of data can be held off-line.

.25 Data Volume Per Band

In many stores, particularly delay-lines, or other cyclic or serial stores such as strips of tape or decks of cards, the data is recorded in sets of tracks called bands. A band is a logical set of tracks recorded or read together. This paragraph states the data capacity of a band of tracks and the number of tracks in the band.

.26 Bands Per Physical Unit

Where bands of data are recorded in a store, the number of bands per module is stated.

.27 Interleaving Levels

Interleaving is the allocation of cells on a track to digits of words so that successive digits of a particular word are separated by a specific number of intermediate cells which may be allocated in a similar way to digits of other words. The number quoted here is the distance apart of corresponding digits or bits of one data item. In effect, the number of interleaving levels is equal to the number of scans of one band that would be necessary to access all the data in the tracks of that band.

.28 Access Techniques

The method of access to data in different stores varies considerably from the elementary cases of simple core stores to the very complex systems such as those of multiple disc stores in which numbers of arms are able to move independently of each other to different discs and to different bands. This paragraph describes the different methods of recording and reading by an access device and the stages by which it obtains access.

.281 Recording method

The methods of recording are stated; e.g. coincident current in core stores, or recording by a magnetic head, or punching with dies, or the various methods of imprinting stationery with characters from an engraved set.

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.282 Reading method

In many cases of internal storage, the method of reading is the simple inverse of the method of recording, particularly when using magnetic heads; otherwise, reading may be by photocell, by brush, or by sense wires in core stores.

.283 Type of access

The method of access to individual locations in the store is stated as a series of stages listed in the sequence in which they are carried out. Each stage of the most complex case is described: e.g., in a multiple-disc file, the series of stages might be:

Wait for access arm to become free.
Remove arm from current disc.
Move arm to required disc.
Move head to required band.
Wait for start of location.
Read or record.

In some instances, not all the steps are necessary. If an auxiliary store is used carefully, the total waiting time often can be reduced considerably by arranging that the data is recorded in a way that minimizes the number of head and arm movements.

If it is possible to begin to obtain access at intermediate stages, those possible starting stages are designated in the list. There are two kinds of starting stage: first, those in which the hardware itself may recognize the fact that preceding stages are unnecessary and by-pass them; and second, those for which instructions can be executed for separate sets of stages. In the latter case, a stage may be a mandatory starting stage.

.29 Potential Transfer Rates

By considering only such factors as the packing density and the relative speeds of the access devices and the storage medium, or the cycling rates of a store, a potential transfer rate is computed. This is a rate which may in many systems be attained only for short intervals. This is because of the form of storage in which waiting times and interleaved recording must be taken into account. The effective performance is summarized in paragraph 7.

.291 Peak bit rates

Where appropriate, the peak rates in bits per second are quoted. These figures are derived either from the cycling rates of disc, drums or delay lines or the relative speeds of the storage medium and its access devices and the packing densities, finally leading to a rate such as bits per second per track.

.292 Peak data rates

Although the peak speed may be stated using bits, a more useful rate is one in which the unit of data of the computer system is used. The size of the unit in bits is quoted, and the name of the unit of data. The data rate in units per second is stated. Any gain factor such as the number of tracks per band, and/or any loss factor such as interleaving, is taken into consideration. A compound data rate is sometimes quoted where the system can take advantage of simultaneous or overlapped transfers.

.3 DATA CAPACITY

The data capacities of each size or module of store available and the maximum capacity of the store in a computer system are stated. The minimum storage is quoted as zero only if the store is not an obligatory part of the computer system.

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.31 Module and System Sizes

For each size of store, from the minimum storage possible to the maximum storage possible, and all the intermediate module sizes, the following items are quoted: identity - that is, the name or model number of the individual module; the capacity in appropriate units such as instructions, characters, words; physical units such as drums, discs, cards or modules; and the capacity in cartridges where a cartridge is a unit of changeable storage which can be changed in one convenient bulk changing operation.

.32 Rules for Combining Modules

If several intermediate capacities of storage are possible, they are specified by stating the rules that govern the way individual modules may be combined to provide one store or storage facility.

.4 CONTROLLER

The controller of a storage device may be a part of the device or a part of the central processor; it may be a separate unit which must always be present; or it may be one of a variety of alternative units depending upon the extent of simultaneous operations required. In complex systems, there may be a hierarchy of controllers. Where the different controllers have an important effect upon the performance of a system, separate replies are made for the different varieties of the controlling system. The controller embraces all the facilities covering the flow of data to and from the internal store.

.41 Identity

The identities of the various controllers are cross-referenced and indexed. The cross-referencing is particularly important where a controller may be able to control a variety of different types of storage devices. The official name, model number and abbreviated name are given.

.42 Connection to System

.421 On-line

Normally, there are quite rigid restrictions upon the number of controllers that can be connected to a system in an on-line configuration. The System Configuration Section shows some of the more popular varieties, and rules are given here for the general restrictions.

.422 Off-line

Many systems provide for peripheral devices to be used off-line, but this is unusual for storage units. Where off-line operation is possible, the special equipment necessary is also listed.

.43 Connection to Device

.431 Devices per controller

The important criterion covering the connection of the individual stores to a controller is the maximum number of stores which the controller can have connected to it at one time. This may be as low as one, or as many as sixteen on some magnetic drum systems. On occasion, there are the special cases where several controllers may be connected to many peripheral devices, and there is no unique relationship between them. In other cases, a controller may be able to be connected to more devices than it can control simultaneously. Examples are given in the System Configuration Section.

.432 Restrictions

When a controller can handle different types of peripheral devices, there may be

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restrictions on the maximum number of each. This may depend upon the configuration. Over-all maxima are also stated where appropriate.

.44 Data Transfer Control

The most important questions, concerning data transfers carried out by the controller, are the sizes of the loads of data that can be transferred and the provision of synchronization that may be necessary, particularly if the storage device relies on program control of timing during transfers. Another important detail is the means of protection of the data transfer areas. When a data transfer involves a working store and an auxiliary store, the transfer is sometimes considered as an input or output to or from the working store.

.441 Size of load

A load is the volume of data that can be transferred by one instruction.

.442 Input-output area

As far as data transfer control is concerned, the Input-Output area is any location from or to which a data transfer is made between internal stores by an instruction. Although there may be one or more automatically controlled buffers used in a transfer, they are not specified here. An area may be a part of working storage or a special store provided for use in transfers.

.443 Input-output area access

The access to these areas may vary, from simple access to a special area addressed as a single location, to the completely general access when the area is a part of the working memory.

.444 Input-output area lockout

Any interlocks provided are specified. Because a program might inadvertently alter information in an output area before it had been copied, or might read information from an input area before it had been filled and use it inadvertently, any checks or interlocks that can be provided here are important. These may be of two kinds: an absolute lockout to all the information until the input or output operation is complete, or the rather more sophisticated gradual release of the lockout on parts of the information as it is read or recorded. One system might allow any reading from an output area, but writing only in locations which have been copied for output. If there are no interlocks, the programmer must normally use a "test busy" instruction, and program the interlock.

.445 Synchronization

Automatic provision of the synchronization implies that the programmer cannot make any timing errors in instructions concerning this storage device. If it is not automatic, considerable effort must be applied to provide it in each program.

.446 Synchronizing aids

If the synchronization is not completely automatic, it is important to show which facilities are available to the programmer to enable him to control the timing: either the primitive form in which he has to mark time on an instruction until a lock-out is released, the intermittent testing of a busy signal, or the sophisticated use of interruption when the busy condition disappears.

.447 Table control

Normal data transfer operations provide for dealing with input or output areas which are composed of a series of consecutive locations. Some sophisticated systems provide a

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table control for input or output in which various sub-areas may be scattered throughout internal storage. In such cases, the table may specify the first location of each sub-block together with its size, or each sub-block may contain a delimiter at its end. Data may be gathered from many places for output in one block or scattered to many places while input from one block.

.448 Testable conditions

In order for a supervisor routine to be able to make efficient use of the computer and implement an efficient operating system, it is a great convenience if the routine itself can test for many of the conditions that will affect future progress of jobs. These tests enable the supervisor to rearrange its schedule to more efficient form, to keep a log, or to inform the operator that his attention to certain devices is required. The conditions that are most frequently provided for testing are as follow:

Disabled - Meaning that it is not possible to access the device until it has been enabled by an operator.

Busy Device - Meaning that the device is still carrying out some operation requested earlier but is not disabled and will be available later.

Busy Controller - Meaning that even if the device is not busy, its controller or all possible controllers that may be used for the device are busy and therefore a wait is necessary until the device can be used.

Access Lock - Meaning that a lock is in force which prevents any access to the location.

Recording Lock - Meaning that a lock is in force which prevents any recording into the location and only reading is permitted.

Receipt Error - Meaning that a check such as parity has been applied to data received at the store and found to be incorrect. Sometimes a re-transmittal will take place.

Recovery Error - Meaning that a check such as parity has been applied to data recovered from the store and found to be incorrect.

Recording Error - Meaning that a recovery of data was made immediately after recording in order to insure that the recording was satisfactory and data was found to be incorrect.

Transfer Error - Meaning either a receipt or a recovery error.

.5 ACCESS TIMING

The performance of any internal store is largely dependent upon the arrangement of its access devices and their relationship to the locations. A second important factor, particularly in auxiliary stores with long waiting times, is the degree of simultaneous operation that is possible. Finally, there are the basic timing parameters and the possible variations of times for different types of access.

.51 Arrangement of Heads

The term "head" is used to refer to the most elementary unit of an access device. When dealing with magnetic recordings on discs or drums or tapes, a stack of heads is used to read or record the logical block of data from or into storage on a set of tracks called a band. When several stacks are physically associated so that they share in the effects of any physical change of registration between stacks and the storage medium, they are called a yoke of stacks.

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.511 Number of stacks

The number of stacks in a yoke module and system are described. The types of answer will vary from examples such as one stack per system, which is frequently the provision for core storage, to a large number of stacks per module such as a magnetic drum with a stack of heads for each band.

.512 Stack movement

If the stacks either as individuals or as yokes are able to move relative to the storage medium, apart from cyclic motions of medium, the type of movement is stated.

.513 Stacks that can access any particular location

In most stores with more than one access stack, it is conventionally arranged that any one location in the store may be accessed by only one stack. Sometimes several locations can be accessed by one common stack. In the cases where there is overlapping of the access areas of different stacks, the number of stacks that can access any particular location is stated.

.514 Accessible locations

The number of locations that can be accessed in different situations varies considerably for different types of store, particularly auxiliary stores. This paragraph states the number of locations that can be accessed, first by a single stack with no non-cyclic movement - for example, all the data recorded on one band of a drum; and second, by the number of locations that can be accessed by a single stack with all its possible movements taken into account - for example, all bands to which a stack can be moved. Finally, the number of locations that can be accessed by all stacks with no movement is quoted for some convenient unit such as a module or system.

.515 Relationship between stacks and locations

Where the various locations are assigned to different stacks, there is often a simple rule by which the relationship is established. The two most frequent cases are that either the most significant digits or the least significant digits of an address specify the access stack. In the first case, the store is logically divided into parts; in the second case, the store is divided in an interleaved way as far as the different stacks are concerned.

.52 Simultaneous Operations

Any simultaneous operations possible in an auxiliary store are described in a style similar to that of the Simultaneous Operations section. First, the various possible operations are grouped and the groups identified by the capital letters A, B, C, D, etc. Second, a list of rules is given in which are defined all the restrictions upon the number of simultaneous operations. The rules are given in algebraic form, usually as inequalities, and all the rules apply at any one time. (For greater detail, see 4:110.3) When using internal stores, the most frequently-provided simultaneous facilities are those of being able to move one or more stacks to be ready for reading or being able to record at the same time as another reading or recording operation is taking place.

.53 Access Time Parameters and Variations

.531 For uniform access

Where a store has a uniform access time, such as a core store, the basic times quoted are access and cycle times. Access time is defined as the period of time from the request by the control unit for an item of data in the store until the completion of the transfer of that item of data; that is, the sum of the waiting time and the transfer time. Cycle time is defined as the minimum period of time between successive accesses to

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any one location of the store. This is often greater than the access time. Also specified is size of the item of data accessed in one operation.

.532 Variation in access time

In complex stores, where the access times are variable, and in which the system of obtaining access is variable not only in times of the individual operations but in the necessity of certain of the different types of operations that are carried out, the times for access are described in a series of steps. These correspond to those specified in paragraph 040.283. A list of the stages in an access operation is given, and for each stage, the variation in time that the stage may take is quoted. As an example, typical times are also given. These are summed to give a total for a complete operation. This is not an average time; it is used only as an illustration. The variation in time may be quoted in one of several ways: first, a fixed time; second, a range of times; third, a pair of times. The first is a nominal or zero time when no movement or switching is required. A range of times may be dependent upon the particular operation, such as the length of movement of an arm, and in some cases may be specified as a formula. In particular, the times for the final operation - the data transfer - may be quoted in terms of the volume of the data transferred, where variable volumes of data can be specified in the instructions.

.6 CHANGEABLE STORAGE

Changeable storage is a store whose recording medium can be physically removed from the control of the computer system and replaced by other parts of the medium with different recordings upon them. It is essential that any storage parts change in this way are fully compatible with the various units on which parts are recorded and read and the different positions which the parts are allowed to occupy. As a special case, a fixed store which can only be read, and can be changed, is also a changeable store.

.61 Cartridges

A cartridge is the smallest changeable unit of storage medium.

.611 Cartridge capacity

The cartridge capacity is a number of locations or the volume of data which can be recorded upon it.

.612 Cartridges per module

The number of cartridges per module defines the size of the particular storage unit and the fraction that can be altered at any time.

.613 Interchangeable

The degree of interchangeability of the various cartridges in the various possible positions in units is specified.

.62 Loading Convenience

.621 Possible loading

There are two convenient facilities which may be available during loading of a cartridge. In the most inconvenient case, the whole computing system must be stopped while loading occurs. In an intermediate case, it may only be necessary to stop a particular storage system while loading takes place. In some cases, it may be possible to load without stopping either the computing system or the storage unit; but this is not common.

.622 Method of loading

The method by which loading is accomplished varies from the simplest procedures

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performed by an operator to those in which a maintenance engineer is necessary. In some cases, there may be special automatic means provided for loading, not necessarily under the control of the central processor.

.623 Approximate change time

The approximate time to unload a cartridge or many cartridges and replace them by others is quoted.

.624 Possible bulk loading

In the cases where a cartridge may be a small unit of storage containing relatively little data, it is sometimes important to be able to make changes of large numbers of cartridges in a time that is less than the product of the number of cartridges and the time to change one cartridge. Where such a bulk loading scheme is available, it is described here.

.7 AUXILIARY STORAGE PERFORMANCE

Some of the important properties of auxiliary stores and also incidentally of working stores in some applications, are the rates at which large blocks of data can be moved or copied from one set of locations to another either within the same store, or with other stores at different levels, or with input-output units or their buffers.

.71 Data Transfer

This is a list of all the potential transfers that might be possible in a system, and shows in each case whether the transfer is possible and how it is effected when it is possible. One end of the transfer is the store under consideration, the other end of the transfer may be the store itself or any peripheral unit or other store.

.72 Transfer Load Sizes

The possible sizes of loads of data that can be transferred in a single operation are stated for all the possible data transfers. A load may consist of one or many blocks or even individual characters of data. In general, the important transfers are those for large quantities of data. The sizes are quoted either as a fixed size or a range of sizes showing the appropriate units and the variations that are possible.

.73 Effective Transfer Rate

The effective transfer rate is stated for all the possible transfers. The rate is stated in some convenient unit such as characters per second, depending upon the particular form data is held in the stores under consideration. The time stated is the effective average transfer rate for the largest possible transfer that could be required, which is the maximum capacity of the lesser of the two stores; that is, the time for the entire contents of the lesser store to be copied into the larger, or for the entire contents of the lesser store to be filled from the larger. The total time for this operation is divided by the number of units of data transferred. The total time includes all allowances for program looping and necessary access and switching delays. It is not necessarily performed in a single operation.

.8 ERRORS, CHECKS AND ACTION

This shows all of the major types of error that may occur within the storage system, and the types of checks or interlocks that are provided to detect or protect against errors. In some cases, particular types of errors are not possible because of the mode of operation of the device. If, when the check fails, or an interlock is applied, some action is automatically taken, this is also noted. The most usual case of action for an interlock is that the operation waits until the interlock is removed.

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There are four steps concerned with checking of data in a store:

Receipt of data -- This data may arrive with check digits and may be checked upon receipt.

Recording of data -- Special check digits may be recorded with the data into the store, These may in fact be the check digits received with the data but may or may not be checked upon receipt.

Recovery of data -- A check may be performed provided check digits were recorded.

Dispatch of data -- Check digits may be transmitted with the data. These check digits may have been recorded with the data and passed on directly without having been checked at recovery.

The most common types of error are as follow:

Physical Record Missing -- This means that in a changeable store, a cartridge has not been inserted.

Invalid Address -- This means that an address has been used which is either out of range or uses improper digits.

Invalid Code -- This occurs when some particular pattern of an internal or external code is not acceptable to the controller.

Timing Conflicts -- These arise when the central processor attempts to start a new operation before the previous one has been completed. Where automatic interlocks are not available, it is necessary to program them using a busy signal or some means of timing.

Particular types of action are:

Stop -- This means that equipment is immediately stopped and cannot continue until some action is taken by another unit or by a human being.

Alarm -- This means that a light or other signal tells the operator that this check has failed.

Signal -- This means that some automatic action is taken by the equipment, such as re-reading a magnetic tape three times in the controller circuits themselves.

Indicator -- This is a condition that can be tested by instructions if they are so written.

Other possible forms of action are error-correction, using redundant codes, and special branching to specific locations, which is a form of interruption. When convenient, the method or form of the check for interlock is specified; otherwise, it may be recorded only as being present.

CENTRAL PROCESSOR

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.1 GENERAL

A central processor is a unit which selects, interprets and initiates the execution of instructions, and/or performs operations of computation and/or data manipulation. The most common operations performed by a central processor are: arithmetic operations; branching and testing operations; the control of input-output and auxiliary storage units; the editing of data; and any necessary code or radix conversion.

.11 Identity

The identity of a central processor may take several forms: its full name; model number; abbreviated name used throughout the report; or perhaps a nickname by which it is widely known. All of these are included in the index for the individual system and in the general index. Where several versions of the unit have similar characteristics, they are described jointly. Annotations describe the differences between the various versions, which are distinguished by their abbreviated names.

.12 Description

This states the general characteristics of all the versions available, notes the differences between them, and any novel or outstanding features. It describes any particular ways in which the instructions are formed and the operations carried out in the processor. Any special facilities, such as built-in operations or special bit character manipulations, are stated. The style and structure of the operands that can be manipulated are also described, particularly when variable length facilities are available. If multi-sequencing or multi-running is possible, a brief description is given of the way in which the facilities are intended to be used.

A brief summary is given of the performance times of the important characteristics of a processor, which are qualified in more detail in the body of the report. All the optional features are listed separately and the additional facilities which they provide are described together with the effects that the options have upon the performance of the processor.

.13 Availability

The first available date quoted is preferably a fully-operational date; otherwise, a date for first pilot operation or field test is given. In the intervening period, both dates may be given.

.2 PROCESSING FACILITIES

The operations available in a central processor fall into two classes - those designed for the processing of data and those designed for the control of equipment units or routines. In this paragraph, the data processing facilities are considered. The major features are the various types of operations available, and the varieties of operands which can be manipulated, the provisions for special cases of operands, the structure of the instructions, and any special storage that is used by the processor.

.21 Operations and Operands

This paragraph lists all the major types of operations that are commonly required and

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provided in central processors. For each operation, two statements are made: first, the provision in this particular processor; and second, the types of operand which can be used. The provision may be automatic, (i.e., built into the hardware) or provided by a standard subroutine. In general, any operation can be provided by a subroutine, but subroutines are quoted only where they are standard conventions; otherwise, the provision is stated as "none". The operands that can be manipulated are normally described by two important features - the arithmetic radix which is used, and the size of the operands. The size may be fixed or variable. When it is variable, the range is stated.

.211 Fixed point

These are the conventional arithmetical fixed-point operations of addition, subtraction, multiplication and division. Two types of multiplication are considered: short multiplication, in which a double length product is not developed; and long multiplication, in which a double-length product is developed. Any automatic rounding procedure that is incorporated in short multiplication is quoted. Long multiplication does not require rounding. Two types of division are considered: one with no remainder and the other with remainder. If the quotient is automatically rounded, this is stated. Division with remainder does not require rounding.

.212 Floating point

In addition to the four basic operations of addition, subtraction, multiplication and division, any other special operations provided in the processor hardware are listed. Any automatic rounding rules are also stated. The size quoted is for the two parts of a floating point number - the exponent and fixed point part.

.213 Boolean

Boolean operations are listed only if they are incorporated in the hardware and if they operate on an array of bits, usually a word of many bits. The size is quoted in bits and the radix is binary. If any two of the basic Boolean operations are provided, another Boolean operation can usually be obtained by a simple combination of them.

.214 Comparison

Comparison operations are performed upon pairs of operands and determine whether one number is, or is not, greater than, equal to, or less than another. Only automatic comparisons are listed. In addition to the comparison of ordinary signed numbers, it is sometimes possible to compare absolute values of numbers. Operations are also provided in most processors to compare items composed of letters, in which A is "less" than B, B is "less" than C, etc. When mixed items, composed of numbers and letters, are compared, the precedence of the various characters is important. This is called the collating sequence, which varies from one computer to another. The set of characters is listed in its collating sequence; for example, the letters A to Z and then the numerals 0 to 9; or, in contrast, the numerals 0 to 9, and then the letters A to Z. In addition, the special characters, such as &, *, and $, are also inserted in their appropriate positions in the sequence. The collating sequence mentioned here is one which is obtained when using the standard comparison operations. If other collating sequences are required, code conversions or subroutines may be required.

.215 Code translation

These are operations which take single characters or sets of characters expressed in one code and translate them into another code, either by means of a table provided in the hardware or by means of a table which can be set up and varied by individual programs. The provision is stated for each possible code translation: the names or descriptions of the codes from which, and into which, translation can be made; and the range of sizes of the operands that can be translated by a single operation.

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.216 Radix conversion

These operations are ones in which numbers expressed in radices, such as decimal or binary, can be converted from one radix to another. The headings used are: the provision; the radices from which conversion is made and into which conversion is made; and the sizes of the numbers that can be converted by a single operation.

.217 Edit format

These are operations which enable the processor to compose items in a form ready for printing. The various possible facilities are listed and the availability of each is stated. The comments note such conditions as whether the facilities are provided in single comprehensive operation or by separate operations to deal with the different set of facilities. Floating characters are those, such as a dollar sign, which are printed immediately to the left of the most significant digit of a value; i.e., they are not fixed in position but are "floated" to a position immediately left of the most significant printed digit. Protection characters are those, such as asterisks, which replace suppressed zeros in order to make unauthorized changes to a value difficult.

.218 Table look-up

Table look-up operations are those which scan the contents of a sequence of locations and compare each with key value in order to determine where in a table an item with the same key resides, where the first item with a greater or lesser key resides, or the location where the greatest or the least key in the table resides.

.219 Others

Any other important operations peculiar to a particular processor are listed here.

.22 Special Cases of Operands

.221 Negative numbers

There are two major forms in which negative numbers are held. In one case, each number is held with a value in absolute form together with a sign. In the other case, negative numbers are held as some form of complement of their positive counterpart. The form of negative numbers may be important when attempting to construct editing operations, logical operations, or subroutines for double-length working.

.222 Zero

The form in which a value of zero is held in some processors is not unique. Sometimes there are two distinguishable forms of zero - plus and minus. If this is the case, it is important to know if both zeros are treated as identically equal in arithmetic, in comparisons and in control operations, such as stepping indexes.

.223 Operand size determination

Where variable-sized operands are used, it is important to note the method by which the size of any operand is specified. The size may be specified by a counter in an instruction, or by delimiters in either the data itself or in the locations which hold the data.

.23 Instruction Formats

.231 Instruction structure

Instructions may be either fixed or variable in size. The fixed size or the range of variable sizes is stated.

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.232 Instruction layout

A diagram of each of the major instruction formats is given, together with a name for each. Each format is divided into its major parts and each part is labeled with a name and its size. The names are the conventional code names used by the manufacturer.

.233 Instruction Parts

The purpose of the parts of the various instruction formats is stated.

.234 Basic address structure

Instructions are normally classified into two different address types - either "N address" or "N + 1 address." "N" refers to the number of addresses which identify operands used in the instruction. The form "N + 1" is used if the location of the next instruction in normal sequence is specified in each instruction.

.235 Literals

Some instructions are able to specify, in their address parts, literals as operands instead of the locations of operands. This enables space to be saved that would otherwise be occupied by address constants. The various types of instructions that may have literals in their address parts are listed and the maximum size or number that can be specified is quoted, usually in decimal digits.

.236 Directly addressed operands

For each type of storage that can be directly addressed in an instruction, three figures are quoted: first, the minimum size of operand that may be addressed; second, the maximum size of operand that may be addressed; third, the total volume of storage that can be addressed directly. This does not include any modification of addresses by the use of indexes or the use of indirect addresses. Only instructions which refer to computing or comparison of numeric and alphabetic data are considered, not operations which are concerned with the transmitting of data between various levels of storage or peripheral units.

.2362 Increased address capacity

When address modification, either indexing or indirect addressing, increases the volumes of storage which can be accessed by an instruction, the increased volumes are listed against the various methods of increasing the capacity.

.237 Address indexing

Address indexing is a facility by which a value called an index, which is often held in a special register called an index register, is added to the address of an instruction after it is accessed by the control unit and before it is executed. By performing arithmetic upon indexes instead of upon the stored addresses of instructions, it is possible to simplify the organization of a program and often to use one index to apply to many addresses in many instructions.

.2371 Number of methods

Most computers supply only one, if any, method of indexing addresses; but additional methods are available in some computers to extend the range of indexing.

.2372 Names

The different modes of indexing are listed here and numbered I, II, etc. These are used for reference later.

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.2373 Indexing rule

The indexing rule is that which specifies how the executed address is formed from the presumptive address and its index, including the senses in which the signs of the various values are interpreted and the effects of any overflow in address registers.

.2374 Index specification

Where there is more than one index register, the method of specifying the index to be used is stated. In general, a particular index register is specified in an indexed instruction. Occasionally the register is specified in a special indexing instruction executed immediately before the indexed instruction; or it may be specified by the current status of indicators in the processor.

.2375 Number of potential indexes

The number of indexes from which an instruction can choose values for the modification of its addresses is stated. This may be less than the total number of index registers provided: e.g., when the index registers are grouped in such a way that any particular instruction may be indexed from only one group.

.2376 Addresses which can be indexed

When there is more than one address in an instruction, the rules for the indexing of the different addresses are stated here. The rules for indexing addresses may also vary among instructions which have different types of operation.

.2377 Cumulative indexing

It is possible on some processors to apply more than one index to an address. If this is possible, the method in which it can be done is stated together with the restrictions on the number of cumulative indexes.

.2378 Combined index and step

Some computers have special instructions which not only specify that an index value be used to modify their addresses, but also that the index value be stepped by its increment at the time that the instruction is executed.

.238 Indirect addressing

A direct address is one whose value is the location of the data being addressed. An indirect address is one whose value is a location that contains a further address specifying the location of the data being addressed. This is a recursive definition because the further address may be indirect. This is a useful facility in subroutines, particularly when nesting to more than one level by using overlays of relocatable routines.

.2381 Recursive

Indirect addressing is said to be recursive when the address in the location referenced by an indirect address may also be indirect and an address chain of indefinite length may be encountered before a direct address is discovered.

.2382 Designation

When indirect addresses are used, there must be a method of designating whether any address is direct or indirect. There are two possible methods - either a designation in an address itself, or in the address which references it.

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.2383 Control

When recursive direct addresses are used, there must be some particular means by which the end of the chain is known. This may be by a designation in the address itself or by a counter which specifies how many indirect addresses must be used before a direct address is obtained. In some systems, a counter is automatically pre-set at a value of one, in which case every indirect address leads immediately to a direct address.

.2384 Indexing with indirect addressing

In some computers, indexing and indirect addressing are mutually exclusive for any address or any instruction. When indexing and indirect addressing can be used together, the different cases and the sequence or precedence of evaluating indirect addresses or applying indexes are specified.

.239 Stepping

Stepping is a facility of changing an index value in specified steps by the value of an item called an increment. Stepping is often associated with a particular end value. Whenever an index is examined to determine whether it has attained or passed an end value, it is called a test. Tests are used to control the execution of a loop of instructions.

.2391 Specification of increments

The increment may be specified in individual stepping instructions or held in a separate part of the index register.

.2392 Increment sign

Some systems allow an increment to have its own sign. Others require it to have a fixed sign; for example, when the value of the increment is implied in a stepping instruction.

.2393 Size of increment

If the increment is held in a special register or stepping instruction, the range of values of the increment is limited by the size of the register or the part of the instruction set aside for it. Sometimes the increment is implied in an instruction and in these cases, its value is normally limited to one fixed value.

.2394 End value

The end value which is used in the test of an index may be implied as zero, held in the index register, or specified in the test instruction.

.2395 Combined step and test

Many computers provide a special instruction which combines the operations of stepping an index and testing for the attainment of the end value.

.24 <u>Special Processor Storage</u>

All the special registers are covered which concern the programmer; i.e., those that are addressable and are mentioned in the instruction lists, whether addressable explicity or implicitly. For each category of storage, the number of special locations, their size in bits, decimal digits or characters are quoted, and the special use that is made of them by the processor. The physical details of the locations in each category of storage, including the access and/or cycle times in microseconds, are also given.

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.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

There are two basic methods of controlling the sequencing of instructions. The most frequently-used is that of a sequence counter or sets of sequence counters. The other, frequently employed with drum or disc working stores, uses an N + 1 type of instruction in which the extra address specifies the location of the next instruction in normal sequence. In the latter case, control is provided entirely within the individual instructions.

.311 Number of sequence control facilities

In most computers, there is only one sequence control counter; but there are two important kinds of variation in computers with micro-coded or built-in micro-coded operations. There may be a hierarchy of counters: one to count through the instructions in a routine; a second, perhaps, to count through special micro-routines; and a third, perhaps, to step through micro-operations. Alternatively, there may be a set of counters for different programs or routines that may be running at one time, as in multi-running.

.312 Arrangement

Where there is more than one sequence counter, the arrangements may be either for a hierarchy or separate ones for routines which are being run together, or separate ones for different sub-processors.

.313 Precedence rule

Where the counters are not arranged in a hierarchy, there may be precedence rules which control the choice of instructions to be executed, either in favor of one counter rather than another, or taking them in turn.

.314 Special sub-sequence counters

These are counters which are subordinate to a main sequence counter. The number provided and their purposes are stated.

.315 Sequence control - step size

The sequence control usually steps in units of an instruction, but the access to storage for the instructions may be in words which obtain two instructions, or may only be in syllables where variable-length instructions are used so that several accesses may be necessary for individual instructions.

.316 Accessibility to routines

It is often useful in routines to be able to utilize the contents of the sequence counter to form index values or otherwise modify the addresses of instructions in order to permit convenient arrangement of relocatable codes.

.317 Permanent or optional modifiers

In some computers, all instructions are automatically made relocatable because each address is automatically indexed by the contents of the sequence counter; in other computers, this facility is optional.

.32 Look-Ahead

A look-ahead facility is one in which a special separate part of the sequence control makes speculative advance access to storage for instructions and data in order to overlap access operations with computing. Such a facility maintains a queue of instructions

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and data and allows access and operation times to be more smoothly overlapped, particularly in the cases where computing operations vary widely from short additions to long multiplications and access may vary due to the use of interleaved core storage. Sometimes such speculative advance accesses are wasted because the jumps in a program cannot be accurately foretold by such a unit and because the storing of intermediate results can sometimes prove awkward.

.321 Length of queue

The length of the queue is specified in terms of the number of operands or instructions - or both - that can be held.

.33 Interruption

Interruption is a facility built into a computer whereby certain prescribed events can cause the normal sequence of execution of instructions of a routine to be arbitrarily interrupted when these events occur. When an interruption occurs, it is usual for the sequence to be jumped to a predetermined position, where a master routine notes the point of interruption, carries out any procedure required by the cause of the interruption, and then resumes the running of a routine. When the resumption of running may be of a routine different from that which was interrupted, multi-running is taking place.

.331 Possible causes

The events that can cause interruption in different computers vary widely, and the particular range of causes controls the ease or scope of the control that can be applied by supervisor routines. The possible causes are grouped according to the different classes of units that exist in computer configurations.

.3311 In-out units

Interruptions may be caused by the fact that a unit has become free to carry out new operations, because an error has occurred, or because special conditions, such as an end-of-tape mark, have been set.

.3312 In-out controllers

Interruption may occur because a controller has become free to carry out operations or because of errors in the controller. These are normally alternative causes to those for in-out units.

.3313 Storage access

Interruptions caused by storage units other than those due to errors and lock-out violations are usually confined to auxiliary storage units, where the completion of data transfers and seeking operations may cause interruptions.

.3314 Processor errors

Interruptions may be caused in the processor by the overflow or underflow of arithmetic operations, the encountering of illegal operations or invalid addresses and other abnormal conditions. In particular, there may be different classes of interruptions and interruption control status so that a higher-level interruption may interrupt a lower-level interruption status.

.332 Program control

Instructions are often provided that enable individual programs to have some control over the potential causes of interruption; that is, the instruction can enable or disable certain causes of interruption.

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.3321 Individual control

Program enabling or disabling by instructions may be either of individual specified units or controllers, groups of causes, or the entire set of causes.

.3322 Method

The method of program control may be the setting of special indicator bits in control registers, the use of input-output instructions which specify that the completion of the operation will or will not cause interruption, or the setting of special indicator bits in individual controllers for input-output units.

.3323 Restriction

Although instructions may be provided to control the enabling or disabling of interruption, there may be restrictions upon their use. In many regimes, it is possible only for a supervisor routine which is acting in an interrupt mode to enable or disable interruption, and ordinary interruptible routines have no control.

.333 Operator control

In many systems, there are switches or console controls by which the operator can enable or disable individual causes or groups of causes of interruption.

.334 Interruption conditions

Even when an interruption cause exists and is not disabled, there are other central control conditions that must occur before interruption is permitted. Sometimes only certain types of instructions may be interrupted, and frequently there is an interruption mode in which the supervisor routine operates to prevent further interruptions. There may, also, be a hierarchy of modes. Another control technique is that of setting a mask register of bits which is compared with interruption conditions by Boolean operations before interruption.

.335 Interruption process

The sequence of steps carried out either automatically or by a standard supervisor routine when interruption occurs usually covers three particular features. First, there is normally the disabling of further interruptions and the entering of an interruption mode operation. Second, there is the saving of certain registers - in particular, the contents of accumulators and sequence control. In many specially-constructed systems, however, there may be separate sets of registers for different programs, so that saving does not involve any time. Third, there is the choice of destination of the jump when interruption occurs, which may be either to a fixed location or to a variable location depending upon the cause of interruption. If the jump is to a fixed location, the supervisor routine must first conduct an examination to discover the cause of interruption.

.336 Control methods

Within the supervisor routine which is executed in the interrupt mode, there are two fundamental tasks which must be carried out. It is necessary to know what methods the supervisor has at its disposal (1) to enable it to determine what has caused the interruption so that it may take the appropriate action, and (2) to re-enable interruption when a return is made to an ordinary interruptible routine.

.34 <u>Multi-Running</u>

Multi-running is the process of intermingling instructions or sets of instructions from several different routines which have no precedence interlocks between the sets; i.e., they are independent routines in which the stopping of the execution of any one routine

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does not lock progress of any other routine. Multi-running is usually effected by the use of interruption facilities or multiple-sequence counters.

.341 Method of control

The method of control of multi-running in the simplest case would be a set of separate independent sequence counters, each of which is advanced in turn according to some precedence rules. Alternatively, there may be a supervisor routine which uses the facilities of interruption to control the various operations without excessive scattering of test busy instructions throughout individual routines.

.342 Maximum number of programs

The maximum number of programs may be theoretically unlimited, though in practice there is usually a reasonable limit to the number of independent programs that may be run. If there is a strict limit to the number of counters or sequence controls that can be maintained at a time, this limit has subtracted from it the number required by the supervisor and is the number available for independent productive programs.

.343 Precedence rules

The precedence of different routines being run together may be decided by a priority list, by their taking turns in a strict sequence, by their taking turns until each routine is temporarily interlocked, or by some individual coding provided by individual users.

.344 Program protection

When independent routines are being run within a computer, it is essential in the general case to have protection of one program against corruption by another. There are two important areas to be considered: first, the corruption of data or instructions held in storage; and second, the illegal use of input-output files on input-output units assigned to different routines. In addition, it may be that the number of separate sets of protectible locations or units is less than the number of routines that could theoretically run together in a system. This depends upon the mode of protection provided. There are three common ways of providing protection. First, there is a simple marking system in which locations or set of locations are marked as being either those of the routine currently being processed or not part of that routine. When routines are changed, the marks must be changed throughout the storage. Second, there is a system in which each location or set of locations is marked with a tag which is compared with a tag held in the control unit for the particular routine. The number of values that the tag can take may restrict the number of possible sets of program protection. The third method involves holding a pair of addresses in control registers which are the delimiters of the storage area assigned to the routine currently being processed. In this case, the transfer from one routine to another is necessary only to alter the pair of control registers.

.35 Multi-Sequencing

Multi-sequencing occurs when it is possible to intermingle individual instructions or sets of instructions from different sequences of the same routine at one time, or operate simultaneously separate sequences of a routine. The most common use of multi-sequencing is the separate control of input of data, computing on the data, and output of results by separate processors.

.4 PROCESSOR SPEEDS

The performance of each central processor is given by two sets of figures. In the first set, times are given in microseconds for a representative sample of instructions, and in the second set, times are given in microseconds for sets of instructions which perform standard tasks. The first set of times is dependent upon the construction of the processor and, in general, a single address computer will perform addition faster than a three-address instruction, but may not necessarily be faster in executing a task. The

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second set of figures for different computers is more strictly comparable among computers; that is, the tasks are largely independent of computer design style. In cases where the time to perform a task is dependent upon the sizes of the operands or the number of operands to be processed, the time is quoted as an algebraic expression in which:

D equals the approximate number of decimal digits in each operand.

C equals the approximate number of characters in each operand.

N equals the number of operands manipulated during the task; e.g., during a table look-up operation.

The times quoted for all instructions and tasks include reasonable allowances for access times for both instructions and operands.

In general, it is assumed that all operands except intermediate results in the standard tasks are held in the working store. Where there is more than one set of working stores with different access times due to alternative working stores or because of different configurations in which different degrees of interleaving are available, separate times are stated. It is assumed, also, that instructions are held in sequential locations except in "n + 1" address systems and that operands are randomly placed with respect to instructions. In computers which use an n + 1 addressing system, it is assumed that only instructions can be optimally placed, but not those instructions that follow instructions which have any modified address.

.41 Instruction Times

The times quoted in .411 and .412 are for straightforward instructions which have no allowance for address modification or re-complementing.

.411 Fixed point

The time given for "addition-subtraction" is the average of a simple addition and a simple subtraction, using as many operands as possible in working storage. For processors with a variable instruction time, the time for multiplication may be dependent upon the sizes of both multiplier and multiplicand or only the multiplier. When a first-degree expression is stated, the number of digits is assumed to be that of the multiplier. Where a second-degree expression is stated, it is assumed that the sizes of the multiplier and multiplicand are equal. For division, either a first-order or second-order expression may be used. When a first-order expression is used, it is assumed that the number of digits developed in the quotient is the independent variable. Where a second-order expression is used, it is assumed that the sizes of the dividend, divisor and quotient are all equal. It is assumed that no shifting or scaling is necessary in these operations.

.412 Floating point

The times for floating point instructions are not normally variable because the operands are fixed usually in size and format. Where more than one size is available, separate times are stated.

.413 Additional allowance for indexing

The additional allowance for indexing on multi-address instructions may be an expression using a variable A, which is the number of indexed addresses in an instruction.

An additional allowance for indirect addressing is quoted per indirect address reference so that when recursive indirect addressing is used, a multiple allowance must be taken into account.

In some computers which hold negative numbers in a "sign and absolute" form, extra time during computation is sometimes required to correct the absolute value part of the number when it alters from a positive to a negative value. This process is called

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re-complementing, because it complements an unwanted complement into an absolute value. If extra time is needed for re-complementing, the time is stated.

.414 Control

When variable length operands are used, it is assumed that operands of equal size are compared. Either separate times are quoted for first, a compare instruction, and second, a branch instruction based upon indicator bits set by the comparison, or else a time for a joint instruction, compare and branch. It is assumed that no shifting or scaling is necessary in these operations.

.415 Counter control

The counters are index registers, tally registers or other counters used for controlling loops. A step instruction increments a counter by one unit or the value of the increment. A test instruction is one that jumps if a counter has not attained an end condition. A step and test instruction is a joint instruction which steps the counter and tests for the attainment of the end condition.

.416 Edit

The particular form of instruction provided for editing in individual processors varies widely. Paragraph .217 states the facilities covered by this instruction. The time quoted is normally dependent upon the number of characters manipulated. Where the operands are of a fixed size, the time is still specified in terms of characters, so that comparisons with other systems are made easily.

.417 Convert

Instructions to convert numbers from binary to decimal radices, from decimal to binary radices, or similar operations, are usually dependent upon the sizes of the operands. The size of the decimal operand in digits or characters is normally used as the independent variable.

.418 Shift

The independent variable used in time stated for shift instructions is a number of steps. Variables B, D and C are used to indicate steps of binary digit, decimal digit, or character positions. In many processors, there are special fast-shifting operations for long shifts. The times quoted apply to shifts of only a few steps.

.42 Processor Performance

The times quoted in this paragraph are intended to be directly comparable between one processor and another. They are largely independent of the style of instruction format and repertoire of a computer but not of its scope. The most elementary tasks frequently required in all types of routines are used as standard tasks for timing. Other times can be formed from them by using selected weightings appropriate to particular applications. Unless otherwise stated, floating point times are for operations using a precision of eight decimal places.

.421 For random addresses

These are individual small tasks that occur repeatedly during the execution of a routine. The first two cases do not require any special explanation. The third case is a situation in which a string of items is to be totaled. The total is formed in-line, not in a loop. The time stated is the increment for each extra item which has to be totaled.

These three different cases give an over-all measure of the performance of addition in a processor. In the first case, other things being equal, a three-address instruction format would show to advantage, whereas in the second case, a two-address instruction format would show to advantage. In the third case, a single-address instruction format

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using an accumulator would show to advantage. In cumulative multiplication, it is assumed that several pairs of numbers are multiplied and the sum of the products is obtained. The time stated is the increment necessary to deal with another product and to add to the total.

In all these cases, it is assumed that no operands are destroyed except in the second addition task.

.422 For arrays of data

These are tasks similar to those in .421 except that they are performed in a loop, and each task is carried out once per repetition of the loop. The times that are quoted are for one repetition of the loop, assuming that it is carried out in the most efficient manner. In all the cases, it is assumed that, for each repetition of the loop, "a" and "c" may be stepped by a unit of the address of their locations, but that "b" must be stepped by some aribitary value such as 7 or 13.

.423 Branch based on comparison

It is assumed that an ordered table of data is held in consecutive locations of a working store. Each location contains a key and the keys are arranged in an ascending collating sequence. The task is to find the first point in the table at which a key equals or exceeds a stated value. A search is made for this point using a dichotomous chopping technique. The time stated is the time per chop. Chart 1 shows the basic loop. Two times are stated - one for numeric keys and one for alphabetic keys. In order to make the times realistic measures of branching, each increment that is added to or subtracted from the current address is obtained from a table of increments to reduce any bias in favor of a binary computer.

CHART 1

Assume that an ordered table of keys stored in locations starts at location A. Assume that there is a table of increments stored in locations starting at location N. The coding in the boxes in the loop may be altered in sequence to reduce times, but all of the functions mentioned in the loop must be carried out.

Box 1: Set initial address equal A plus first increment.

Box 2: Compare table key against stated value.

Box 3: If less, decrease address by next increment; if greater, decrease address by next increment; if equal, exit.

Box 4: Test end of table of increments; if not, go back to Box 2.

.424 Switching

.4241 It is assumed that an item of data is numeric in form and its value is used to select a jump from a table of jumps and execute it. The possible values are the integers 1 through 6. This data switch is usually performed by placing a switch at a location X in a routine and following it, in locations X + 1, X + 2, x + 3, X + 4, etc., by unconditional jumps which are to be executed if the value of the data item equals 1, 2, 3, 4, etc. The value of the data item is used to form the address of the switch to jump to the appropriate unconditional jump.

.4242 This is the same task as .4241 except that two checks are made to insure that the value of the data item is within range; i.e., that the value is not less than 1 and not greater than 6.

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.4243 In this task, the data item may only assume one of a set of arbitrary values such as 3, 42, and 87. The value of the data item is compared with each of the possible values in turn until a match is found; then a jump to the appropriate routine is executed. The time for this form of switching depends upon the number of comparisons that must be made before a match is discovered. The time is given in the form "a bN" where "N" is the number of comparisons made.

.425 Format control per character

Two tasks are timed - one of unpacking input data and the other of composing output data. In unpacking, it is assumed that a card of 80 characters has to be unpacked and stored as nine separate numbers. In the second task, it is assumed that a line of 120 characters is composed. The times are then divided by 80 and 120, respectively. The line of print for this task is the one that is used in standard problem A of the System Performance Section.

.426 Table look-up for comparison

Three different tasks are considered. We assume that a table of data similar to that used in .423 is held in the store, and only in the third of these tasks is it necessarily ordered. In these particular tasks, the table is scanned in sequence from one end to the other, and many computers have special table look-up operations to enhance their performance. In the first task, comparisons of each key are made with the stated value until any match is found. In the second task, a search is made through the entire table and a note made of the address of the least or greatest key in the table. In this task, the time stated is the average of the two cases in which a change is, and is not, made to the current minimum or maximum. In the third task, a search is made through the table until the first key that exceeds the stated value is formed.

The times stated are the increments required for each extra key that is examined.

.427 Bit indicators

In a computer which has special facilities for dealing with arrays of bits in patterns, times are stated for operations on patterns, but where these facilities are not available, times are quoted for operations on single bits in separate locations. In this latter case, of course, one word, or one character, is used to hold one bit of data in the most convenient way, perhaps by the values zero and non-zero.

.4271 Set bit in separate location

This is normally a simple move or store operation to put a value one or zero into a location.

.4272 Set bit in pattern

Where tests or different values of a bit may be different, an average is taken.

.5 ERRORS, CHECKS AND ACTION

A list is given of all of the major types of error that may occur within the central processor and the types of checks or interlocks that are provided to detect or protect against the errors. In some cases, particular types of errors are not possible because of the mode of operation or control of the central processor. If, when a check fails or an interlock is applied, some action is automatically taken, this is also stated. The most usual case for action for an interlock is that the operation waits until the interlock is removed. The most common types of errors are as follow:

Overflow - Meaning that the size of an operand generated as a result of an operation exceeds the capacity of the location or register intended to receive it.

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Underflow - This is an error which occurs only with floating point operations in which the number generated as the result of a multiplication or a normalized addition or subtraction has an exponent algebraically smaller than the smallest allowed by the conventions.

Zero Divisor - Meaning that a division has been attempted in which the divisor is zero and therefore the division is not meaningful.

Invalid Data - Meaning that some particular pattern of a character or digit or type of data has been encountered, but is not permitted in the operation that is being attempted.

Invalid Operation - Meaning that an operation code has been encountered in an instruction which does not exist in the repertoire.

Arithmetic Error - Meaning that a check of the arithmetic shows that an error has occurred. The verification may consist of duplicate operation of the arithmetic or some form of redundancy check such as casting out nines.

Invalid Address - Meaning that a request for access has occurred to an address which cannot exist or does not exist in the system.

Receipt of Data - Meaning that an operand or instruction has been received in the central processor from storage but that the check supplied to insure correct transmittal of data has failed; for example, a parity check.

Particular types of action are:

Stop - Meaning that the processor is immediately stopped and cannot continue until some action is taken by another unit or an operator.

Alarm - Meaning that a lamp or other signal indicates to the operator that this check has failed.

Signal - Meaning that some automatic action is taken by the equipment, such as re-computing a number or making a re-transmittal of data.

Indicator - Meaning that this is a condition that can be tested by instructions if they are so written in a routine.

Other possible forms of action are error correction using redundant codes or special branching to specific locations.

CONSOLE

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.1 GENERAL

The console is that part or those parts of a computer configuration provided for the use of the operator. The console provides a display of the current status of the computer and its contents, a means of starting, stopping and otherwise controlling its operation manually, and channels of communication between the operator and executive routines or operational routines.

.11 Identity

The identity of the various consoles may take several forms: full name, model number, and an abbreviated name used throughout the report. All of these are included in the contents of the individual system.

.12 Associated Units

The console cabinet or pedestal may contain several other related units which have separate identities, such as input-output typewriters and special display units. These are listed in two sections: those that are attached permanently to the console, and those which are optional.

.13 Description

This paragraph states the general characteristics of the console and notes any novel or outstanding features. If any optional features are available, it describes their advantages.

.2 CONTROLS

A list is given of the important controls provided upon the console and for each control is stated first, how it is provided, and second, its effect. The provision of the control may be simple on-off buttons, rotary switches, keys, multi-way switches or even calibrated dials. The controls are classified under the following headings:

.21 Power - both for individual units and the system as a whole, including an "emergency off" control.

.22 Connections - any switches or other controls which enable the operator to set up connections between peripheral units and controllers, the identities of peripheral units, or the on-off line switching of peripheral units.

.23 Stops and Restarts - controls which enable the operator to halt or continue the operation of the central processor and peripheral units.

.24 Stepping - facilities by which the individual sequencing and stepping from instruction to instruction or through other elementary operations is under manual control rather than automatic control.

.25 Resets - controls which enable the operator to remove conditions which have been set up by errors and faults and which have usually interlocked the machine against further operation. One particular type of reset is that of clearing the store before loading new programs.

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.26 Loading - any special facilities which are used for the loading of new routines - sometimes just a single button; sometimes a series of actions which have to be performed.

.27 Special - this includes miscellaneous features such as special switches to make one machine compatible with another, to remove interruptions, or to ignore special checks such as overflow.

.3 DISPLAY

Display covers all those facilities by which data held within the internal store of the computer can be shown to the operator either in a transient form on cathode ray tubes or neon lamp and digital displays or in a permanent form as printout on typewriters. For each type of display are stated its name, its physical form, whether it is a static or dynamic display, and whether it is permanent or transient.

.31 Alarms

These are usually displays by single lamps which light up when particular faults occur. It is important that these be clearly visible or audible at a distance from the console.

.32 Conditions

These displays show under which conditions the computer is operating, such as whether or not interruptions are being permitted, or whether or not overflow is being permitted. These are often color-coded.

.33 Control Registers

These are usually transient displays of the bit patterns in the accumulators and the sequence control and sometimes other central processor registers.

.34 Storage

The display of storage is useful in fault tracing and sometimes as a regular means of display under program control. The important factors are the quantity that can be displayed at one time and whether the display can be static although the computer is running.

.4 ENTRY OF DATA

Many consoles provide means by which manual insertion of data into the computer is possible. For each of the various types of data that can be entered, the following items are stated: first, the method by which data can be entered, such as switches for individual bits or a telephone dial; and second, the volume of data that can be inserted at one time. Two particular types of entry are distinguished.

.41 Into Control Registers

.42 Into Storage

.5 CONVENIENCES

This paragraph lists the important facors which determine the general convenience of use of a particular console.

.51 Communication

If any special means of communication with the data preparation room or the library or another remote place is provided by means of a special telephone or hand set, this is stated.

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.52 Clock

A logging of the progress of computer runs is a fundamental part of good control and some consoles provide a clock for convenient reference by the operator. The clock may be dependent upon the computer power supplies.

.53 Desk Space

The amount of space available to the operator is stated in terms of the length and depth of the desk, and its height above the ground.

.54 View

The view of the operator from the control desk should not be unduly impeded. He should be able to see all the peripheral units that may be arranged in the configuration. The view may be described from the consideration of an operator standing or sitting.

.6 INPUT-OUT UNIT

Where a computer console contains an input-output unit, usually for communication with executive routines or working programs, it is described.

.61 Identity

The identity of the various units may take several forms: full name, model number, and an abbreviated name used throughout the report. All of these are included in the contents of the individual system.

.62 Description

This paragraph states the general characteristics of the unit and notes any novel or outstanding features. If any optional features are available, it describes their advantages.

.63 Performance

These are the speeds at which the device can operate, though the actual operation of input is usually limited by the operator's ability unless he is using such devices as prepunched tapes or cards.

INPUT-OUTPUT

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.1 GENERAL

Input-output embraces all the principal methods for transferring data between internal and external storage within any computer system; i.e., those methods where the transfer is essentially sequential as far as the external storage is concerned. For example, a system such as the magnetic card CRAM unit (made by National Cash Register Company) would be considered as an input-output unit and described in this section. Such a system is also covered as a random access internal storage unit. Where external storage is used primarily as changeable internal storage, it is not reported from an input-output viewpoint unless rapid bulk loading is practicable. When a unit is described in more than one place, it is cross-referenced.

.11 Identity

The identity of a device may take several forms: its full name, its model number, an abbreviated name used throughout the report, and perhaps a nickname by which it is widely known. All of these are included in the index for the individual system and in the general index. Where several versions of the unit have similar characteristics, they are described in a common set of statements. Annotations, which describe differences between them, are distinguished by the abbreviated name.

.12 Description

This paragraph states the general characteristics of all the versions available, notes the differences between them, and notes any novel or outstanding features. It states whether the unit is an adaptation of a well-known unit or has other interesting antecedents. It also makes clear whether the unit is an input or output unit or some combination of the two. When a unit works in such a way that input and output cannot be separated, they are covered jointly in one section of the report. If any optional features are available, their official names, abbreviations, and associated advantages are stated. The brief description states the basic speeds and any important drawbacks.

.13 Availability

The first available date quoted is preferably a fully operational date; otherwise, a date for first pilot operation or field tests is given. In the intervening period, both dates may be given.

.14 First Delivery

This is the date of first delivery to and acceptance by a customer.

.2 PHYSICAL FORM

The physical form section identifies the form of the drive mechanisms that control the movement of the external storage medium; the system used for recording on the external storage medium and for sensing the data pattern held there; the read or write heads; the physical arrangement of these heads; and the provisions for making multiple copies.

.21 Drive Mechanism

This section describes the mechanics provided to transport the external storage medium

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through the unit. In input-output devices with reservoirs, there may be three drive mechanisms. For example, in magnetic tape units there are often separate motors for the feed and take-up spools and a third drive for taking the storage medium past the heads. Often all three are integrated into one system, as in a card reader.

.211 Drive past the head

The most complex cases of drives past the head occur in printers where intermittent motion is required. Several alternative systems are used, ranging from simple friction drives used on low speed devices to duplicate push and pull traction used for accurate registration at high printing speeds. On other units, pinch or clutch operated rollers are widely used. The recently-developed pneumatic capstan drives are used on some magnetic tape units.

.212 Reservoirs

The most difficult problem in building reliable high-speed input-output devices is the need for intermittent operation in order to avoid the need to prepare all programs with the unbearable restriction that input-output units must be run at full speed for long periods. The mechanical problem is overcoming the inertia of the external storage medium in any series of rapid stops and starts. Two indirect methods of reducing the overheads involved--off-line use and large block sizes--are discussed later. The direct method is use of reservoirs. They are buffers between the drive past the heads and those for the supply and take-up locations. This means that the inertia to be overcome by the drive past the head is small, and then high speeds and low overheads are obtainable. The control is normally a servo-mechanism using an on-off or proportion signal method of control. Sensing of the amount of material in the reservoir is provided by photocells, pressure sensitive devices, or other sensors.

.213 Feed drive

Feed drive is the mechanism which (in forward running of the external storage in a serial manner) fills the reservoir which is emptied by the drive past the heads.

.214 Take-up drive

The take-up drive empties the reservoir filled by the drive past the head.

.22 <u>Sensing and Recording Systems</u>

Even an output unit may include a sensing system in order to provide some form of checking of a recording. Checking of recording is imperative if important results are to be stored for some considerable time, especially if they are in a form not legible to human beings. Many installations without an output check re-read the recording on an input unit to verify the recording.

.221 Recording system

The greatest variety in recording systems that affects the user occurs in printers where the system of forming the individual characters affects both the clarity in the various copies and the repertoire available. The method of selecting the symbol and causing it to appear on the output medium is stated here. Recording using magnetic heads is straightforward except that the various methods of recording patterns are not compatible; e.g., "non-return to zero" and "return to zero" representations. There is one special method of punching tape in which the holes are not completely punched called "chadless tape", which cannot usually be read by photoelectric readers.

.222 Sensing system

The most important varieties of sensing are the special methods of character recognition and of output checking. In character reading, there is the fundamental difference between photoelectric reading which requires no special ink, and magnetic reading

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which can tolerate more creases and spurious marks. It is of prime importance to note whether or not an output checking system actually senses the external storage medium; for example, a magnetic tape recording check may sense the recording at a separate head (called a read-back check), may only verify the parity of data received from the processor, or may sense the current in the recording head (called an echo check). An echo check cannot guarantee that the recording is accurate. A recording on a tape with flaws may be incorrect although an echo check is satisfactory.

.223 Common system

In some cases, a single system is used alternatively either to sense or to record, and only one type of operation can be executed at a time, as on magnetic tape with a single head. In other cases, such as a complex read-punch-read card unit, both sensing and punching may be available, either jointly or separately.

.23 Multiple Copies

This section normally refers only to printers, but it also covers the special cases where a paper tape punch can produce duplicates by running two tapes under the dies or where two units can be connected simultaneously to one output control to produce duplicates.

.231 Maximum number

The fact that multilith or spirit masters can be generated for producing multiple copies elsewhere is not counted here. In obtaining the maximum number of copies, it is assumed that optimum supplies of raw storage medium are used, such as special quality paper and carbons. No special setting-up procedures or adjustments are permitted, only those that are considered standard.

.232 Types of master

The types of reproducible masters that can be prepared are stated.

.24 Arrangement of Heads

The arrangement of heads in an input-output device corresponds closely to the arrangement of data on the storage medium. At any one time, a single head is associated with some particular track, a stack of heads is associated with some particular band, and sometimes several stacks of heads are physically united in a yoke which is associated with a set of bands. The heads are physically located at various positions called stations in the path of the external storage medium past the heads. This section describes the patterns, position and use of each station and the heads used in each station.

The details for each station are stated separately in the sequence in which the external storage medium passes through them.

The use may be invariant, as at a punching station, or dual-purpose record or sense, as in some magnetic tape systems. Where necessary, separate columns are given for the cases of different usage.

The distance quoted is the distance from the previous station stated in convenient units, usually of storage locations; e.g., 1 card or 20 rows.

Where the number of stacks is other than one, or where the heads per stack are not equal to the number of tracks, the explanation is given under "operation." "Operation" also explains which stacks are active during the different operations.

.25 Range of Characters

The range of characters is important in two cases:

(1) The major case is on printers, where the standard and any alternative character

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sets are important. The total is based on the recognizably different characters. If the letter "O" and numeral "0" are different, they are shown so; if not, the numerals 0 to 9 will be counted as only nine in number. The ability of the available character sets to meet the specifications for the ALGOL, FORTRAN, and COBOL languages is indicated. The COBOL requirements permit the use of special alternative characters in pairs or singles, but this answer assumes no such substitutions. Any electives included will be shown separately.

(2) This paragraph reports any special characters such as special patterns on magnetic tape that are ignored by the data circuits but recognized by control circuits.

.3 EXTERNAL STORAGE

The "external storage" is the medium on which, or from which, data is recorded or sensed by the input-output device. This section is concerned with the medium itself; the phenomenon used for the recording; the arrangements or format of the data on the medium; the coding used; whether the formats and codes are compatible with any other special or standard systems; and any important physical dimensions.

.31 Form of Storage

This paragraph describes the medium itself and its supporting medium where appropriate (as in magnetic tape where the magnetized medium is supported upon a plastic tape), and the phenomenon used to indicate the various patterns of data. The phenomenon may be punched holes, or patterns of magnetization, or printing of characters on paper, or even key depressions on a typewriter keyboard. Where a device such as the Flexowriter is used, there may be several varieties of external storage that are not blended together. If so, each is listed separately (for example, a keyboard, punched tape, edge-punched cards). In such a case, reports are completed separately for each.

.32 Positional Arrangement

The arrangements of the data on the external storage medium are closely associated with the arrangements of the heads.

.321 Serial by locations

Normally, rows of data succeed each other, as operated on by one stack of heads as the medium goes past the heads.

.322 Parallel by locations

Each row in a band is composed of a mark in each track. Exceptions in terminology can occur; for example, a sideways card reader, which reads the data one column at a time, each consisting of holes in several rows.

.323 Bands

A section of storage on the external medium is normally composed of a fixed or variable number of rows of data recorded on one band. If there is more than one set of bands, the total number of bands is stated and also the reason for the multiplicity of the bands. Multiple bands may be used for simple duplication of the data or as logically separate bands containing data which are read at different times; for example, a magnetic tape which is divided into two bands, one of which is recorded in one direction when unwinding, the other of which is recorded in the other direction and rewinds the spool. Another example is the magnetic cards in CRAM: each has seven bands which can be read only one at a time. Sets of tracks which are separated only for timing purposes, but are all read together as one block of data or recorded in this way, are treated as one band for this report, except for duplicates.

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.324 Track use

In most systems, individual tracks have permanent roles assigned to the data recorded in each. On magnetic tape, a clock track is physically similar to a data track; but on punched tape, the clock track, called the sprocket track, is normally composed of much smaller holes than the data tracks. The major uses of tracks are for data (the patterns that are read into the system and manipulated in computations and data rearrangements). check bits, control signals, or clock tracks. Sometimes the information may be arranged in such a way that it is self-clocking; that is, there is at least one signal in each row, and by mixing all tracks, a clock track is not necessary. Redundancy checks can consist of simple parity checks or sophisticated error-correcting codes. The particular kind of code is noted. Some tracks may be used for special control signals, such as addresses of blocks on pre-addressed tapes. There may be spare or unused tracks. Where there are many bands with the same layout, the layout for one band is given.

.325 Row use

Where the external storage is divided into fixed sections, it is possible to specify the rows allocated to specific uses. These include the delimiters used, any longitudinal check row positions, and the intersection gap, if it is calibrated. Where variable block sizes determine the section size, the use is given in terms of the variable unit of block size.

.33 Coding

Except for printers, the marks that are made on the external medium are normally binary, hole or no hole, mark or no mark, etc. The coding of information is an equivalence set up between printable characters or symbols and the patterns which the marks can take. Data code tables show the characters and symbols that are equivalent to the various patterns by breaking down the pattern into two parts, assuming that it is a binary pattern. The binary equivalent of the code is divided into a more significant part and a less significant part; for example, a sextet may be broken into two bits and four bits, a punched card into punching curtates, an upper and a lower curtate, in which there may be multiple punchings.

.34 Format Compatibility

Compatibility involves two factors -- (a) format, and (b) code. Format compatibility means that the patterns of data produced by this unit can be sensed or recorded in some other system. Then, even though the coded representation may be different and a code translation is necessary, it is possible to transmit data from one system to the other, even if not convenient. Code compatibility means that no code translation is necessary, and the format and patterns are equivalent in the two systems. If only formats are compatible, a statement is made indicating whether and in what way the translation can be provided automatically.

.35 Physical Dimensions

The physical dimensions indicate the size of the external storage medium and whether the sizes are any particular standard.

.351 Over-all width

In many cases, the width, particularly of a tape, is fixed; but paper tape may vary in width, as may stationery on a printer. In this case, it is also important to know the increments of width that can be accepted, as well as the minimum and the maximum dimensions.

.352 Length

Lengths are important on tapes, indicating whether there is a fixed size or some variability. On printers, it is important to know the maximum and minimum lengths

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and the increments that can be handled for continuous stationery or single-sheet feeding.

.353 Maximum margins

On printers, it is also important to know the sizes of allowable margins. Although the printing width can be subtracted from the maximum over-all width, the margin allowance is not always equal on both sides. Of course, extra margins can always be made available by not using certain numbers of the left or right hand printing positions.

.4 CONTROLLER

The controller of an input-output device may be part of a device or a part of a central processor; it may be a separate unit which must always be present; or it may be one of a variety of alternative units depending upon the extent of simultaneous operations required. In complex systems, there may be a hierarchy of controllers. Where the different controllers have an important effect upon the performance of the system, separate replies are made for different varieties of the controlling system. The controller embraces all the facilities covering the flow of data between the input-output area and the external storage medium.

.41 Identity

The identities of the various controllers are cross-referenced and indexed. The cross-referencing is particularly important where a controller may be able to control a variety of different types of input-output devices. The official name, model number and abbreviated name are given.

.42 Connection to System

.421 On-line

Normally, there are quite rigid restrictions upon the number of controllers that can be connected to a system in an on-line configuration. The System Configuration Section shows some of the more popular varieties, and rules are given here for the general restrictions.

.422 Off-line

Many systems provide for input-output devices to be used off-line. Sometimes the normal on-line controllers can be used; at other times they must be replaced by or used in connection with special off-line adapters. Where off-line operation is possible, the special equipment necessary is also listed.

.43 Connection to Device

.431 Devices per controller

The important criterion covering the connection of the individual input-output devices to a controller is the maximum number of devices which the controller can have connected to it at one time. This may be as low as one or as many as sixty-four on some magnetic tape systems. On accasion, there are the special cases where several controllers may be connected to many input-output devices and there is no unique relationship between them. In other cases, a controller may be able to be connected to more devices than it can control simultaneously. Example are given in the System Configuration Section.

.432 Restrictions

When a controller can handle different types of input-output devices, there may be restrictions on the maximum number of each. This may depend upon the configuration. Over-all maxima are also stated where appropriate.

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.44 Data Transfer Control

The most important questions concerning data transfers which are carried out by the controller are the sizes of the loads of data that can be transferred and the provision for synchronization that may be necessary, particularly if the input-output device relies on program control of timing during input and output. Another important area is the means of protection of the output or input area.

.441 Size of load

A load is the volume of data that can be transferred by one instruction.

.442 Input-output areas

As far as data transfer control is concerned, the I-O area is that location from which the output program instruction directs data to be sent to a recording device, or the location to which the input program instruction directs it to be transferred. Although there may be one or more automatically controlled buffers between this area and external storage, they are not specified here. It may be a part of working storage or a special store provided especially for an input or output area.

.443 Input-output area access

The access to these areas may vary from simple access to a special area addressed as a single location to the completely general access when the area is a part of the working memory.

.444 Input-output area lockout

Any interlocks provided are specified. Because a program might inadvertently alter information in an output area before it had been copied, or could read information from an input area before it had been filled and use it inadvertently, any checks or interlocks that can be provided here are important. These may be of two kinds: either an absolute lockout to all the information until the input or output operation is complete, or the rather more sophisticated gradual release of the lockout on parts of the information as it is read or recorded. One system might allow any reading from an output annex, but only writing in locations which have been copied for output. If there are no interlocks, the programmer must normally use a "test busy" instruction, and program the interlock.

.445 Table control

Normal input or output operations provide for dealing with input or output areas which are composed of a series of consecutive locations. Some sophisticated systems provide a table control for input or output in which various sub-areas may be scattered throughout internal storage. In such cases, the table may specify the first location of each sub-block together with its size, or each sub-block may contain a delimiter at its end. Data may be gathered from many placed for output in one block, or scattered to many places while input from one block.

.446 Synchronization

Automatic provision of the synchronization implies that the programmer cannot make any timing errors in instructions concerning this input-output device. If it is not automatic, considerable effort must be applied to provide it in each program.

.447 Synchronizing aids

If the synchronization is not completely automatic, it is important to show which facilities are available to the programmer to enable him to control the timing: either the primitive form in which he has to mark time on an instruction until a lock-out is

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released, or the intermittent testing of a busy signal, or the sophisticated use of interruption when the busy condition disappears.

.5 PROGRAM FACILITIES AVAILABLE

This section is concerned with all the facilities available to the program to control the movement of the external storage medium and the transfers of data between the internal storage and the external storage medium, as well as any special facilities that are made available to assist in this task.

.51 Blocks

A block of data held in external storage is an item of data held in a single section. When sections, such as punched cards, are of a fixed size, the block is usually the same size. Occasionally on output, a block may not fill a section, and then input may be able to ignore the empty part of a section. This can be made possible by a block delimiter or by an input operation with a cut-off controlled by a counter. In most cases where the form of the storage medium does not require a fixed section size, such as magnetic or punched tape, section size is determined by block size, and it is only necessary to insure that section gaps or other facilities are provided to permit separate input of each block. In all cases, all blocks of data can be read separately in turn by a sequence of input instructions, although instructions may be able to be given to read an incomplete set of blocks using some cut-off technique. A subsequent input would probably begin at the start of the next block.

.511 Size of Block

This paragraph states whether or not the size is fixed and gives the size. It also gives the variation and limits of size for variable sized blocks. Often a block has a conventional name; for example, a line of print, a card, or even one character.

.512 Block Demarcation

This should be specified for the two separate cases of input and output. In cases where the size is not fixed, demarcation is normally either specified by a counter or by a delimiter such as an end-of-block character.

.52 Input-Output Operations

This paragraph covers all the operations available for transferring data between the internal and external storage, and movement of the external storage.

.521 Input

This paragraph lists the various input operations possible. In the case of variable amounts of data that can be input under the control of the input instruction, the limits and varieties which are possible are noted. This may be a variable number of characters, but if an input instruction may specify a single block which may itself be variable, it is noted as an invariable instruction because the variation is in the data, not in the instruction. In some cases, there may be a cut-off applied to cause the input to stop after a certain volume has been transferred, even if the number of blocks specified by the instructions has not been completed. For magnetic tape, it is noted whether blocks can be read backward as well as forward.

.522 Output

This is essentially the same as that provided for input, except that in this case the block sizes as well as the number of blocks may be varied; the possible sizes of blocks, however, and the method of demarcation have already been noted in §070.51 above. It is unusual when output can be performed backward, but if it is possible, it is so noted. Partly-filled sections are possible on outputs; for example, an output instruction might specify 100 characters through a card punch, which is interpreted

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as 2 blocks, the first consisting of 80 characters and the second of 20, the remainder of the second card being left empty.

.523 Stepping

Stepping is the operation of moving the external storage medium backward or forward a specified number of locations or a specified distance. The most frequent cases are a single backspace on a magnetic tape or stepping the paper forward a certain number of line spaces on a printer. It does not include the automatic stepping that is essential, such as the feeding forward of a single card when punching. It notes the range of possibilities and whether they are separate operations or combined with input and/or output. When they are combined with other operations, it is important to specify whether the stepping occurs before or after the input or output operation.

.524 Skipping

This is similar to stepping, except that the distance or number of positions that the external storage medium is moved is not explicit; but the movement forward or backward is to some special type of marking. This may be a special control mark on a magnetic tape or a hole in a paper tape loop on a printer with an automatic carriage. It is important in this case that the number of alternative skipping controls available be specified. This facility also includes, as a special case, the operation of moving to a specific address, which applies when the external storage medium is divided into sectors, each of which has an individual address permanently recorded with it on the external storage medium. Noted particularly are those cases where stepping and skipping are alternatives or combinations.

.525 Marking

These are cases where special marks, not normally recognized by the ordinary data input circuits, can be recorded ready to be sensed, for example, by a skipping facility. This is normally confined to magnetic tape.

.526 Searching

This is a special form of skipping usually combined with an input operation. In searching, a criterion is provided by the program as a data pattern, which is compared with all blocks (while moving either forward or backward in external storage) until some particular condition exists. The normal conditions are either "equality" or else "greater than or equal to," enabling the external storage medium to be positioned ready to read the next data in sequence.

.53 <u>Code Translation</u>

Data in external storage is normally represented by some pattern of marks. The particular patterns in external storage are the external storage code, and this may be related to the internal storage code in one of four ways:

a. Matched Codes

In this case, the patterns of information in external storage are the same as those in internal storage code, and no translation is necessary. Usually there are special or general-purpose equipments that prepare data in these patterns if it originated externally, or else it occurred naturally as previous output of a computer.

b. Automatic Input Translation

In this case, the external code is standard to the computer but is different from the internal form, and the input controller makes the translation automatically. When the controller can deal with several external codes, it is called "variable automatic input translation."

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c. Automatic Processor Translation

In this case, the external code is different from the internal storage code. The input controller makes no translation, but a special translation instruction is provided in the program repertoire to make the translation to internal code. A translation instruction which can deal with several external codes is called "variable automatic processor translation."

d. No Translation

In this case, the external code is different from the internal code, and no automatic translation operations are provided; therefore, they must be provided by a programmed subroutine.

.54 Format Control

In the simplest and most general case, there is a fixed one-to-one correspondence between locations for data in the internal storage and the external storage. Where this is not true, format editing has been provided. This may be provided in one of two ways: either by some form of external control panel or plug board in the controller, or by means of some special format instructions or data that have been given to it by the program. It is important to show how many alternative formats are available for transformation at any one time and whether it is possible to alter them under program control. Other important features that may be provided in addition to data rearrangement are zero suppression, insertion of special characters, and control of arithmetic signs.

.55 Control Operations

These are operations which, in general, make for greater convenience in setting up operating systems. To "disable" a device is to put it into a condition in which it is not able to respond to further instructions until enabled by an operator. Disabling is usually used in cases where the operator is required to reload, replenish or adjust the equipment before it is used any further in the program. In particular, the operation "unload" on a magnetic tape device disables the device, whereas "rewind" does not. To rewind is to wind the tape back on to the supply spool in a position in which it can be read or written again from the start. To unload is normally to carry out the operation of rewind, sometimes to unthread and then to disable the device.

Where interruption facilities are available in the central processor, it is sometimes possible to request interruptions after a specific input or output operation is completed.

On punch card equipment, it is often possible to specify that the card which has just been read or punched can be directed to some particular stacker under program control or that other cards be offset in their stacker so that they may be readily recognized by the operator.

.56 Testable Conditions

In order to be able to make efficient use of the computer and implement an efficient operating system, it is a great convenience if the program itself can test for many of the external conditions that will affect its future progress. This enables it to rearrange its schedule to a more efficient form, or to keep a log, or to inform the operator that his attention to certain devices is required. The conditions that are most frequently provided for testing are as follow:

Disabled -- This means that the device will not respond to instructions until it has been enabled by an operator.

Busy device -- This means that the device is still carrying out some operation requested earlier, but is not disabled and will be available later.

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Busy controller -- This shows that even if the device is not busy, its controller, or all possible controllers that may be used with the device, are busy and therefore a wait is necessary until the device can be used.

Output lock -- This means that a lock has been applied which prevents any recording into the external storage, and only reading is permitted.

Nearly exhausted -- This means that the external storage in the supply spool or input hopper is nearly exhausted and that replenishment will soon be necessary. Operating procedures often require that special sentinel and other routines be initiated. It is important to know the minimum volume of the storage medium that remains.

.6 PERFORMANCE

This paragraph shows how different conditions, such as choice of controller, and the peak or optimum speeds of the equipment, influence the overheads occurring in normal use, and what are the resulting effective speeds. In addition, it lists the demands that operation of these devices make on the other parts of the system; for example, the extent to which the internal store and central processor are prevented from doing other work while each input-output operation is proceeding. Special overheads are indicated, such as the processing time required to translate data which has not been automatically translated during input, or will not be translated during output. It does not include times and overheads for external operations such as reloading, replenishment and operator adjustments, which are specified later.

.61 Conditions

When the choice of controller or other factors influence the performance of the device, the various combinations for which separate performance figures are calculated are given. These are normally related to the different configurations that have been shown earlier.

.62 Speeds

This paragraph gives the operating speeds of the equipment independent of loading and operator adjustments. They are quoted in the normally-accepted units such as blocks per second, lines per minute, characters per second, etc.

.621 Nominal or peak speed

This is the instantaneous speed of which the equipment is capable, and is the usual speed quoted in specifications, making no allowances for overheads such as stopping, starting, record gaps, etc.

.622 Important parameters

These are the various parameters from which the overheads and effective speeds can be computed or estimated. They include such details as gap sizes, stop-start times, storage medium speeds, and fixed block lengths, etc.

.623 Overhead

This paragraph shows how the overhead can be computed. The overhead is normally related to a line, or a block of some kind, and is based upon the parameters stated above. It may also include statements regarding the number of clutch points per cycle on equipment such as card readers and punches. In computing the overheads for magnetic tape, allowance is made for re-reading and for all elapsed time between recording separate loads. Other overheads include: a fixed delay after a stop signal during which a start signal cannot be given; a certain amount of switching time to be taken into account. Switching from read to write or write to read on the same device is not taken into account here.

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.624 Effective speeds

Stated here is a formula or a graph showing the effective speed computed for various load sizes or other variables. Suitable values for load sizes are 30, 100, 300, and 1,000 characters, or (when printing) 1, 2, 3, 4, and 6 line spacings as well as 1 inch, 2 inch, and 4 inch spacing. Also stated are all the timing criteria that must be met if maximum speeds are to be maintained.

.63 Demands on System

This paragraph shows the extent to which other parts of the computer system are involved with the various operations that are carried out, such as input, output, searching, etc. The parts usually involved are the central processor, an internal store, and the controller. Controllers are not listed here if they are used full-time with the input-output unit. The various types of involvement depend upon conditions such as the different controllers that are available and their options, as well as the different types of operations that are being carried out. The time may be quoted in several ways, either as a fixed amount of time per block or load, or as a percentage of the time involved in a block or in a load, or as a combination of the two.

.7 EXTERNAL FACILITIES

This paragraph lists the controls and adjustments that are provided for the operator and shows the facilities available for holding external storage medium. It also derives the overheads associated with operators' actions. There are two basic types of operation concerned. The first is the simple operation of replenishment during a run in which new supplies of storage medium must be loaded and old supplies taken off. The second is initial loading in which, apart from the loading of new external storage medium, it may be necessary to make adjustments because of different widths of stationery, etc.

.71 Adjustments

This is a list of all the adjustments that may be necessary when loading new material for a new job. The particular adjustment required is noted, the method by which the operator makes it, such as a knob, a button or a switch, and finally any calibration by which he may determine the setting other than by trial and error. Only the adjustments that may be necessary in the course of ordinary operating are listed, not those required of a maintenance engineer from time to time.

.72 Other Controls

This paragraph includes all special controls other than power on-off and card run-in and card run-out that may be provided on the device for use by the operators. This includes special switches for controlling code conversion, or setting the nominal speed of the equipment.

.73 Loading and Unloading

This concerns the locations supplied for external storage and the times necessary for typical manual operations.

.731 Volumes handled

This paragraph shows the maximum volume of material that the device can handle without attention. The separate capacities of input hoppers or supply spools and output stackers or take-up spools are stated. Where there are multiple hoppers or stackers, the paragraph gives the capacity of the maximum hopper and maximum stacker, showing the others as alternatives, since the usual method of operation is movement of cards from one hopper to one stacker. The alternatives are generally used for exceptional cases only. The capacity may be quoted in any convenient unit, normally as a length of tape on a reel, or a number of cards; but for stationery, the only convenient unit is

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normally the height of the stack. It may be noted that a 12-inch stack of stationery corresponds approximately to 2,500, 1,000 or 600 sets of fanfold continuous forms for 1-, 2- or 3- part sets with interleaved carbon, respectively.

.732 Replenishment time

This is the typical time required by an operator to replenish the input hopper of a device and empty the output stacker when no adjustments are necessary. In particular, it is noted whether or not the device or other equipment must be stopped during this operation.

.733 Adjustment time

This is the time necessary for an operator to adjust the equipment for a new job in which the storage medium has different dimensions or for any other reason. It includes changing control panels, etc.

.734 Optimum reloading period

This is a time interval which can be used together with the operating times to compute an operating overhead. It is assumed that the computer is running in such a way that the input-output unit is working at its maximum effective speed. This, then, is the time interval at which replenishment is necessary if at each occasion the input hopper is fully loaded and the output stacker emptied.

.8 ERRORS, CHECKS AND ACTION

This shows all of the major types of error that may occur within the input-output system, and the types of checks or interlocks that are provided to detect or protect against errors. In some cases, particular types of error are not possible because of the mode of operation of the device. If, when the check fails, or an interlock is applied, some action is automatically taken, this is also noted. The most usual case of action for an interlock is that the operation waits until the interlock is removed. The most common types of error are as follow:

Recording -- This is an incorrect recording of the output on the external storage medium. (This error may be detected by a reading check which implies that the external storage medium has been read back for the check or by an echo check, which is a more limited type.)

Input Area Overflow -- This may occur if a variable length block is larger than the input area set aside to receive it. An output block size error occurs if, for example, recording too long a line is attempted.

Invalid Code -- This occurs when some particular pattern of an internal or external code is not acceptable to the controller.

Exhausted Medium -- This means that there is no further tape on a tape machine, or cards in a card reader, or paper in a printer.

Imperfect Medium -- On an output device, this can be completely checked only by rereading. Where rereading is not available, there is sometimes a limited facility for checking certain imperfections.

Timing Conflicts -- These arise when the central processor attempts to start a new operation before the previous one has been completed. Where automatic interlocks are not available, it is necessary to program them using a busy signal or some means of timing.

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Particulare types of action are:

Stop -- This means that equipment is immediately stopped and cannot continue until some action is taken by another unit or by a human being.

Alarm -- This means that a light or other signal tells the operator that this check has failed.

Signal -- This means that some automatic action is taken by the equipment, such as rereading a magnetic tape 3 times in the controller circuits themselves.

Indicator -- This means that this is a condition that can be tested by instructions if they are so written.

Other possible forms of action are error-correction, using redundant codes, and special branching to specific locations, which is a form of interruption. When convenient, the method or form of the check for interlock is specified; otherwise, it may be recorded only as being present.

INPUT-OUTPUT: PRINTERS
: MAGNETIC TAPE
: OTHER

Please note that exactly the same format is used for all reports with section numbers :07, :08, :09 and :10. Therefore refer to section 4:070 for the commentary appropriate to sections 4:080, 4:090 and 4:100.

SIMULTANEOUS OPERATIONS

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.1 SPECIAL UNITS

Simultaneous operations are often dependent upon the inclusion of special units in a configuration. These units may be optional parts of a central processor, integral parts of peripheral controllers, or special multiplexing or time-sharing units.

.11 Identity

Each unit which provides simultaneous operating facilities is listed. The full title, the model or serial number, and any abbreviated name used in the reports is stated.

.12 Description

A general description of a configuration's basic facilities is given, followed by the effects of including each of the optional facilities. Each description emphasizes the value and use of each facility rather than a rigorous specification of the detailed times and interlocks.

There are five major kinds of technique which may be used to provide simultaneous operations:

Independent Operations
Multiple Data Paths and Multiplexing
Partial Overlapping
Restricted Operations
Programmed Time-Sharing

.13 Independent Operations

In general, independent operations are those in which the controllers concerned are using units which are not required by any other controller. A typical independent operation is rewinding a magnetic tape. Other typical operations are a controller searching on magnetic tape for a block with a specific key, data input or output using a buffer which is a separate store, and employing a buffer which is part of a store being used by other controllers but which has its own separate access device.

.14 Multiple Data Paths and Multiplexing

Simultaneous data transfers, usually for input-output, are possible when each uses a separate data path. A special case exists when several paths share one cable but are multiplexed, or intermingled, in such a way that one cable is logically equivalent to several cables. Another common form of multiplexing is the time-sharing, or intermingling, of accesses to a store from many units. This is equivalent to multiplexing several data paths into a store.

.15 Partial Overlapping

In many simple systems, input-output transfers cannot be overlapped with other operations. In operations such as card reading, card punching, on-line printing, only part of an input-output cycle is covered by data transfers. There are usually periods at the start and end of each card cycle, or during paper movement, during which no access to storage is required. In these cases, some systems only prevent (interlock) the

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operation of the central processor during the transfer period, and permit computing during the other periods in input-output cycles.

.16 Restricted Operations

In a few rare cases, an input-output operation may only partially restrict the operation of a central procesor. One example might be the use of a special register for input-output transfers that is also used for multiplication. Then input-output inhibits only multiplication.

.17 Programmed Time-Sharing

Programmed time-sharing is possible in some systems, in which case a routine is used to arrange data transfers for input-output in small units and these transfers must be carefully timed. The penalty paid in central processor time devoted to this type of activity depends upon the speed and type of facilities available. In the order of preferred facilities, there may be automatic interruption, a "test busy" facility, or nothing. In the last case, instructions must be carefully timed by the programmer. Programmed time-sharing simulates multiplexed access to storage.

.2 CONFIGURATION CONDITIONS

In order to define the facilities in a comprehensive way, the different conditions that affect simultaneous operations are listed. The conditions are usually a set of possible combinations of optional units. The various cases are labeled with Roman numerals.

.3 CLASSES OF OPERATIONS

In order to define the simultaneous operating facilities in a comprehensive way, the various operations that can be performed are grouped into classes. Each class is labeled with a capital letter: A, B, C, . . .

.4 RULES

For each condition listed in paragraph .2, a set of rules is given which defines the restrictions upon the number of possible simultaneous operations at any instant. In these rules, the lower case letters a, b, c, d, e, ... represent the number of operations occurring at one time of classes A, B, C, D, E... respectively.

Examples:

$a + b + c$ = at most 1
means that not more than one operation out of those in classes A, B and C can be occurring at one time.

a = at most N
means that the number of operations of class A occurring at one time cannot be more than the number of operating units provided; e.g., the number of tape units.

$ab = 0$
means that if one or more operations of any one class, A or B, are occurring, none can be occurring in the other class.

$(a + b)c = 0$
means, first, that if any operation of class C is occurring, none of those in A or B can occur; and, second, that if any operations in either or both classes A and B are occurring, none of class C can occur.

Note that at any one time, all the restrictions must be considered; thus
$a + b$ = at most 1
$a + b + c$ = at most 2

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mean that either one operation of class A, or one operation of class B, two operations of class C, or one operation of class A or B and one operation of class C, are possible at one time.

.5 TABLE OF POSSIBLE SETS OF SIMULTANEOUS OPERATIONS

In some cases, the rules covering simultaneous operations are not straightforward; a tabular presentation, in these instances, may assist the explanation (see example below). A table may be given for different conditions enumerated in 2.

The rows of the table correspond to the groups A, B, C, ... of operations. Each column corresponds to a possible mode of simultaneous operations.

A blank entry means that in that column, the operations in the group of that row are not possible.

An entry "1" means that one operation of that group is possible in the mode represented by its column.

An entry "N" means that the number of operations in that group is limited only by the number of operating units provided.

An entry "N-b" means that the number of operations in that group and group B together cannot be more than the number of operating units provided.

Example:

a + b = at most 1
a + b + c = at most 2

could be tabulated as:

CLASS	POSSIBLE MODES OF SIMULTANEOUS OPERATION		
A	1		
B		1	
C	1	1	2

The table enumerates several modes in each of which no further simultaneous operations are possible. The table implies that sub-modes of simultaneous operations are allowed: e.g., one operation of type C.

INSTRUCTION LIST

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A comprehensive list is given of the instruction repertoire of the computer system. The meanings given for the operations are abbreviated and use the notation of the manufacturer. It is intended only to show the style and scope of the facilities.

.1 INSTRUCTION

For each operation code is shown a symbol for each part of the instruction using the notation explained in 4:041.223. The mnemonic operation codes are those of the most common machine-oriented language.

.2 OPERATION

The table is arranged by groups of operations, and the meaning of each operation is given in abbreviated form using abbreviations which are widely used and understood.

.3 ARITHMETIC

This group includes all fixed and floating point operations.

.4 LOGIC

This group includes Boolean operations, comparisons, jumps, use of indicator bits, repeat, tally and index control operations.

.5 INPUT-OUTPUT

This group includes all operations concerned with input-output units except testing of status and other conditions which are covered in the Logic group.

.6 AUXILIARY STORAGE

This group includes all operations concerned with auxiliary storage except testing of status and other conditions which are covered in the Logic group.

.7 DATA TRANSFER

This group includes all operations concerned with movement of data within and between working storage and registers. It also includes editing and format control.

In some cases, extra headings may be used to improve the presentation.

In some cases, a list of unusual abbreviations is included.

DATA CODES

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.1 USE OF CODE

A list is given of the stores in which the code is used.

.2 STRUCTURE OF CODE

.21 Character Size

The size is usually expressed as a number of bits, or columns of a card. Only data bits are considered, not parity or clock bits.

.22 Character Structure

In order to show both the coding pattern and the collating sequence that would result from simple subtractions or comparisons, values are quoted for each bit position in a character. In order to present the coding patterns in a simple table, the bit pattern of a character is divided into two parts, called the more and less significant parts.

In most six-bit data codes, the more significant part will be understood to be two bits of values 32 and 16, and the less significant part, four bits of values 8, 4, 2 and 1. These values indicate the collating hierarchy of the various bit positions.

In special codes, such as bi-quinary, the values of bit positions are, where possible, chosen to agree with the values assumed for digits in arithmetic.

.23 Character Code

The coding arrangement is specified by entries in a table. Rows correspond to values of less significant parts. Columns correspond to values of more significant parts.

In the special case of codes for punched card columns, the less significant part is specified as the pattern of underpunched holes, and the more significant part is specified as the pattern of overpunched holes.

Blank entries in the tables represent undefined codes.

PROBLEM ORIENTED FACILITIES

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.1 UTILITY ROUTINES

This paragraph covers the important standard routines with the exception of translators and executive routines. Utility routines are those designed to work independently. They are not subroutines, service routines or executive routines, but normally provide some frequently-required process, such as merging or sorting or card to tape transcription, for which it is convenient to write a standard routine to be used for many similar jobs. For each utility routine, its identity is given, a reference where further information can be obtained, the data on which it became, or will become, generally available in a operatable, fully-documented form, and a brief description of its facilities. All these routines are, to a large extent, problem-oriented; that is, they have been written to carry out certain specific kinds of process which are designed to solve standard, often recurring problems. They are usually controlled by parameters to control variations in the process to match the variations in the different problems. One specialized case of a utility routine is the simulation of another computer.

The routines may vary in their form and completeness in several ways. Some may be permanent routines that vary in their operation only by the type of data that is fed to them. Others may be controlled by parameters which are used to set up the routine to operate in different ways. Yet others may be produced by generators according to a description of the kind of data to be processed. In all of these, there may also be facilities for what is known as "own coding". Own coding is the facility of being able to write short sequences of special coding into standard routines in order to adapt them for special cases not covered by the parameters; e.g., putting a non-standard key into standard form for merging.

.11 Simulators Of Other Computers

Computers are often used to simulate each other. This may be done for one of several reasons. Suppose that machine A is being simulated by a routine in machine B. One reason is that an installation, which now has a machine B, formerly had a machine A and has many routines which are written for machine A which have not been translated for machine B.

Second is that an installation currently has a machine B and is later going to use a machine A. Routines are being prepared for future use on machine A and are checked out on the machine B. A third reason is that a person who has a machine B wants to use routines written for a machine A, and does not want the bother and cost of translating them into the language of machine B. A fourth reason is that machine A does not exist, and simulations are being run on machine B to determine how machine A would behave.

In this paragraph, we are concerned with simulations by this computer of other computers. In the description, points such as restricted capacity or facilities are mentioned, as well as the comparable speed of running.

In a special case, the simulated computer may be an imaginary computer. A program is accepted in a language that is not the language of any real computer and the program is obeyed interpretively.

.12 Simulation By Other Computers

This paragraph covers the simulation of this computer on other computers. The general

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remarks about simulation are covered under .11. In this case, it is important to note in the description whether there are again any restrictions on the simulation.

.13 Data Sorting and Merging

These are often the most frequently-used utility routines in any installation. Normally these are independent routines and operate by themselves. They may require data in a standardized form on magnetic tape or cards. In addition to the identity, reference, and date available, a specific note is made of the record sizes, block sizes, key sizes, and file sizes that can be used - whether or not they are dynamically variable, pre-set, or fixed sizes - and the number of tapes (which may also be variable). The description covers the method used, distinguishing between simple n-way merging, cascade or polyphase merging, and pure sorting, which is most often used internally for small loads of data.

Different types of routine are used for different sizes of file to be reordered. They are of three main types - internal sorting, automatic multi-pass merging, and multi-reel one-pass merging.

An internal sorting routine is limited in the size of file it can reorder by internal storage. It can also be used as a preliminary phase to the reordering of larger files to increase the length of initial strings before using magnetic tape.

An automatic multi-pass merging routine is limited in the size of file it can reorder by the storage capacity of the number of magnetic tapes on line. In the simplest case of 2p tapes, it merges from one set of p tapes to another and then back, repeatedly. By suitable refinements, a capacity of 2p-1 tapes can be utilized. Such a routine requires no intervention by an operator in normal, fault-free running. This type of routine can be used as a preliminary to multi-reel one-pass merging.

A multi-reel one-pass merging routine is used to handle the largest files and is limited only by the number of tapes available in an installation. It usually operates by using two tapes as alternators for output and the rest for as-many-a-way merge as possible, and is arranged to handle multi-reel files.

There are two basic kinds of programs available. First, there are parametrically controlled routines. These are usually fast to set up but may be slow to run. Second, there are generators which produce special routines to fit individual cases as they are required. There are two types of generator - hot and cold. A hot generator is one that generates the object routine in a form ready to load and run. A cold generator is one that generates a routine in an intermediate language which then has to be translated before loading. Generated routines are usually slow to set up, but efficient when running.

.14 Report Writing

Report writers are utility routines that read a file of records and print some specified report from data in the file. There are two major levels of sophistication in the reports produced - tabulation and analysis. Tabulations are listings, in the sequence of the file, of the values of selected data items of all records that meet certain conditions. Subtotals and grand totals may also be listed; for example, a report might be required from a payroll file of the ages and basic pay rates of all men over 50 years of age, with subtotals for each factory and grand totals for all factories. Tabulations are printed out in the sequence of the file. Analyses are reports that are independent of the sequence of the file and are built up as a run progresses. It may be possible to prepare several analyses in one run. The number of analyses is usually limited by storage space; for example, an analysis required for the same payroll file might consist of two tables, one showing the number of men and women in each age group, and another showing the number of people absent on sick leave by age, sex and factory. Report writers may be parametrically controlled and may be produced by a generator. (See conclusion of .13.)

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.15 Data Transcription

These are utility routines which perform pseudo off-line functions, often otherwise done off-line, such as punched card to magnetic tape transcription or even such tasks as magnetic tape to auxiliary store for bulk loading purposes. The routines vary from those that are limited to straightforward copying to those in which some editing or code conversion takes place.

.16 File Maintenance

There are two basic types of file maintenance routines. First are those which are really a type of patching facility enabling a file to be altered in minor respects. The file may be a library file or a data file. The routine is used for non-routine or non-conventional changes and corrections. Typical uses are those of "patching" a file during debugging or other short-cut procedures to amend a file without the use of a proper updating routine. The other type are generalized routines for file updating and are capable of taking amendments, insertions and deletions from a detail file, matching them against a master file, and making changes in the master file. Since many of these master files require some particular attention that is dependent upon their own particular form, such routines may have provision for own coding. They may, in fact, be a skeleton upon which a particular file updating routine for a specific file can be written.

.2 PROBLEM ORIENTED LANGUAGES

Problem oriented languages are languages whose design has been oriented toward the specification of a problem. They can be contrasted with process oriented languages, which are designed to be used to specify processes employed in solving problems.

PROCESS ORIENTED LANGUAGE

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1. GENERAL

Process oriented languages are languages whose design has been oriented toward the specification of a data processing activity. The specification is called a program, and describes a data processing activity designed to solve a general data processing problem. The program is independent of the particular data occurring in different specific instances of the problem. A particular application of the process at one time is called a run. The specification includes a set of procedures, the data structure, and sometimes details of the configurations of computers to be used for translation and running. The set of procedures is usually in the form of operations on the data expressed in an imperative style. Process oriented languages are largely computer-independent and many have been designed with the express intention that they can be translated into routines of many different computers. The compatibility of one program with many different designs of computers is not easily achieved. In addition to the need to restrict a program to the use of the subset of common facilities of the chosen computers, some variations among programs may still be required. To reduce the inconvenience of these changes, the COBOL language introduced the concept of a separate division of the program in which to specify computer-dependent details. This division is called the Environment Division, but it has not yet completely resolved all the difficulties and care is necessary when compatibility is required.

.11 Identity

.12 Origin

Many process oriented languages have originated at places other than the manufacturer of a computer with which the language may be used. In some cases, a language originated by one manufacturer is made available on the computers of another manufacturer. Many languages are developments by universities or by independent groups of computer users. The languages so developed may be evolutions or extensions of earlier languages.

.13 Reference

This is a reference to a document concerning the use of the language with a particular computer system.

.14 Description

The description outlines the orientation and style of the language and gives an indication of its areas of application. The orientation may be biased toward mathematics and scientific research, toward business and commercial applications, or toward program translators. The two major styles being implemented at present are based on algebraic expressions and pseudo-English, a restricted formal use of English words and English language structure. Description also indicates both the good and bad points of the language; for example, its simplicity or sophistication, ease of understanding and learning.

.15 Publication Date

This is the first date of a detailed specification comprehensive enough to permit programs to be written.

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.2 PROGRAM STRUCTURE

This section describes the way a written program is structured and logically divided, in the same way a book is divided into Contents, Material and Index, and into Chapters, Paragraphs and Sentences. As languages grow more sophisticated, the structure becomes more elaborate. At the same time, there is a trend toward more freedom in the structure of individual sentences because the separation into logical divisions (as in COBOL) and the use of key words mean that different categories of material can be more easily recognized.

.21 Divisions

These are the major parts of a program devoted to the specification of different subjects, such as data and procedures. The degree of separation of data description from the procedures varies widely in different languages. In COBOL, they are completely separate divisions; in many algebraic languages, the data description may in part be coded in the names of variables, as in FORTRAN, or by separate sentences intermingled with the procedures, as in ALGOL.

.22 Procedure Entities

Procedures are often formally grouped together. This is necessary in order, at least, to recognize subroutines. The largest group is the entire set of procedures. In many languages, there may be levels of grouping, either to permit nesting of subroutines or loops of procedures. Parts of programs may be designiated to provide regions over which local data names are recognized. Some categories of procedure groups have recursive properties. As a common example, a subroutine may have some of its parts that are subroutines, and so on. If a category is described as possibly being part of an entity of the same category, it has a recursive property. It is not usually possible to name any procedural entity that is less than a complete statement; i.e., an operation and minimum set of operands.

.23 Data Entities

The stratification of data into many levels and their division into many different items can be complex and intricate. Such a structure may have to provide for differences at all levels. At the highest level, there are differences between input-output, constants, and working variables. At the lowest levels, the class of individual items may be numeric or alphabetic. In this section, the size variations are ignored. The hierarchical and divisional structures are emphasized.

.24 Names

The rules for giving names range from those that provide for extremely free forms to those that restrict names to rigid formal structures. Usually there are some general rules of structure and size, and then variations which enable kinds of entities to be recognized by some property of their names. This section is concerned only with simple one-word names.

.241 Simple name formation

Normally there is a common rule for forming names. The most common restrictions are in the alphabet used and maximum size. Minor variations, such as those used as designators, are ignored here. There are often many words that have special meaning in the language and must be avoided because they cannot be recognized by position. These special key words usually include all the verbs and special names, such as ROUTINE. When formal formation rules are fairly rigid, the rules themselves may automatically exclude the key words. Although the upper limit on sizes of names may be high, the translator may restrict its discrimination to the first few characters, in which case they must be unique for each name. The most common alphabet restriction is the exclusion of special characters. Pure numbers are usually prohibited as names in order to simplify use of numbers as literals. Some languages do not permit any

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numerals in names. Those that do usually require that one character be a letter - often the initial character.

.242 Designators

For the benefit of the reader, and usually the translator, too, there are sometimes conventions or rules by which certain important kinds of entity may be designated in some particular way in their names. By using complementary rules, the kinds of entity can be recognized from some properties of their names. All the key words are usually recognized individually. In many cases, the designation may be made by using a compound name in which one word is a key word denoting the kind of entity. The compound word may be formed with a hyphen to avoid confusion as separate names, as in ""FILE-MASTER". There are five kinds of entity that can normally be distinguished.

. Levels of procedures - most important are the subroutines.

. Classes of Data, and the special conventions used to designate literals.

. Comments, which are provided only for the reader and have no effect on the translator, usually designated by an introductory key word.

. Equipment - usually designated by key words.

. Translator Control.

.25 Structure of Data Names

Data names may have two kinds of structure formation used either separately or together: qualification and subscription.

.251 Qualified names

Apart from compounding with key words to provide designators, compound names are often formed in data names. These are often related to the levels of the data structure. They are convenient to the reader and writer because they show the data structure and allow a basic name to be qualified in many ways; i.e., MASTER PRICE, DETAIL PRICE. The compound names may be formed in several ways; i.e., MASTER PRICE, PRICE IN MASTER, MASTER-PRICE. A language may require each level to be a qualifier, but sometimes an incomplete set is allowed, provided that the set of qualifiers is sufficient to specify the data item uniquely.

.252 Subscripts

Subscripts are used to refer to items in tables of data. The important characteristics are:

. Number - How many dimensions may a table of data have?

. Application - The range of different data item types or levels that may be subscripted.

. Class - Can the subscripts be any variable or are they limited to special variables?

. Form - Subscripts can only be integers when used, but if the variable is not an integer, then the rounding rules are important.

.253 Synonyms

When it is possible to refer to an item by more than one name, the name is either preset in the original writing of the program or set dynamically during execution. The

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first case is elementary. The second case is rare, and is similar to setting parameters.

.26 Number of Names

The restrictions on the number of entities that may be named are usually upper bounds. There may be one general limit or separate limits for different kinds of entities.

.27 Region of Meaning of Names

For a label, a name, or any identifier to be of practical use in a program, its meaning must be defined for each use in every place it occurs in program statements. Each identifier, however, does not have a unique meaning for all time and for all contexts in which it may be used. The name XYZ may mean one thing in one program and something else in another. In fact, the meaning of an identifier is restricted to a region. In the simplest case, the region of a particular meaning of any identifier is the program in which that meaning is defined.

In many languages, the region of a meaning of an identifier, usually only a part of the program, may be different from the entire program. Some languages have severe restrictions on the number of identifiers allowed in one program. This may be due to restrictions of translator space or language style. In these cases, the program can sometimes be divided into parts in which two kinds of identifiers are used - "universal" and "local." A universal identifier is defined as having one meaning for the whole program. A local identifier is defined for only one part of the program. Then one name can have a different local meaning in each part.

Some languages allow parts of programs, written separately with many local identifiers, to have statements that make certain local identifiers in different parts mean the same thing; that is, their meaning becomes universal by the use of synonyms.

An important use of local identifiers is in subroutines. A subroutine may be written without the writer knowing the identifiers that will be used in all the different programs with which it may be associated. It is a common convention that all identifiers in a subroutine are local to the subroutine or else are dynamic parameters. Local identifiers refer to variables or statements that are used only by the subroutine itself, such as destinations for internal jumps and working locations. Parameters are associated at different times and for different uses, with the current inputs and outputs of the subroutine. At the time of cuing a subroutine, the parametric identifiers are stated; i.e., the meanings of the parameters are defined; for example, when a program using identifiers p, q and r uses a sine routine whose parameter is named x, then at different times x may be set to be the same as p or q or r, as required. The setting of a parameter may be done in either of two ways - by value or by name.

To set a parameter x by value p means that everywhere in the subroutine, identifier x is taken as meaning the value of the item identified by p at the time the subroutine was cued.

To set a parameter x by name p means that everywhere in the subroutine that identifier x is used, it is taken as meaning the identifier p. In this case, it is possible that the value of p can be altered by the subroutine, even if p is not its prime result, called a side-effect of the subroutine.

All identifiers local to a region (such as a subroutine) must be defined for the region. If an identifier is not defined for a region, it is called non-local. If regions can be nested, the convention usually adopted is that a non-local identifier has the same meaning as it would have in the region in which the current region is nested. This is a recursive definition. Suppose, for example, that if identifiers A to Z are defined for a program, A to M defined for a subroutine, and A to G defined for a sub-subroutine; then in the sub-subroutine, A to G are local and H to Z are non-local, taking the meanings they have in the subroutine; in the subroutine, A to M are local and N to Z non-local;

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in the program, A to Z are all local. Note that identifiers N to Z have the same meaning everywhere - they are universal by implication; A to G are different at each level of nesting of the regions.

An identifier universal to region X is one that may not be local to any other region nested within region X.

Key words are universal to a language and there may be certain key words universal to an installation. The setting up of a common data description in COBOL can produce identifiers universal to a suite of programs.

The existence of regions and different types of parameters allow sophisticated and flexible language structures, but if used in an indiscriminate way, the results can also be confusing, difficult to understand, or even ambiguous.

.3 DATA DESCRIPTION FACILITIES

All the data used in a program is described somewhere in the program. In process oriented languages, the data description is usually explicit. This section shows how many implicit descriptions have been eliminated, and the variety of data that can be described. There are in general six basic types of answer:

- None, meaning the facility is not available; e.g., multi-reel: none, which means multi-reel files cannot be used.
- Automatic, meaning that the facility is assumed to be incorporated automatically by the translator or operating system; e.g., input-output error control is a part of the operating system.
- Indirect, meaning that the facility is implied by choices made in the use of certain procedures; e.g., rounding of results is implied unless truncation is specified.
- Own procedure, meaning that the facility must be provided explicitly; i.e., a procedure must be written by the programmer.
- Subroutine, meaning that as an alternative to "own procedure", a standard routine is available.
- Description, meaning that an explicit data description is used.

In addition, there are comments to show whether or not a facility is optional or mandatory, and to record any special limitations that may exist.

.31 Methods of Direct Data Description

The method of describing data varies widely from one language to another. This paragraph shows which ones are used in the language.

.311 Concise item picture

COBOL has a system by which a neat description of an item is possible; e.g.,

AAA99	three letters followed by 2 numerals.
XXXXX	five alphameric characters.
99.99	showing a real decimal point.
99v99	showing an assumed decimal point.
ZZZ9.9	showing where zero suppression is required.

and even more sophisticated conventions.

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.312 List of kind

ALGOL has a system by which all integers are given in one list, real variables in another, and so on.

.313 Qualify by adjective

In this method, a list of adjectives, such as "numeric", "signed", "zero-suppressed", are given for each item.

.314 Qualify by phase

This is a slightly longer method in which phases, such as "size is 4 digits", "zeroes are suppressed", are given for items.

.315 Qualify by code

This is similar to 313 and 314 except that a coded system is used.

.316 Hierarchy by list

This is a method of showing the grouping of items by the sequence of listing data items, usually an item of one level being followed by all its parts.

.317 Level by indenting

It is convenient to the reader to use a system in which the indenting of a list of names shows the various levels of data.

.318 Level by coding

The most usual way for the translator to discover the level structure is by some numerical coding.

.321 File labels

It is usual for operating systems to require labels at the beginning and end of each file, whether on tape or cards. Even when standard labels are provided, there may be provision to vary the layout and nominate certain control or "hash" totals to be maintained. When the identity procedures can be controlled, sophisticated job, file and run number checks can be considered. When a job uses very large files, it is essential that the programmer be able to specify that a file may extend over several reels - "multi-reel file".

.322 Reel sentinels

It is usual that there be a requirement for sentinels at the start and end of each reel, particularly where multi-reel files do not have logical groups corresponding to each reel. They may also contain standard data about the age, size and use of the tape. It is more convenient if they are separate from the file labels. The layout facilities should be adaptable for different installation standards if it is not provided in an automatic way for each installation. When a large number of small files are used in an integrated job, there can be a large saving of tape-loading time if many files can be placed on one reel to become "multi-file reels".

.33 Records and Blocks

There are several important considerations in the layout allowed of records and blocks.

.331 Variable block size

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.332 Variable record size

Variation may be of three types:

Fixed - none allowed.
Pre-set - meaning that the choice is made at the time of writing or loading the program.
Dynamic - meaning that choice is made during the run and varies with the data structure or procedure statement.

.333 Record size range

.334 Block size range

Range is the maximum and minimum sizes allowed and intermediate steps between sizes.

.335 Choice of record size

.336 Choice of block size

When there is variation, it is important to note who makes the choice and, when it is automatic, on what basis.

.327 Sequence control

Any provision that is made to insure that data is treated in sequence and/or that none is missed. There are two basic checks, step and monotonic. A step check uses a serial number, which is stepped by 1 for each record or block, to see that none is missed. A monotonic check merely insures that data is not out of sequence and that the value of a key steadily increases or decreases. The check is weaker if made on blocks rather than records, but a step block check is stronger than a montonic record check.

.328 In-out error control

This is the checking that no error indicators are set for each input-output load, or initiating and controlling error recovery procedures if errors do occur.

.329 Blocking control

This is the organization of packing and unpacking several records held together in a block.

.34 Data Items

.341 Designation of class

This is the way in which the data class of an item is specified, usually by a designator in the name or by data description.

.342 Possible classes

If the data can be classified, it may help the translator to economize in storage space, simplify coding and implement automatic rules such as justification.

.343 Choice of external radix

.344 Possible radices

These show if a language can handle more than one radix in its input-output data, which implies either some automatic conversion or multi-radix arithmetic.

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.345 Justification

This is usually an automatic facility in which alphameric data is left justified, whereas numeric data is aligned by its decimal point.

.346 Choice of code

.347 Possible codes

This covers any choice available to a programmer to specify the input-output codes used for data. Normally, these are standardized and provided automatically for individual installations.

.348 Item size

The same remarks apply as for .331 and .332, with the added note that some computers designate item sizes by counters in the instruction and others by delimiters in either the data or the location cells. It is usually difficult and inefficient to provide dynamic variation when translating a process oriented language, however.

.349 Sign provision

Rules for handling signs can be complex. The comments here are limited to the cases where provision is made to allow a number to be set as negative or positive, or to declare a number unsigned because it never attains a negative value, implying that no space should be provided for its sign.

.35 Data Values

Not all the operands specified in a program are variables; some are constants whose values are specified directly in the program. Sometimes there are conditional variables whose limited set of values are defined and have unique names.

.351 Constants

Constants are data items whose values are fixed when the program is written or loaded but are given names and treated in the procedures in a manner similar to that of other data items, except that it is an error to designate them as the result of an operation. Some translators scrutinize procedures to insure such errors are not ignored. When the facility of using literals is available, the main use of name constants is in tables of data, such as price lists, discounts or other rates referenced by subscript, e.g., "ADD DUTY (CLASS, GRADE) TO PRICE" or as parameters which are set at loading time.

There may be severe restrictions on the size or types of constants allowed.

.352 Literals

These are a special and convenient type of constant. They are used mainly in procedure statements. Instead of being represented by their names, their values are written directly into statement; for example, instead of

"ADD TIP TO BILL"

in which TIP is a constant, value 17 units, it may be possible to write

"ADD 17 TO BILL".

Usually, numeric literals are recognizable because they contain no letters. If alphameric literals are permitted, there must be some designation rule, because it is difficult to distinguish such a literal from a name; for example, does

"PRINT TIP"

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cause "TIP" or its value "17" to be printed? In many languages, the possible forms of literals are restricted in order to facilitate recognition.

.353 Figuratives

These are special named values, usually constants, which are a part of the language, and their names are key words; e.g., BLANKS, which might have an undefined size in order to fit any result area; PIE, which equals 3.14159 . . . to some degree of precision in a specific computer; and DATE, which may be the current date and is a variable rather than a constant.

.354 Conditional variables

These are variables, each of which may have only a restricted and stated set of possible values. Each value is given a unique name; for example, a variable called "CONDITION" in a payroll may have four values - 1, 2, 3 and 4 - which are given the names NORMAL, SICK, ON-LEAVE and RETIRED, respectively. Then the language allows conditional clauses of a form such as

" IF ON-LEAVE"

or

"IF CONDITION IS ON-LEAVE"

to be written.

.36 Special Description Facilities

This section covers any special provision in the language to reduce repetitive descriptive statements.

.361 Duplicate format

There may often be several separate data items which have identical layouts and differ in name, particularly if compound data names are being used, when describing input-output data formats. It is then convenient to be able to note that one format is the copy of another, without repeating the details. In COBOL, this feature is called "COPY".

.362 Redefinition

This is a term used to refer to the facility of being able to use an area for two different data layouts. Of course it is necessary to have different names for each use, and the programmer himself must insure that the appropriate names are used in the procedures. If the rules permit one area to be larger than another, there may be conditions requiring, for example, that the larger must be described first. Usually, the two areas must be the same size and this can easily be arranged by adding dummy items to the smaller. It is most useful if the higher levels of data formats can be re-defined.

.363 Table description

If subscripting is to be used for tables of data, it is essential to have some method of denoting the various levels of subscripting and the range of each subscript. Usually there is a facility to state that one item format is to be repeated a certain number of times. In a sophisticated system, the subscripted items may be subdivided into lower levels and the subscript allowed to apply to them too. For example, a table of FIELDS subscripted by AGE might each be composed of three items - RATE, DISCOUNT and CODE - and then

"CODE (AGE)" may mean

"CODE OF FIELD (AGE)"

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A table need not necessarily be referred to by subscript. It may be allowed to specify arguments and values.

.364 Other subscriptible entities

A few languages allow procedure or equipment names to be subscripted.

.4 OPERATION REPERTOIRE

This paragraph deals with the various operations provided for use in the procedures written in the language. Because of the great freedom and diversity of the syntactical structure of these languages, it is not possible to concisely summarize their structure. Instead, examples are selected for most groups of operands to illustrate both the general style and any particularly distinctive features that add to or detract from the facilities in a significant way. With each group of operations are specified the properties of the operands upon which they can operate. If an operation is not available, it may of course be possible to construct it by a subroutine. If an operation is available directly, its form is given, together with any important qualifying remarks that are not covered by associated entries on operands, special cases, etc.

.41 Formulae

In algebraic languages, formulae are the prime method of describing procedures. Use of formulae may also be included as a subset of pseudo-English languages.

.411 Operator list

This is a list of all the operators available. For simple arithmetic, addition, subtraction, multiplication and division are usually required. For more scientific use, exponentiation and other mathematical functions should be provided. In addition, there is some conventional symbol to represent "is set equal to" or some equivalent function.

.412 Operands allowed

Some languages restrict the kinds of numbers that can be used, some to fixed point, some to floating point.

.413 Statement structure

There are three important facilities - the use of parentheses, the limit of size of a statement, and the ability to set several results equal to one expression. There may be a limit on the nesting of parentheses. There is usually an implied parenthesis rule and in general, the accepted mathematical convention imply:

a - b - c	=	(a-b)-c,	not	a-(b-x);
a + b x c	=	a (bxc),	not	(a+b)xc;
a ÷ b c	=	(a b) c is preferred;	=	(a÷b)÷c is preferred;
$a^{b^{c}}$	=	$((a)^{b})^{c}$ is preferred.		

The size may be limited by a restriction on the complexity of expressions.

.414 Rounding of results

Whenever the size of a result field is such that truncation or rounding is required, there may be programmed control allowed or an automatic provision. If the automatic provision is not the one required, it may take extensive programming to alter its effect. The control may be provided on an exception basis, in which an automatic procedure is used unless an alternative is specified. The means of specification may be in the data description or in the procedure. The former has the disadvantage of being in an

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inconvenient place when reading a program. The latter has the inconvenience of sometimes requiring repetitive entries, but is more flexible.

.415 Special cases

Examples are given to illustrate how the language handles some of the well-known special cases. Their individual importance varies with the sophistication and tastes of the user.

.416 Typical cases

These illustrate the general style and any particular characteristics of the language.

.42 Operations on Arrays

Computations on arrays of operands are sometimes provided in specialized languages, for matrix operations ranging from simple addition to the complex operations of establishing eigen vectors, and for statistical calculations of various kinds. Boolean or logical operations are sometimes provided for arrays of binary digits usually in one dimension. Less frequently found are the operations of scanning tables or lists of data, using criteria such as least, greatest, or greater than some value. A variable step size is an added convenience.

.43 Other Computation

This section covers the computations described by pseudo-English statements and the operators are usually selected English verbs.

.431 Operator list

This is a list of the verbs as written in the language and their meanings. Any important or unusual properties are noted here or illustrated in the examples.

.432 Operands allowed

The operands must normally be single numeric items and are sometimes restricted to special classes, or to one class at a time; for example, it may not be possible to multiply a fixed point variable by a floating point constant.

.433 Statement structure

The general style is illustrated by examples. This paragraph concentrates on a few particular points:

Whether several equal-valued results can be specified in one statement.

Whether any size limit is set for statements.

Whether there is a limit on the number of operands.

Whether results can be implied; e.g., in COBOL, when no explicit result is named, the result is implied as the last named operand.

Whether different verbs can be used in one statement, not usual.

.434 Rounding of results

Whenever the size of a result field is such that truncation or rounding is required, there may be programmed control allowed or an automatic provision. If the automatic provision is not the one required, it may take extensive programming to alter its effect. The control may be provided on an exception basis, in which an automatic procedure is used unless an alternative is specified. The means of specification may be in the data

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description or in the procedure. The former has the disadvantage of being in an inconvenient place when reading a program. The latter has the inconvenience of sometimes requiring repetitive entries, but is more flexible.

.435 Special cases

Examples are given to illustrate how the language handles some of the well-known special cases. Their individual importance varies with the sophistication and tastes of the user.

.436 Typical cases

These illustrate the general style and any particular characteristics of the language.

.44 Data Movement and Format

These operations are concerned with data movement within the program and only changes to the data in the form or format in which it is held are considered, there being no computation other than that necessary for changes of radix or code.

.441 Data copy example

This is an example of a simple copy statement setting one data item's value equal to another and keeping the original unaltered.

.442 Levels possible

When levels other than the lowest level can be used in a copy or move operation, it is assumed that all the lower levels are moved as well, and the item is moved in toto. This may be possible for complete records; it is usually not possible for complete files.

.443 Multiple results

Often when copying, the problem requires that several data items be set at the same value as one original. If this is possible in one statement without repeated copies, it is stated here.

.444 Missing operands

It is possible in some languages to ask for some group of items to be copied to another group of items not necessarily of the same level, when in fact their formats are not exactly the same. They may not match for sizes and they may not match for the individual contents of the items. In these cases, there must be conventions by which the excess sources are ignored and the excess destinations are left unaltered.

.445 Size of operands

Depending upon the sophistication of the facility provided in the language, there may be the restriction that individual operands of the source and destination have to be the same size so that there is no problem in the movement. If they are not exactly the same size, and with numerical items exactly the same scaling, there must be some rules for alignment. Numbers are usually aligned by their decimal points and alphabetic information is normally left justified, but there may be other standards in a few languages or options to allow the programmer to specify the alignment. If the destination area is larger than the source area, there must be some rule for filling the places left over. For numerical information, this is conventionally done with zeros, and for alphameric information, with spaces. If the destination area is less than the source area in size, there must be some form of truncation. For numbers, the truncation is normally determined by alignment of the decimal point positions and perhaps rounding the less significant digits. The rules for the more significant digits may vary considerably.

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In some translators, truncation of most significant digits is treated as an error. For alpha information, there is either simple truncation or treatment as an error.

.446 Editing possible

When a move or copy takes place, it is usually permitted that the formats of the destination items be different from the formats of the source items in order to provide the facility of editing information, particularly for printed output; however, most languages have some restrictions on these facilities. It is unusual to allow a general change of class of information except perhaps between fixed and floating point and from numeric to alphameric form. The class change from alphameric to numeric form is less common. A change of radix is not common. Although it is usual to be able to insert editing symbols, the provision for being able to delete them is usually awkward even if available. The editing symbols that are generally available include the simple insertion of a decimal point, the suppression of leading zeros on numbers, the insertion of special characters such as dollar signs for prices, the so-called "check protection" symbols, in which non-significant digits are replaced by asterisks to make the alteration of numbers more difficult, and the sophistication of being able to "float" certain symbols; e.g., a floating dollar sign is one in which the actual position of the dollar sign depends upon the size of the number and is normally positioned just to the left of the most significant digit.

.447 Special moves

Some languages provide special types of move in which the source is not specified as a data item but as a kind of data to be placed in the destination area. Typical of such moves are "fill", and "clear", and implementation of them depends somewhat upon the individual computers. "Clear" normally means setting all the character positions to blanks or zeros for alphabetic and numeric items respectively, but "fill" is not so easily specified in general and an explicit character is often given; e.g., "Fill with Z".

.448 Code translation

This details any facility that may be included to control the code in which the individual characters of input or output operations may be coded.

.449 Character manipulation

This covers any facilities in a language for the manipulation of individual characters, not necessarily one-character items. This is not a common feature in conventional languages, but is being introduced in order to assist such operations as language and program translation by the manipulation of strings of symbols.

.45 File Manipulation

Standard file manipulation operations are becoming more common, and in this section, those that are most frequently required are listed. The corresponding operations, if any, provided in the language are given, together with any unusual facilities or restrictions that may be imposed. The provision of "open" and "close" operations implies that a routine is automatically brought in to deal with the file labels. The facilities to "start a new reel" or to "start a new block" are not common, but are convenient in some operations when dynamic control over the blocking and unblocking of files is required. Rewind and unload are sometimes provided and sometimes not.

.46 Operating Communications

This paragraph covers the manner by which a routine can communicate with the operator to make a log of its programs or to offer to the operator from time to time the choice of different routes of proceeding during a run and be able to accept the operator's answer when he chooses one of the options. If operations are generally available to do such things, the details given here describe the manner in which they are available, and any restrictions or special facilities that are associated with each operation.

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.47 Object Program Errors

It may be possible for a programmer to provide in a routine some standard action that he requires to be taken when certain kinds of errors occur in a run, even though he may not be able to write procedures which enable his routine to discover the errors. It may be that a master routine or a supervisor or standard routines supplied by the translator will automatically carry out the actions chosen by the programmer when certain kinds of errors occur. If this is the case, then for each of the possible kinds of errors in which the program can be concerned, this paragraph states how the discovery is made as far as the program is concerned, and what kind of special actions are available to him or whether any action is restricted to whatever he can code himself out of the ordinary operations provided in the language. The typical types of discovery are either that each routine may make its own tests or that it cannot make any discovery at all, and that the chosen action is entered automatically by the supervising system when required.

.5 PROCEDURE SEQUENCE CONTROL

Although the procedures written in a program are normally obeyed one after another in the sequence in which they are written, it is frequently necessary to arrange that the sequence be modified using one of several methods.

One method is to insert a jump to another part of a sequence. It may be a permanent jump, or a switch which is set to different destinations from time to time by other statements.

A second method is use of a conditional procedure; if the conditional clause is true, the conditional procedure is obeyed. If the clause is not true, the procedure is not obeyed. In the latter case, it may be that some alternative procedure is obeyed. These conditional and alternative procedures may themselves be jumps.

A third method is to execute a subroutine. This is really a controlled jump, a cue, to some other place in the program, the carrying out of a certain number of procedures at that place and then a return jump, or link, to the place from which the original jump was made.

A fourth method is loop control, in which a given set of procedures is obeyed repetitively a certain number of times, depending upon counters or conditions. The set that is obeyed may in fact be a subroutine, and the criteria that regulate the repetition may themselves be some kind of conditional clause.

.51 Jumps

These are the most straightforward changes of sequence in a program and normally indicate a new procedure or statement to be executed immediately after the one which is the jump. An interesting point is the particular kinds of destinations of the jumps that are allowed. Normally these are restricted to certain levels of procedure.

An example is given of a simple unconditional jump. A switch is a jump that may be altered from time to time by procedure elsewhere in the program. It must normally have a name by which it can be referenced. The setting of a switch is also given as an example. There may be a special kind of switch called a data switch whose setting depends upon a data item which may have a variety of values. On each occasion when the switch is encountered, the item's current value defines the destination of the jump. For example, an item of data may have value 1, 2 or 3, and a data switch depending on this item is set to jump to a certain place A, B or C, depending upon whether this data item has a value of 1, 2 or 3, respectively.

.52 Conditional Procedures

Conditional procedures are those whose execution at any time is dependent upon some conditional clause with which they are are associated.

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Normally they take the form

"if (some conditional clause is satisfied), then (do this procedure)"

and, occasionally, there is added

"otherwise (or else) do this alternative procedure".

These procedures may, in fact, be "jumps". Their most important property is the way that they are recognized. This is usually done by a word such as "if" at the beginning of a conditional procedure.

The conditional clauses, in their simplest form, normally take the form of (one kind of operand) - (a relation) - (another kind of operand)

such as

"A equal to B".

The operands themselves vary in the degree of complexity allowed, from simple items to complex expressions. The relations also may be restricted or quite complex. One of their common properties is the ability to negate the relation by inserting the word "not" or some equivalent symbol.

A second form of conditional procedure is one in which a condition of one operand is considered, such as whether the sign of an item is positive or negative, or whether the operand is numeric or alphabetic.

.525 Compound conditionals

In many languages, a single conditional clause such as "if a equals b" is not the only type of conditional clause. It is often possible to form compound conditions without having to write many interconnected statements. Normally the compound conditionals are formed using the connectives "and" and "or". The examples given in Figures 1 and 2 illustrate this in a simple way. Figures 3 and 4 illustrate a more complex method sometimes allowed.

Figure 1. IF A AND B DO C

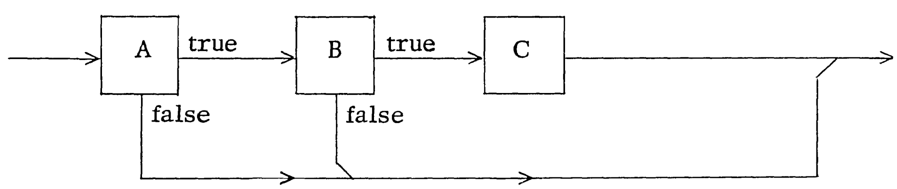

Figure 2. IF A OR B DO C

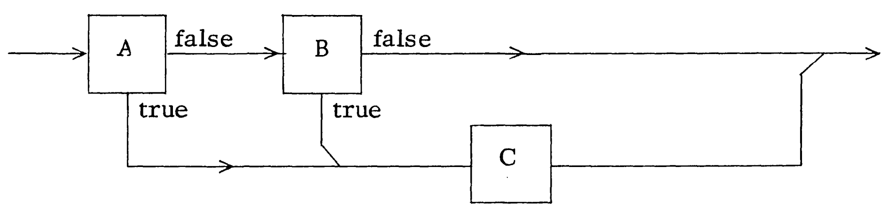

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Figure 3. IF A DO C AND IF B DO D

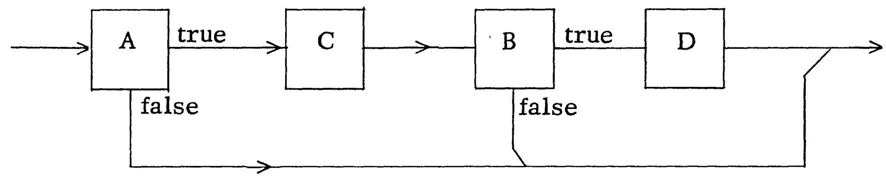
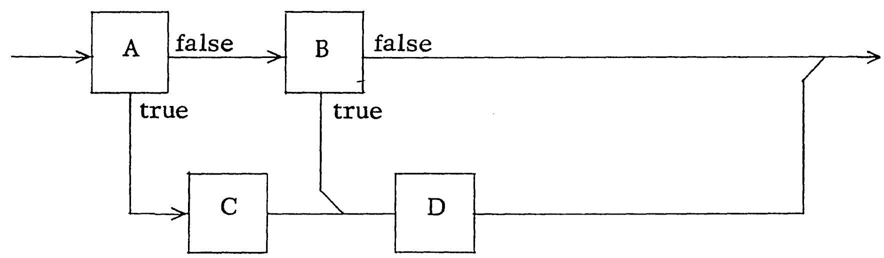


Figure 4. IF A DO C OR IF B DO D



.526 Alternative designator

A conditional clause, either simple or compound, may have an alternative procedure to be carried out if the condition is not true; e.g., a simple case

"DO A; OTHERWISE DO B".

If this is possible, the method of designating the alternative clause is stated.

.527 Condition on alternative

Unless the language is quite sophisticated, it is not usual to allow the alternative procedure itself to be a condition, because this may introduce complex conditionals. These are difficult to translate and sometimes lead to ambiguities which are also difficult to read and understand.

.528 Typical examples

These examples illustrate the styles of various conditional clauses. They show any important features that have not been covered in the earlier parts of the paragraph.

.53 Subroutines

Subroutines are groups of procedure statements which are associated by a common name or some such designator and which may be executed in place of the program different from that in which they are written; for example, there may be a procedure named TAX, and elsewhere in the program a statement such as

> "do TAX" which causes a sequence jump, called a cue, to the beginning of the subroutine TAX. At the end of the subroutine, a return jump is made to the place from which the cue was originally made. Cuing a subroutine means using a statement that causes the subroutine to be executed each time this cue is encountered at run time.

.531 Designation

This states how a set of statements that are to be considered as a subroutine can be recognized by the reader or translator.

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Usually a subroutine has a clearly-marked beginning and end; i.e., it contains its own delimiters. In COBOL, a subroutine is defined only by the cue and any procedures can be obeyed as a subroutine. (See also .533.)

.532 Possible subroutines

This states the different groups or levels of procedures that can be used as subroutines.

.533 Use in-line in program

All subroutines referred to in this paragraph .53 can be used as closed subroutines. In most languages, such procedures can be executed only by using a cue. In COBOL - and perhaps some other languages - a set of procedures used as a subroutine is no different from other procedures and can be executed as an open subroutine. The procedures are used in-line in the program. (See also .531.)

.534 Mechanism

This paragraph gives key words or examples of the various forms of cues and returns. Cues may be made with or without parameters and the number of possible parameters may be limited.

In a language which delimits the subroutine, the return may sometimes be omitted because it is implied as a jump immediately following the last procedure before the delimiter. If alternative returns from other places in the procedures are required, a formal return verb may be used, but if not available, it is usual to insert a named dummy procedure at the end of the routine and jump to that as a means of alternative exit.

.535 Names

When writing a subroutine which may be used in more than one program or in many places in a program, the names of data items referred to in the subroutine may have certain restrictions. Names may have local or universal meaning. A local name is one which has meaning only of a certain kind within its own subroutine, and if that same name is used elsewhere in the program, it does not refer to the same data item. A universal name means that a name used in the subroutine will refer to exactly the same item as it would if used elsewhere in the program. When local names are being used, it is necessary for a subroutine entry procedure to arrange that these be treated as parameters. The cue must specify the meaning of the parameters and other names must refer to locations or data items used only within the subroutine. (For a more detailed discussion of the regions of meanings of names, see paragraph .27.)

.536 Nesting limit

This shows any restrictions on the degree to which subroutines may be nested inside each other; that is, whether or not a subroutine can call another subroutine within itself.

.537 Automatic recursion allowed

This is the property of a subroutine being able to call itself. It also includes the property whereby a lower level subroutine nested within some higher level subroutine is able to call the higher level subroutine. It is not frequently available.

.54 <u>Function Definition by Procedure</u>

This is a particular type of subroutine. Instead of being cued formally by a verb such as DO or PERFORM, it has an implied cue. The subroutine is given a name (for example, SIN) which can be used as a variable in a statement; e.g.,

Z = Y + SIN(X)

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and whenever it is encountered, the value of SIN(X) is defined as that produced by cu-ing subroutine SIN and setting its parameter by using X.

.55 Operand Definition by Procedure

This is a particular type of subroutine. It is similar to Function Definition (See .54) except that there are no parameters; therefore, the names used must be non-local.

.56 Loop Control

This is the ability to be able to specify a certain set of procedures that are to be executed repetitively. The specification of the number of times that the loop is to be excuted may be given in a number of different ways. It is usually possible, at the same time, to arrange that a subscript is stepped through a number of values as the individual repetitions of the loop are initiated. Loops may be nested within each other. It is usually possible to exit from a loop before the externally-specified condition occurs because of some alternative criteria within the loop.

.561 Designation of loop

It is necessary to be able to show the start and the end of the series of procedures that comprise the loop. This may be done by the delimiters, by quoting a name given to the set, or by quoting the names of the first and last procedures in the set.

.562 Control by count

The simplest form of loop is that which is executed a certain number of times. The number may be specified by a literal or by the value of some data item.

.563 Control by step

This is a frequently-employed method of control when using subscripts. A control variable is initialized at a given value and then stepped by a given increment for each repetition of the loop until it either attains some end value or some condition exists. The control variable may be restricted to being a special index variable or allowed to be any variable. The step size may be restricted to integer values and sometimes is even restricted to positive integer values. The criterion for the end of the loop is normally that point at which the value of the control variable has attained a limit value, or when it has exceeded the limit. Instead of one control variable, it may sometimes be possible to step several variables in synchronism with each other, usually because they need different sizes of step.

.564 Control by condition

This may or may not be combined with a stepping facility for each repetition of the loop. It means that the end of the loop is controlled by some kind of conditional clause, usually preceded by the word "until".

.565 Control by list

This is a case in which the control variable takes values which are not obtained by a series of steps of a fixed increment but is a specific list of values; e.g., x = 1, 5, 6, 42, 17.

.566 Nesting limit

Sometimes there are limits to the number of loops that may be nested within each other.

.567 Jump-out of loop

In most languages, it is possible to write statements within a loop that can jump to statements outside the loop. Some languages forbid such jump-outs. Most systems do

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not allow "jump-ins" because then the control variable is not initialized and is undefined. Returns from subroutines are one special form of jump-in that is allowed.

.568 Control variable exit status

Some condition finally causes the stopping of repetitions of the loop, such as the value attained by the control variable. After coming out of the loop, some systems insure that the value of the control variables is still available. Other systems make the control variables available only when a jump-out has or has not been taken. If such facilities are not provided within the loop itself, some special procedures must be written to provide the facility where it is required.

.6 EXTENSION OF THE LANGUAGE

It is not usually possible to make changes in the language while writing programs in it. If problems arise which can take advantage of extensions to the language, they normally are solved by writing a subroutine for use within a particular program; however, it is possible in some languages to make additions to the language, and any available facilities are described.

.7 LIBRARY FACILITIES

A program library is a collection of open and closed subroutines, even complete programs and sometimes data descriptions which are available for use with programs written in the language. The important features are the rights of making insertions into the library, the entities it contains, the form of the library, and the method of call of items from the library.

.71 Identity

This is the name, nicknames and abbreviations by which the library is known.

.72 Kind of Library

A library may or may not accept insertions by programmers in general, It may be a general library for use by any programmer or a facility for providing a private library for individual programmers or groups of programmers.

.73 Form of Storage

The most convenient form is magnetic tape or auxiliary internal storage such as a disc store. A less convenient form is punch cards or paper tape. Sometimes the library only exists in a written form and has to be transcribed by the programmer or a data preparation system to suitable form for use with individual programs.

.74 Variety of Contents

The most usual library contents are open and closed subroutines for incorporation in programs. Other possible contents are complete programs for use in operating systems, diagnostic routines, supervisor systems and interpreters. Libraries can also contain data information such as file and record layouts, conversion tables and special format tables for input-output control.

.75 Mechanism

This describes the general running and use of the library.

.751 Insertion of any item

If this is done during a computer run, it is sometimes possible to do it as part of program translation and sometimes restricted to special library runs.

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.752 Language of new item

This is the way in which new items must be prepared for insertion.

.753 Method of call

This is the mechanism which causes a copy of an item of the library to be inserted into a program. It may be automatic when a cue or macro in the program is encountered referring to that item, or each program may have to provide a list of calls, or it may be that manual preparation of packs of cards is necessary.

.76 Types of Routine

Libraries vary in the types of routines which can be held in them. Some only permit open routines, some only permit closed routines, some may accept either provided each routine is one or the other, a few permit a routine to be variable; i.e., it can be called either as open or closed. This section states which types can be inserted, open, closed or variable.

.8 TRANSLATOR CONTROL

These are facilities that enable a programmer to control the translation or to give information to the translator to assist the translation.

.81 Transfer to Another Language

This facility enables a programmer to take advantage of other languages. There are two main cases. In one case, the other language is a lower-level language, usually the language of the object program. This enables a programmer to overcome limitations or restrictions in a language by by-passing the translator, or to optimize a particular routine by by-passing the translator. In the other case, the language is a similar level but different orientation. This enables a programmer to use a mixture of languages, perhaps ALGOL for algebraic computation and COBOL for input-output. The interfaces between the parts of the program in different languages, moreover, must be very carefully considered.

.82 Optimizing Information

A written program does not usually contain any significant amount of information that would assist the translator in optimizing the translation or the object program. Some languages do allow special statements to overcome this. The statements divide into two kinds: the first indicates the amount of use of groups of procedures; the second indicates the amount of use of groups of data.

The quantity of information that can be extracted from such statements varies widely, and the use made of the information by different translators, therefore, varies even more.

In FORTRAN, information of the first kind is given indirectly by stating the relative frequency of taking alternative paths at its branch points. Other useful information includes the sizes of variable tables or arrays and the abandonment of parts of a program when no longer required during a run.

.83 Translator Environment

This enables the programmer to describe the configuration of the translating computer so that the translator can adjust itself, or be adjusted, to the facilities available.

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.84 Target Computer Environment

This enables the programmer to describe the configuration of the target computer - the one on which the program will be executed - so that the appropriate allocations can be made.

.85 Program Documentation Control

This enables the programmer to control the kinds and quantities of detail of the program and translation documentation. By eliminating unnecessary detail, it is sometimes possible to have faster translation, but still be able at other times to produce detail in special places.

The programmer is usually able to indicate a title to be printed at the head of all documentation.

.9 TARGET COMPUTER ALLOCATION CONTROL

This enables the programmer to make specific statements about allocation as opposed to just describing the facilities available. Sometimes it is mandatory that the programmer make the allocation.

.91 Choice of Storage Level

This enables the programmer to state in which level of storage segments of a routine should be held. Sometimes his statement is limited to a priority list or preferred segments for particular levels.

.92 Address Allocation

This enables the programmer to specify actual addresses within a level, not necessarily in absolute form. In a multi-running system, allocation might be relative to one reference location for each program.

.93 Arrangement of Items in Words in Unpacked Form

This is any facility similar to SYNCHRONIZE in COBOL, by which the programmer specifies how an item must be held, rather than allows the translator to make a free choice.

.94 Assignment of Input-Output Devices

This enables the programmer to specify the units to be used for each file.

.95 Input-Output Areas

This enables the programmer to allocate areas so that simultaneous operations can be performed, or to share input-output areas for chosen files.

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COBOL

.1 INTRODUCTION

COBOL is a language specifically oriented toward business applications. It is intended to be used as a common programming language for many varieties of computers, both large and small. The style is that of formal English phrases, with the option of omitting certain words which only affect clarity to the reader; e.g.,

WRITE REPORT AFTER 5

is the same as

WRITE REPORT AFTER ADVANCING 5 LINES.

The second and current official publication, known as "COBOL 61" (reference 1, see paragraph .9) was made available in the summer of 1961. The earlier publication is known as "COBOL 60." Meanwhile, extensions such as "report writer," "sort," and table-handling functions are being considered for inclusion in 1962. Currently, thirteen manufacturers are implementing thirty COBOL compilers in the USA.

For each implementation of COBOL, the following details are important and are covered in the various descriptions.

COBOL edition - e.g., COBOL 60.

Deficiencies - the "required" facilities that are not covered.

Electives - the electives that have been included.

Extensions - any additional facilities beyond those of Required and Elective COBOL 61 that have been included.

All the required facilities should be included for general compatibility. The electives add to the general convenience, as do the extensions. As far as compatibility is concerned, it is important to know the common sub-set of facilities of the various versions of the language which one intends to use. It is also important to note any potential incompatibilities caused by extensions; e.g., extra key words. Some comments on compatibility are made in paragraph .2 and the electives are listed in paragraph .3.

.2 COMPATIBILITY

Compatibility may be judged by the ease with which a program running on one system can be transferred to another. The transfer involves two important factors: first, the proportion of the program to be re-written; second, the difficulty of the re-writing. COBOL tends to minimize both of these factors. In the first case programs should be written to use parts of COBOL that are common to both systems, hence the existence of "Required COBOL." Some changes are, however, inevitable where input-output and environment are concerned. These have been gathered into separate divisions of COBOL, and re-writing is easy because the original and revised programs both use the same language.

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However, there are some hidden differences in which the COBOL specifications are not specific and are open to alternative implementations, or where the specifications are ambiguous. Although several ambiguous cases are known to exist, these are not officially published.

At present, COBOL is not a perfect common language and requires the user's careful attention to the relevant manuals. Each implementation of COBOL varies in some way from the others, and none of them cover all the possible facilities. During the present phase, a sub-set of COBOL 61 called REQUIRED COBOL 61 has been defined. A "proper COBOL compiler" is one that covers at least this sub-set of facilities. There are two other important sets of facilities - electives and options.

Options are those facilities that a programmer may or may not use, as he desires.

Electives are those facilities that are not part of REQUIRED COBOL 61.

Certain facilities are undefined and may be implemented in different ways. There is no COBOL standard to show whether a letter "A" should collate "lower" than "B", let alone whether letters collate lower than numerals and how the other characters are treated. A second undefined feature is the OPEN REVERSED facility.

.3 ELECTIVES

The electives for COBOL 61 are numbered and listed below. The same numbers are used in the description of each version of COBOL. A reference to the page number of the official Department of Defense Report (reference #1) is given for each; e.g., (IV-3).

.31 Chapter V. Characters and Words

#1 Characters Used in Formulas (V-2)

(See #22 COMPUTE)

#2 Characters Used in Relations (V-2)

The use of algebraic symbols

> Greater Than

< Less Than

= Equal to

#3 Semicolon (;) (V-1)

This is used freely in all divisions as an option to separate statements for the convenience of the reader; it is ignored by the translator; e.g.,

ADD A TO B   ADD C TO D.

is equivalent to

ADD A TO B; ADD C TO D.

#4 All literals above 120 characters in length (V-4)

#5 UPPER-BOUND (V-5)
UPPER-BOUNDS
LOWER-BOUND
LOWER-BOUNDS

These are used to represent the high and low sentinels or delimiters of sets of data.

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#6 HIGH-VALUE (V-5)
HIGH-VALUES
LOW-VALUE
LOW-VALUES

These are used to represent the high and low values of a computer's collating sequence.

#7 The "PREPARED FOR Compute-name" option (VI-2)

These enable sets of data descriptions applicable to several computers to be written and labelled separately. The translator may not ignore the inappropriate ones.

.32 <u>The following File Description clauses and/or options:</u>

#8 The "integer-2 TO" option of BLOCK size (VI-6)

This enables a block size to be expressed as a range instead of a fixed number of records or characters.

#9 The "FILE CONTAINS....." clause (VI-9)

This enables the programmer to indicate the approximate size of a file, to assist the translator in optimization.

#10 The "data-name-1," and the "library-name IN LIBRARY" options in the LABEL RECORDS clause (VI-10)

This enables the programmer to insert his own label formats, or choose from sets held in the library instead of being restricted to the choice between an installation standard or none (see #21).

#11 The "SEQUENCED ON...." clause (VI-14)

This specifies the keys on which records in a file are sequenced. It is useful for the reader and could enable a translator to check them at run time, but it is not required to do so..

#12 The "data-name-4 HASHED" option in the VALUE clause (VI-15)

This specifies that certain items in all records are to be "hash-totalled" and checked against a total in the end-label for the file.

.33 <u>The following Record Description clauses and/or options</u>

#13 The "integer-1 TO" and the "DEPENDING ON..." options in the OCCURS clause (VI-31)

This enables the number of entries in a table to vary, enables the range to be specified, and provides an optional means of knowing the number at any time.

#14 The symbol "L" and the "DEPENDING ON..." option in the PICTURE clause (VI-33)

This enables items to be designated as variable length and provides an optional means of knowing the length at any time (see also #19).

#15 The "BITS" option in the POINT LOCATION clause (VI-36)

This enables items to be specified in a binary scale.

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#16 The "RANGE IS..." clause (VI-37)

This enables the range of values of a numeric item or of the individual character of alphameric items to be specified for the convenience of the translator.

#17 The complete RENAMES clause (VI-39)

This enables alternative, possibly overlapping, groupings of items of data to be specified for efficient object space.

#18 The "SIGN IS data-name" option in the SIGN clause (VI-40)

This enables a separate data item to be specified, whose values represents the sign of the data item being described.

#19 The "integer-1 TO" and the "DEPENDING ON....." options in the SIZE clause (VI-41)

This is an alternative method for that shown in #14.

#20 All of Option 2 under the VALUE clause (VI-44)

This enables one condition name to be associated with more than one value of a conditional variable.

#21 All of paragraph 4.1.2 entitled "Specifications and Handling of Labels" (VI-46)

This is a facility to describe file and tape labels in detail (see #10).

.34 The following verbs:

#22 COMPUTE (VII-31)

This enables algebraic formulae to be used (see #1 and #32).

#23 DEFINE (VII-32)

This enables new verbs and formats of statements using them to be defined.

#24 ENTER (VII-36)

This is a means of changing to another language.

#25 INCLUDE (VII-41)

This enables library routines to be called (also see # 48).

#26 USE (VII-60)

This enables "own coding" to be specified for input-output errors and file and tape labels in addition to any standard routines.

.35 The following verb options:

#27 LOCK option of the CLOSE verb (VII-28)

This enables a tape to be rewound and locked.

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#28 CORRESPONDING option of the MOVE verb (VII-44)

This enables moves to be made in which there are excess source or destination items; and permits the formats of individual items to be different.

#29 REVERSED option of the OPEN verb (VII-48)

This enables a single-reel file to be opened at its file-end label and read in the reverse sequence to the recording.

#30 ADVANCING option of the WRITE verb (VII-61)

This enables a variable amount of paper advance to be specified at each line of print.

#31 The provisions of Note 3b under the STOP verb (VII-58)

This specifies that a translation for a target computer with no alpha display must arrange and print a numeric-alphabetic item list used in the display.

#32 All provisions regarding the use of formulas (VII-21)

See #22.

#33 With reference to all of the arithmetic verbs, the ability to handle data items larger than ten (10) decimal digits in size. Affected are the verbs:
ADD, (VII-25)
COMPUTE, (VII-31)
DIVIDE, (VII-35)
MULTIPLY, (VII-46)
SUBTRACT, (VII-59)

#34 The following specific relation forms

IS UNEQUAL TO (VII-7)
EQUALS (VII-7)
EXCEEDS (VII-7)

#35 The following specific test form (VII-7)

IF {data-name / formula} IS NOT ZERO

#36 In the composition of compound conditional sentences, the use of implied objects with implied subjects (VII-8).

#37 Compound conditions other than those formed from a simple condition, with a common subject and relation (or test), connected to objects by either all ANDS or all ORS (VII-8).

#38 In form 1 of VII.2.2.2, the ability to have "statement-1" be a conditional statement, and the permitting of conditional statements in "statement-2" beyond one level in depth (VII-1)

Form 1 is:

IF condition {statement-1 / NEXT SENTENCE} {OTHERWISE / ELSE} {statement-2 / NEXT SENTENCE}

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#39 When form 2 of VII. 2. 2. 2 is not embedded in form 1, of VII. 2. 2. 2, the ability to handle anything other than ON SIZE ERROR, or AT END (VII-1).

.36 The following Environment Division options:

#40 In Option 2 of the SOURCE-COMPUTER paragraph, all options except "computer-name" (VIII-2)

These enable the programmer to describe a sub-set of an automatic description rather than rely on a library routine or an unqualified automatic description.

#41 In Option 2 of the OBJECT-COMPUTER paragraph, all options except "computer-name" (VIII-4)

These enable the programmer to describe a sub-set of an automatic description rather than rely on a library routine or an unqualified automatic description.

#42 All of Option 3 of the SPECIAL-NAMES paragraph (VIII-6)

This enables names to be given to parts of a console so that they can be referred to as data names in ACCEPT, WRITE, and DISPLAY.

#43 Option 1 of the FILE-CONTROL paragraph (VIII-8)

This enables a library description to be used to describe a file, and thus be common to several programs.

#44 In Option 2 of the FILE-CONTROL paragraph, the "PRIORITY IS priority" option (VIII-8)

This enables priorities to be assigned to files for multi-programming situations.

#45 Option 1 of the I-O-CONTROL paragraph (VIII-10)

This enables a library description to be used to describe the input-output, re-run, input-output area, and multi-file techniques, and thus be common to several programs.

#46 All of Option 2 of the I-O-CONTROL paragraph. However, each implementor is expected to provide at least one of the specified forms of the RERUN option. (VIII-10)

This enables the programmer to describe his own input-output, re-run, input-output area, and multi-file techniques.

.37 The following Identification Division option:

#47 Note 1 under the DATE-COMPILED entry (IX-3)

This enables the programmer to have the current date printed when his program is compiled.

.38 The following Special Features:

#48 The discussion on the PROCEDURE DIVISION entries in the library (X-1)

This enables library routines to be called. (Also see #25.)

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#49 The entire discussion on "SEGMENTATION" (X-3)

This enables the programmer to divide his program into segments and to give them priorities, to allow a compiler to arrange efficient allocation to different storage levels and suitable overlay procedures.

.4 GENERAL DESCRIPTION OF COBOL

(Reprinted from reference 1)

.41 General Philosophy Of COBOL Development

The task of the committee was that of preparing a common business oriented language. By this is meant the establishment of a standard method of expressing solutions for a certain class of problems normally referred to as "business data processing." The word "common" was interpreted to mean that the source program language would be compatible among a significant group of computers. Differences in computers relating to size, types of peripheral equipment, and different order structure make complete compatibility impossible. Thus, the realistic goal of achieving the maximum amount of compatibility on present day computers was the philosophy or framework within which all work was done.

In describing a data processing problem, there are two elements involved. One is the set of procedures which specify how the data is to be manipulated, and the other is a description of the data involved. Furthermore, it was recognized that certain information pertaining to the specific computer on which the problem is to be run, and some information identifying the program were also a necessary part of the description of a problem. The information pertaining to the computer itself, of course, would never carry over from one computer to another. However, it was felt that the advantages of having a common means of expression were sufficiently great to warrant the development of a standard form for even those items which clearly changed from computer to computer.

.42 COBOL System Description

.421 General

The COBOL system is composed of two elements – the source program written in COBOL, and the compiler which translates this source program into an object program capable of running on a computer. This report, in general, considers only the source program and does not consider the second element (the compiler) directly. However, the specifications of a language obviously determine, to a large extent, the boundaries of a compiler. Therefore, the compiler is mentioned in certain cases to facilitate the explanation of the language.

A source program is used to specify the solution of a business data processing problem. The four elements of this specification are:

1. The identification of the program.
2. The description of the equipment being used in the processing.
3. The description of the data being processed.
4. The set of procedures which determine how the data is to be processed.

The COBOL System has a separate division within the source program for each of these elements. The names of these divisions are:

IDENTIFICATION
ENVIRONMENT
DATA
PROCEDURE

.422 Identification Division

The purpose of the IDENTIFICATION DIVISION is to identify the Source Program and outputs of a compilation. In addition, the user may include the data that the program was written, the date that the compilation was accomplished and any other information which is desired.

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.423 Environment Division

The ENVIRONMENT DIVISION is that part of the source program which specifies the equipment being used. It contains descriptions of the computers to be used both for compiling the source program and for running the object program. Memory size, number of tape units, hardware switches, printers, etc., are among many items that may be mentioned for a particular computer. Problem oriented names may be assigned to a particular equipment. Those aspects of a file which relate directly to hardware are described here. Because this division deals entirely with the specifications of the equipment being used, it is largely computer dependent.

.424 Data Division

The DATA DIVISION uses file and record descriptions to describe the files of data that the object program is to manipulate or create, and the individual logical records which comprise these files. The characteristics or properties of the data are described in relation to a Standard Data Format rather than an equipment oriented format. Therefore, this division is to a large extent computer-independent. So, while compatibility among computers cannot, in general, be absolutely assured, careful planning in the data layout will permit the same data descriptions, with minor modification, to apply to more than one computer.

.425 Procedure Division

The PROCEDURE DIVISION specifies the steps that the user wishes the computer to follow. These steps are expressed in terms of meaningful English words, statements, sentences, and paragraphs. This aspect of of the overall system is often referred to as the "program"; in reality it is only part of the total specification of the problem solution (i.e. the program), and is insufficient, by itself, to describe the entire problem. This is true because repeated references must be made – either explicitly or implicitly – to information appearing in the other divisions. This division, more than any other, allows the user to express his thoughts in meaningful English. Concepts of verbs to denote actions, and sentences to describe procedures, are basic, as is the use of conditional statements to provide alternative paths of action. The PROCEDURE DIVISION is essentially computer independent. That is, any user of COBOL can understand the information appearing in this division without regard to any particular computer. Furthermore, every COBOL compiler will interpret this information in the same way.

.426 Compatibility

The amount of inter-computer compatibility throughout the COBOL system varies with the division, and the users' effort expended to obtain this goal. In the PROCEDURE DIVISION, virtually no effort is needed to maintain compatibility among computers. In the DATA DIVISION, some care must be taken to minimize the loss of object program efficiency. In the ENVIRONMENT DIVISION, almost all information is computer-dependent and, therefore, the compatibility is based on ease of understanding rather than direct transference. The IDENTIFICATION DIVISION, like the PROCEDURE DIVISION, should require virtually no effort to maintain compatibility.

.427 Summary

The COBOL System is the first large scale effort in defining a single language which permits the writing of data processing problems for many computers. That this publication is merely one step along the way, with a great deal of additional work required before the final system can be achieved, is undeniable. However, with the significant amount of compatibility which has already been achieved, the COBOL System provides the user with an effective means of describing the solution of his data processing problems.

.43 <u>Objectives</u>

There are hundreds of business, government, and educational organizations using a wide variety of electronic computers in data processing operations. Some of the major users have more than one type of computer applied to the same general data processing application at different locations. The experience of these organizations to date indicates that a major problem in using computing equipment wisely and efficiently lies in stating the data processing application in such a way that computer programs are developed and maintained with a minimum of time and programming effort.

A <u>CO</u>mmon <u>B</u>usiness <u>O</u>riented <u>L</u>anguage, independent of any make or model of computer, open-ended and stated in English, would do much to solve or reduce this problem. Such a language would also simplify and speed up the related problem of training personnel in the design of data processing systems and the development of computer programs for such systems.

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#49 The entire discussion on "SEGMENTATION" (X-3)

This enables the programmer to divide his program into segments and to give them priorities, to allow a compiler to arrange efficient allocation to different storage levels and suitable overlay procedures.

.4 GENERAL DESCRIPTION OF COBOL

(Reprinted from reference 1)

.41 General Philosophy Of COBOL Development

The task of the committee was that of preparing a common business oriented language. By this is meant the establishment of a standard method of expressing solutions for a certain class of problems normally referred to as "business data processing." The word "common" was interpreted to mean that the source program language would be compatible among a significant group of computers. Differences in computers relating to size, types of peripheral equipment, and different order structure make complete compatibility impossible. Thus, the realistic goal of achieving the maximum amount of compatibility on present day computers was the philosophy or framework within which all work was done.

In describing a data processing problem, there are two elements involved. One is the set of procedures which specify how the data is to be manipulated, and the other is a description of the data involved. Furthermore, it was recognized that certain information pertaining to the specific computer on which the problem is to be run, and some information identifying the program were also a necessary part of the description of a problem. The information pertaining to the computer itself, of course, would never carry over from one computer to another. However, it was felt that the advantages of having a common means of expression were sufficiently great to warrant the development of a standard form for even those items which clearly changed from computer to computer.

.42 COBOL System Description

.421 General

The COBOL system is composed of two elements – the source program written in COBOL, and the compiler which translates this source program into an object program capable of running on a computer. This report, in general, considers only the source program and does not consider the second element (the compiler) directly. However, the specifications of a language obviously determine, to a large extent, the boundaries of a compiler. Therefore, the compiler is mentioned in certain cases to facilitate the explanation of the language.

A source program is used to specify the solution of a business data processing problem. The four elements of this specification are:

1. The identification of the program.

2. The description of the equipment being used in the processing.

3. The description of the data being processed.

4. The set of procedures which determine how the data is to be processed.

The COBOL System has a separate division within the source program for each of these elements. The names of these divisions are:

IDENTIFICATION
ENVIRONMENT
DATA
PROCEDURE

.422 Identification Division

The purpose of the IDENTIFICATION DIVISION is to identify the Source Program and outputs of a compilation. In addition, the user may include the data that the program was written, the date that the compilation was accomplished and any other information which is desired.

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.423 Environment Division

The ENVIRONMENT DIVISION is that part of the source program which specifies the equipment being used. It contains descriptions of the computers to be used both for compiling the source program and for running the object program. Memory size, number of tape units, hardware switches, printers, etc., are among many items that may be mentioned for a particular computer. Problem oriented names may be assigned to a particular equipment. Those aspects of a file which relate directly to hardware are described here. Because this division deals entirely with the specifications of the equipment being used, it is largely computer dependent.

.424 Data Division

The DATA DIVISION uses file and record descriptions to describe the files of data that the object program is to manipulate or create, and the individual logical records which comprise these files. The characteristics or properties of the data are described in relation to a Standard Data Format rather than an equipment oriented format. Therefore, this division is to a large extent computer-independent. So, while compatibility among computers cannot, in general, be absolutely assured, careful planning in the data layout will permit the same data descriptions, with minor modification, to apply to more than one computer.

.425 Procedure Division

The PROCEDURE DIVISION specifies the steps that the user wishes the computer to follow. These steps are expressed in terms of meaningful English words, statements, sentences, and paragraphs. This aspect of of the overall system is often referred to as the "program"; in reality it is only part of the total specification of the problem solution (i.e. the program), and is insufficient, by itself, to describe the entire problem. This is true because repeated references must be made — either explicitly or implicitly — to information appearing in the other divisions. This division, more than any other, allows the user to express his thoughts in meaningful English. Concepts of verbs to denote actions, and sentences to describe procedures, are basic, as is the use of conditional statements to provide alternative paths of action. The PROCEDURE DIVISION is essentially computer independent. That is, any user of COBOL can understand the information appearing in this division without regard to any particular computer. Furthermore, every COBOL compiler will interpret this information in the same way.

.426 Compatibility

The amount of inter-computer compatibility throughout the COBOL system varies with the division, and the users' effort expended to obtain this goal. In the PROCEDURE DIVISION, virtually no effort is needed to maintain compatibility among computers. In the DATA DIVISION, some care must be taken to minimize the loss of object program efficiency. In the ENVIRONMENT DIVISION, almost all information is computer-dependent and, therefore, the compatibility is based on ease of understanding rather than direct transference. The IDENTIFICATION DIVISION, like the PROCEDURE DIVISION, should require virtually no effort to maintain compatibility.

.427 Summary

The COBOL System is the first large scale effort in defining a single language which permits the writing of data processing problems for many computers. That this publication is merely one step along the way, with a great deal of additional work required before the final system can be achieved, is undeniable. However, with the significant amount of compatibility which has already been achieved, the COBOL System provides the user with an effective means of describing the solution of his data processing problems.

.43 Objectives

There are hundreds of business, government, and educational organizations using a wide variety of electronic computers in data processing operations. Some of the major users have more than one type of computer applied to the same general data processing application at different locations. The experience of these organizations to date indicates that a major problem in using computing equipment wisely and efficiently lies in stating the data processing application in such a way that computer programs are developed and maintained with a minimum of time and programming effort.

A COmmon Business Oriented Language, independent of any make or model of computer, open-ended and stated in English, would do much to solve or reduce this problem. Such a language would also simplify and speed up the related problem of training personnel in the design of data processing systems and the development of computer programs for such systems.

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.46 Maintenance

In recognition of the fact that the task of defining a COmmon Business Oriented Language does not end with publishing specifications, the Executive Committee has created a Maintenance Committee.

The Maintenance Committee is comprised of a Users Group and a Manufacturer Group. Its task is to give continuing attention to the system in order to answer questions arising from users and implementors of the language, and also to make definitive modifications (including additions, clarifications and changes). Additions, clarifications, and changes to COBOL, on which the Users and Manufacturers Groups are agreed, will be reproduced as working papers pending the next annual publication of a revised COBOL Manual. Proposals for supplements to COBOL will be accepted from outside organizations or individuals by the Executive Committee, and sent to the Users and Manufacturers Groups for concurrent consideration.

.47 Acknowledgment

It is requested of all organizations who intend to implement the COBOL system, and expect to write a manual describing the operation of their processor of the COBOL system, that the remainder of the Acknowledgment Section be included in its entirety as part of the preface to any such publication.

"This publication is based on the COBOL System developed in 1959 by a committee composed of government users and computer manufacturers. The organizations participating in the original development were:

Air Materiel Command, United States Air Force
Bureau of Standards, Department of Commerce
David Taylor Model Basin, Bureau of Ships, U.S. Navy
Electronic Data Processing Division, Minneapolis-Honeywell Regulator Company
Burroughs Corporation
International Business Machines Corporation
Radio Corporation of America
Sylvania Electric Products, Inc.
Univac Division of Sperry-Rand Corporation

In addition to the organizations listed above, the following other organizations participated in the work of the Maintenance Group.

Allstate Insurance Company
Bendix Corporation, Computer Division
Control Data Corporation
DuPont Corporation
General Electric Company
General Motors Corporation
Lockheed Aircraft Corporation
National Cash Register Company
Philco Corporation
Standard Oil Company (N.J.)
United States Steel Corporation

This COBOL-61 manual is the result of contributions made by all of the above mentioned organizations. No warranty, expressed or implied, is made by any contributor or by the committee as to the accuracy and functioning of the programming system and language. Moreover, no responsibility is assumed by any contributor, or by the committee, in connection therewith.

It is reasonable to assume that a number of improvements and additions will be made to COBOL. Every effort will be made to insure that the improvements and corrections will be made in an orderly fashion, with due recognition of existing users' investments in programming. However, this protection can be positively assured only by individual implementors.

"Procedures have been established for the maintenance of COBOL. Inquiries concerning the procedures and the methods for proposing changes should be directed to the Executive Committee of the Conference on Data Systems Languages."

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MACHINE ORIENTED LANGUAGE

§ 170.

1. GENERAL

Machine oriented programming languages are those in which there is a general one-to-one correspondence between the statements of the source program and the instructions of the object program. The statements may use absolute address or relative address or symbolic form. Frequently macro and pseudo operations are included to provide special facilities. These languages have one additional feature distinguishing them from process-oriented languages in that they have few or no explicit data descriptions, and it is often necessary to control code conversion, the scaling of fixed point quantities, alignment of alphameric items, and the structure of records and files, by the procedure statements.

.11 Identity

The identity of the language may take several forms: its full name, a code number, an abbreviation used throughout the report and perhaps a nickname by which it is widely known. All of these are included in the index for the individual system and in the general index. Where several versions may exist for different configurations of the system, they are described in one section. Any differences between them are specified in the appropriate places and annotated with the abbreviated name.

.12 Origin

In addition to the languages developed by the manufacturer of computers, many programming languages have been developed by organizations who are users of the equipment. This does not occur very frequently for machine oriented languages in their basic form, but does occur for adaptations and extensions introduced in order to provide macro operation facilities or to fit in with supervisor routines and other software facilities.

.13 Reference

This is the name and number of any document that is a formal definition or descriptive specification of the language.

.14 Description

This states the general characteristics of the different versions available and notes the differences among them. It also draws attention to any novel or outstanding features or deficiencies, and to any relationship to other languages of the same type.

.15 Publication Date

This is the date of the first comprehensive published specification of the language of sufficient detail to enable programs to be written.

.2 LANGUAGE FORMAT

This paragraph is divided into two parts: a diagram of the form used for writing the procedures and a description of its use.

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.21 Diagram

The diagram is usually a coding sheet which is prepared in such a way that the subsequent transcription of the program onto cards, paper tape or magnetic tape is formalized. It shows the fields available for the different parts of the statements, the layout and sizes of fields and the notation for delimiters, if a variable format is employed.

.22 Legend

This states the prime use in the language of each of the important fields on the diagram. It shows the parts that are optional, the fixed size or variation allowed, and how these parts are related to the parts of instructions in machine code. It also shows whether the entries are made in decimal, alphameric, hexadecimal, or other forms.

.23 Corrections

While a program is being debugged, it is necessary to be able to make changes. This section describes any special facilities available to assist in the three different types of change: insertions of new items, deletions of items, and alterations to items. Some languages and their translators have no special provision for corrections, and either the relevant parts must be entirely re-written and re-translated or, to avoid re-translation, the changes may be made to the object program.

.24 Special Conventions

The legend gives the straightforward use of the coding sheet; this section describes any special conventions that may exist.

.241 Compound addresses

Any method of forming a complex address by adding or subtracting values of labels and literals is stated; e.g., a relative address composed of a base value and an adjustment.

.242 Multi-addresses

Any method of specifying several operands in a space normally used for one is stated.

.243 Literals

Any permitted use of literals for either the absolute or adjustment parts of an address is stated.

.244 Special coded addresses

Any special conventions used are stated; e.g., a symbol that means the address of the current instruction.

.3 LABELS

Labels are the formal names given in the language to entities such as statements, routines, locations, and sometimes devices. Each label has the following important properties.

Existence

This states whether the label of some entity is optional or mandatory, or has any special property; e.g., that it should be in some special sequence. In most languages, it is only mandatory to label those statements that are referenced elsewhere, and the labeling of un-referenced statements is optional.

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Region

For a label, a name, or any identifier to be of practical use in a program, its meaning must be defined for each use in every place it occurs in procedure statements. The name XYZ may mean one thing in one program and something else in another. In fact, the meaning of an identifier is restricted to a "region". In the simplest case, the region of a particular meaning of any identifier is the program in which that meaning is defined.

In many languages, the region of a meaning of an identifier can be different from the entire program, being usually only a part of the program.

Some languages have severe restrictions on the number of identifiers allowed in one program. This may be due to restrictions of translator space or language style. In these cases, the program can sometimes be divided into parts in which two kinds of identifiers are used: "universal" and "local". A universal identifier is defined as having one meaning for the whole program. A local identifier is defined only for one part of the program. Then one name can have a different local meaning in each part.

Some languages allow parts of programs which have been written separately with many local identifiers to have statements that make certain local identifiers in different parts mean the same thing; that is, their meaning becomes universal by the use of synonyms.

An important use of local identifiers is in subroutines. The writer of a subroutine may not know the identifiers that will be used in all the different programs with which his subroutine may be associated. It is a common convention that all identifiers in a subroutine are "local" to the subroutine or else are "dynamic parameters".

Local identifiers refer to variables or statements that are used only within the subroutine itself, such as destinations for internal jumps and working locations. Dynamic parameters are associated with the current inputs and outputs of the subroutine. At the time of cueing a subroutine, the meanings of the parameters are defined; for example, when a program using identifiers p, q and r uses a sine routine whose parameter is named x, at different time, x may be set to be the same as p or q or r, as required. A parameter may be set by value or by name.

To set a parameter x by value p means that, everywhere in the subroutine, identifier x is understood to mean the value of the item identified by p at the time the subroutine was cued.

To set a parameter x by name p means that everywhere in the subroutine that identifier x is used, it is understood to mean the identifier p. In this case, it is possible that the value of p can be altered by the subroutine, even if p is not the principal result of the subroutine (called a side-effect of the subroutine).

All identifiers local to a region (such as a subroutine) must be defined for the region. If an identifier is not defined for a region, it is called non-local. If regions can be nested, the convention usually adopted is that, in a region x, a non-local identifier, p, has the same meaning as p has in the region y, in which the current region, x, is nested. This is a recursive definition. For example, suppose that identifiers A to Z are defined for a program, A to M defined for a subroutine, and A to G defined for a sub-subroutine; then

> in the sub-subroutine, A to G are local and H to Z are non-local, taking the meanings they have in the subroutine.
>
> in the subroutine, A to M are local and N to Z non-local.
>
> in the program, A to Z are all local.

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Note that N to Z have the same meaning everywhere; they are universal by usage. A to G are different at each level of nesting of the regions.

An identifier universal to region X is one that may not be local to any other region nested within region X.

Key words are universal to a language, and there may be certain key words universal to an installation. The setting up of a common data description in COBOL can produce identifiers universal to a suite of programs.

The existence of regions, and different types of parameters, allow sophisticated and flexible language structures, but if used in an indiscriminate way, the results can also be confusing, or difficult to understand, or even ambiguous.

Formation Rule

Because of the formalized nature of machine-coded languages, the freedom given to the programmer in composing labels is usually restricted, both in the size of the label and in the choices of the characters that may be used and their positions.

Designators

Frequently the formation rules are arranged in such a way that different kinds of entities have their labels formed so that the kind can be recognized from the label; for example, the initial letter of a label may denote the kind of entity being labeled.

.31 General Restrictions

These are the restrictions on labels that are necessary because of the formal nature of the language and are often conditioned by the layout of statements on the coding sheet.

.311 Maximum number of labels

This restriction is usually caused by the storage available in the translating computer and may be a function of the translator rather than of the language. The maximum may be coded as an over-all figure or may be coded as a series of separate figures for the labels of the various kinds of entities such as procedures, constants and items. There may be separate maxima for "universal" and "local" labels.

.312 Common label formation rule

Provision is made elsewhere to describe the formation rules separately for each of the different kinds of entities which may be labeled. If they have a common rule, there is less restraint on the composition of labels.

.313 Reserve labels

Often it is necessary that the labels be distinguished from certain other key words in the language. Sometimes this is accomplished by the position of the label on the coding sheet.

There may also be certain entities whose labels are used by master routines and library entries. If these labels were used by the programmer in an incorrect way, confusion could arise. This section lists the various classes of such "reserved" labels and states how many there are.

.314 Other restrictions

These are any other rules which are not obvious from the formation rules given below and which must not be violated in forming labels.

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.315 Designators

This is a list of those kinds of entities of data whose labels are formed in such a way that the class of the entity can be recognized from its label. The methods of designation are listed.

.316 Synonyms permitted

This states the conditions under which one entity may be referred to by more than one label.

.32 Universal Labels

.33 Local Labels

Where they exist, the existence, region and formation rule for the labels for each of the kinds of entities is enumerated. In some cases, the entities as such may not be recognized in the language. Labels for files and records are likely to be found only in special routines for input-output file operations or for the blocking and unblocking of input-output data.

.4 DATA

There are three kinds of data in a program, and in many machine oriented languages, there are no explicit differences among their labels. The three kinds are: Constants, Items in Working Areas, and Items in Input-Output Areas.

.41 Constants

Constants may exist in two forms in a program: either as tables of constants which are referred to by their labels or as literals in the procedures, in which case they are their own labels.

.411 Maximum sizes of constants

This states the maximum sizes of all the various types of constants that can be written into the program.

.412 Maximum sizes for literals

If the maximum sizes of constants that can be written as literals are different from those held in tables, the differences are listed here.

.413 Constants per line

When tables of constants are written, it is sometimes possible to write more than one on a line. This states the limitations that exist for this type of packing.

.42 Working Areas

These are areas set aside for variables that are used in the procedures but which are not covered by the input-output areas.

.421 Data layout

It is unusual for the data layout in machine oriented languages to be explicity written in a program unless the storage is able to accept variable length items, and it is necessary to set word marks or otherwise specify the boundaries of individual items. In general, the layout is implied by the method of writing the procedures, although the layout may be specified in a "comment" to assist the reader of the program.

.422 Data type

If it is necessary or convenient to indicate the type of data to be placed in an area, e.g.,

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alphameric as opposed to numeric, it is noted here. In some systems, the translators use this data either to make some consistency checks upon a program or to assign appropriate volumes of storage to individual items.

.423 Redefinition

This shows if it is possible to indicate that a given set of locations may be used at different times or places in a program to hold different items of data. They may be of different types or formats and have different labels. When the types and formats are not different, the use of redefinition is not logically different from the use of synonyms.

.43 Input-Output Areas

These are the areas in which a routine expects to find data after an input operation or into which it places data before an output operation. Labels of these areas may be the names of the input-output files or records.

.431 Data layout

The layout of input-output records and blocks may be specified by parameters to an input-output control routine; otherwise, the layout is usually implied by the method of writing procedures, although the layout may be specified in a "comment" to assist a reader of a program.

.432 Data type

If it is necessary or convenient to indicate the type of data to be placed in an area, e.g., alphameric as opposed to numeric, it is noted here. In some systems, the translators use this data either to make some consistency checks upon a program or to assign appropriate volumes of storage to individual items.

.433 Copy layout

It is often necessary to have several areas with identical layouts. The output area for the master file is usually identical with the input area for the master file. In addition, there may be multiple input-output areas used to organize simultaneous input-output operations for the blocking and unblocking of records; therefore, a facility by which all such areas with identical layouts can be specified only once is useful.

.5 PROCEDURES

The procedures in a machine oriented language are very closely allied to the instruction format of the computer. The labeling and/or addressing facilities are covered by paragraphs 2 and 3, whereas this paragraph is concerned with facilities that are usually covered by the operation codes. There are three types -- direct operation codes, macro operation codes and pseudo operation codes.

.51 Direct Operation Codes

These are codes used in languages which have a one-to-one correspondence with the codes in the computer instruction repertoire. For each type of code it is shown whether or not that code exists; how many such codes there are; an example of the way a code might be written; and whether the use of that type of code is mandatory or optional. The optional form cannot exist, of course, when there is only one type of code for each computer operation.

.511 Mnemonic codes

These are codes whose form is a mnemonic guide to the operation provided in the computer; e.g., SUB and MTY for "subtract" and "multiply", respectively.

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.512 Absolute codes

These are codes usually given in a form which is a numeric or alphabetic direct representation of the code used in the computer instruction. They are less easy to memorize than mnemonics.

.52 Macro Codes

These are operation codes which introduce operations into the language which do not exist on a one-for-one basis in the computer code. They are usually provided by calling an open or closed subroutine into the program or forming jumps into the supervisor routine from the program.

.521 Number available

The number of macro codes is given for each of the various classes of operations that are provided, such as mathematical functions or input-output control. They are listed in detail in paragraph 8.

.522 Examples

Two examples are given, one simple and one elaborate. A simple example is normally indistinguishable in form from a direct operation, except perhaps for some conventional designator. On the other hand, an elaborate mcaro code may require the specification of several parameters to control the routine which provides the operation.

.523 New macros

If it is possible for the programmer to insert new macros of his own coding into the program or the system, the method of doing so is given.

.53 Interludes

These are sequences of statements that are indistinguishable from the remainder of the program except for some delimiters or designators, but which are executed at the translation time and do not appear in the object program.

.531 Possible roles

Interludes are frequently used with load and go translators for such purposes as modifying the translator itself in some way, or developing inserting constants which cannot be expressed directly in the language, or because they are parameters which are not set until loading time.

.532 Example

This illustrates how the interlude is distinguished from conventional coding.

.54 Translator Control

Although machine oriented language programs are usually written in relatively addressed code and use labels liberally to avoid having to make the allocation of absolute addresses, there are many occasions when it is necessary and desirable to be able to control the allocation of absolute addresses. In general, it is assumed that allocation is made by the translator to serially numbered locations. The control of the translator allocation is normally provided by means of pseudo codes. These are codes which are of the same form as and sometimes are indistinguishable from the direct or macro codes except for their actual values but in fact have no corresponding computer code or routine. Instead, they indicate to the translator that some form of translator control is required. The main types of control concern the allocation counter, label adjustment and annotation of the program.

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.541 Method of control

For each of the different types of control, the method of indicating the control to the translator in the program is specified. This is usually by pseudo codes or reserved labels.

.542 Allocation counter

Except in cases where the object program is produced in a relocatable form, it is usually necessary to initialize the allocation counter. At other times, the counter may need to be reset to a value that it had used earlier and which had been marked by some label. It is also convenient to be able to step the counter forward or backward in order to arrange that areas of store are left for tables, working areas and input-output areas and to reserve certain areas for use by special routines.

.543 Label adjustment

Most labels have values assigned to them by the translator equal to the current value of the allocation counter at the time they are encountered and these values are held in a label table. In order to arrange the storage in a convenient way, it is often necessary to be able to make certain labels equal in value, to set labels at specific absolute values and to clear the label table when local labels are being used and a new region is begun.

.544 Annotation

Many programs include information which is not necessary for the translator but is used to help people reading the program to understand it. They consist of comments inserted into the program and titles both of which are recognized by the translator and printed out with the listings of the program.

.6 SPECIAL ROUTINES AVAILABLE

Although not an integral part of the language, most programs written in machine oriented languages can take advantage of special routines written for the purpose of being used with the language. They are not always automatically combined into programs by a specific library feature. Where such routines are available, a brief description of the facilities and method of call is given.

.61 Special Arithmetic

This covers such features as multiplication, division, double-length operation and floating point on those computers where they are not provided in the hardware. They are usually sufficiently integrated into the language to become macros.

.62 Special Functions

These include sophisticated mathematical functions such as LOG, SIN and any business or commercial features such as an FICA routine.

.63 Overlay Control

These are routines provided to manipulate program and data between various levels of storage by the use of overlay techniques.

.64 Data Editing

These are routines provided to assist in the compilation of sophisticated printing layouts, code translation and radix conversion of data.

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.65 Input-Output Control

These are routines provided to handle the label and control procedures for files and reels, the error control procedures of input-output operations, and the blocking and unblocking of records.

.66 Sorting

These are routines which are embedded in a program to perform sorting of small volumes of data that are normally handled within internal storage.

.67 Diagnostics

These are facilities, routines, or parameters that may be embedded in or carried along with a program to assist in easy debugging of programs. It is important to note how these facilities can be removed or inhibited when no longer required. There are three basic types -- dumps, tracers and snapshots.

.7 LIBRARY FACILITIES

A program library is a collection of open and closed subroutines, even complete programs and sometimes data descriptions which are available for use with programs written in the language. The important features are the ability to make insertions into the library, the entities it contains, the form of the library and the method of call of items from the library.

.71 Identity

The name, nicknames and abbreviations by which the library is known are stated here.

.72 Kind of Library

A library may or may not accept insertions by programmers in general. It may be a general library for use by any programmer or a private library for individual programmers or groups of programmers.

.73 Form of Storage

The most convenient form is magnetic tape or auxiliary internal storage such as a disc store. A less convenient form is punch cards or paper tape. Sometimes the library exists only in a written form and has to be transcribed by the programmer or a data preparation system to suitable form for use with individual programs.

.74 Variety of Contents

The most usual library contents are open and closed subroutines for incorporation in programs. Other possible contents are complete programs for use in operating systems, diagnostic routines, supervisor systems and interpreters. Libraries can also contain data information such as file and record layouts, conversion tables and special format tables for input-output control.

.75 Mechanism

This describes the general running and use of the library.

.751 Insertion of any item

If this is done during a computer run, it is sometimes possible to do it as part of program translation and sometimes restricted to special library runs.

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.752 Language of new item

This is the way in which new items must be prepared for insertion.

.753 Method of call

This is the mechanism which causes a copy of an item in the library to be inserted into a program. It may be automatic, when a cue or macro in the program is encountered referring to that item; each program may have to provide a list of calls; or it may be that manual preparation of decks of cards is necessary.

.76 Types of Routine

Libraries vary in the types of routine which can be held in them. Some permit only open routines, some permit only closed routines, some may accept either, provided each routine is one or the other. A few permit a routine to be variable; i.e., it can be called either as open or closed. This section states which types can be inserted, open, closed, or variable.

PROGRAM TRANSLATOR

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.1 GENERAL

Program translators are special routines provided to translate programs from either a process oriented language or a machine oriented language into a machine oriented language or an intermediate language. The input, called the source program is translated into the object program. In an integrated system, the object program is in machine language ready for loading. Sometimes a translator is, in fact, a whole series of smaller translators which translate the program through a series of languages before finally arriving at the machine language.

.11 Identity

The name, code number, serial number, the conventional name by which the translator program is known, and any abbreviation by which it is referenced in these reports, are stated.

.12 Description

This paragraph gives an over-all view of the program translator. It states the general orientation and style; e.g., whether the translator is designed for fast and cheap translation of one-time programs or whether it is a sophisticated translator which, although taking a relatively long time to translate programs, produces an efficient object routine. The translator may be biased toward certain uses of the language or toward certain environments in which the language may be used.

.13 Originator

It is not unusual, in the software provided with computers, for languages to be designed by someone other than the manufacturer. Sometimes translators are provided by user organizations. This may be because the user organization produced a language, or variations to a language, or required a special orientation or style of translator that was not included among those issued by the manufacturer.

.14 Maintainer

Even though the translator may have been produced by an outside organization, it may be that the manufacturer has assumed responsibility for the maintenance of the translator after it has become established and has been accepted into his repertoire. This report does not necessarily restrict itself to translators which are approved by the manufacturer; however, if the manufacturer is the maintainer, this does indicate, to a large degree, his approval.

.15 Availability

This indicates the dates at which a working properly-documented version of the translator is available for general use.

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.2 INPUT

The input to a program translator is the source program, as far as the translator is concerned. The important facts are the languages in which it may be written, the form in which it is held, and any restrictions, such as size limitations or special sequencing.

.21 Languages

Usually, the name of the language is a sufficient identification of the language in which the source program may be written; however, with a standardized or common language that is used in many places, there may be variations in the use of the language from place to place. These are usually restrictions placed upon the language as used in conjunction with different translators or different classes of target computers. The restrictions are those principal facilities of the language that are not covered by the translator but are nevertheless (optional) facilities available in other (prospective or alternative) implementations of the language. The exemptions may be listed in the description of the language.

.22 Form

There are three factors concerned with the form in which a source program may be presented. First, media: in any particular program translator, there is usually a restriction on the input media on which a source program can be accepted. Second, sequence: many translators have obtained some efficiency in translation by depending upon some particular ordering of the different parts of the program as they are presented to the translator; for example, there may be a requirement that all the subroutines that are cued in the program be listed at the beginning, or that the data description precede the procedures. Third, grouping: often different parts of the source program are required to be grouped together in various categories; e.g., all the procedures in one group, all the data descriptions in one group, and so on.

.23 Size Limitations

Some program translators have rigid restrictions on the sizes of source program they can handle. Sometimes the restriction is on the number of source statements, but, of course, this may depend upon the complexity of the procedures. A figure is normally given here in terms of elementary statements. There may also be restrictions on the sizes of individual statements that the translator can accept and on the maximum number of data items that may be named and handled in any one particular program. The limitations on size for a particular translator can be unique to the translator and in the way it is written. Other special restrictions are also included in this section.

.3 OUTPUT

The output of a program translator is the object program as far as the program translator is concerned, although it may be necessary to further translate the object program into another level of language before it becomes possible to load it onto the target computer (in which case the pertinent details of the subsequent program translator are also of interest). Another part of the output that is also of fundamental importance is the documentation provided with the program translator. Good documentation makes debugging of a routine easier and permits another user to understand the program more easily.

.31 Object Program

There are three important properties of the object program. First, there is the language in which the output is written. Second, there is the style in which it is written; for example, even if an object program is written in a potentially sophisticated output language, there may be rigid restrictions in the translator on the degree of sophistication actually used in the object program. This may be designed to simplify or make more efficient a subsequent translation. Third, there is the output media which may

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vary among the different kind of external storage media to be used.

.32 Conventions

These are any particular facilities that may be included automatically in the object program, either as service routines or as entries into monitor or supervisor routines to deal with restart procedures, the logging of run progress, input-output control, and special operating procedures. The program may also be written to be compatible with certain operating systems, libraries, or program collecting schemes into which it is required to fit. All of these facilities may be organized into a sophisticated operating environment for the general convenience and efficiency of running a particular computer installation.

.33 Documentation

The different types of documentation that may be produced by a program translator are varied. The output often includes listings of the source and object programs, a storage map of the lay-out expected in the target computer; and particular details, such as lists of checkpoints established in the program, language errors discovered in the source program, and warnings such as an overflow of the storage capacity of the target computer. The way such output is provided may vary from translator to translator. In some cases, there is one completely integrated output; in other cases, the source program and object programs are produced separately and cross-referenced by means of labels. The reports and errors may either be intermingled with the source program or listed separately. Usually the output is printed directly or written on a tape for off-line printing.

.4 TRANSLATING PROCEDURE

The translating procedure is a description of the way the translator goes about the translation, including the logical way the program is organized; the different or optional modes of translation; any special features, such as whether it is possible to translate many programs in one run, the convenience and facilities that the translator provides for use with program diagnostics; and the way in which the translator uses its library.

.41 Phases and Passes

This paragraph describes the general mode of operation of the translator. Generally, an important characteristic of any translation is the number of times the translator works through the program data from one end to the other. These are divided into two types - passes and scans. A pass occurs when the bulk of the program is significantly modified or moved from one form of storage to another. It is an internal pass if both the origin and destination are internal storage, and an input-output pass otherwise. A scan is an examination of the program or a skeleton of the program usually made in order to locate certain properties. When all the program cannot be held in internal storage, a pass may have to be made that does no more translation work than does a scan.

Where the number of passes or scans is high, they may be grouped as a phase of translation. A phase may consist of a variable number of passes. Many translators can deal only with a limited number of identifiers at one time and with a different set of identifiers in each pass. The number of passes then depends on the number of identifiers.

.42 Optional Modes

It is unusual for a translator to be a primitive translator, and normally a translator includes checks on the source program and other features, such as the ability to load and run. Load and run means that at the end of the translation, the object program is automatically loaded into the store of the target computer (which must also, therefore, be the translating computer), and it is possible to jump straight into the object routine and

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execute it. In addition, it may be possible, when it is suspected that there are too many errors in the source program to justify a complete translation, to restrict the translator so that it is used only as a checking device. This saves much of the time that would be consumed by a full translation.

There may also be special modes of running in which the translator is used only to modify a previous program. This is called patching. Patching implies that there is no particular attention paid to optimization or tidiness of the layout of the object program. Patching is used to obtain fast translation. This may be a convenience during debugging. The usual practice is that the original program is patched until it is logically correct. It is then properly translated in a final translation to tidy-up the program and the deficiencies that may have occurred because of patching. Updating is the facility of collecting all the patches and the original translation of the program maintained in some convenient intermediate form, and performing a sophisticated correction of the intermediate form.

.43 Special Features

These are variations of the different modes of translation, which normally provide some degree of optimization, either of translation time or of some other facility.

.431 Alter to check only

During the translation of the program, it may become obvious that there are too many errors in the source language for the object program to be of any use for debugging runs. In this case some translators are able to alter to the mode of "checking only" during a run, and then save the time that would otherwise be wasted by full translation.

.432 Fast unoptimized translate

In those translators in which a large degree of optimization is built into the translation, it is usually obtained at the expense of a lengthy translation time. It is possible on some translators to indicate that an unoptimized translation is required in order to save translation time. Note that the results may not only be a slower object routine but also a larger object routine, taking up more space in the target computer than would otherwise be occupied. Unoptimized translation may be used for one-time programs or debugging runs.

.433 Short translate on restricted program

In a multi-phase or a multi-pass translator, some of the passes may be devoted to taking care of the fact that the source program may be in an unspecified order or that certain facilities, particularly difficult to translate, have been used. It is sometimes possible to state that the source program has been properly ordered or that certain facilities are not being used in the program so that certain phases or passes can be eliminated from the translation.

.44 Bulk Translating

When a large number of programs have to be translated at one time, the translator may be designed so that they can be loaded one after another as input and translated straightforwardly, without pausing, one after another. On the other hand, some multipass translators have to be reloaded for each of these programs. In the former case, bulk translating is possible; in the latter case, it is not.

.45 Program Diagnostics

Translators sometimes have the ability to incorporate facilities directly in the object program for special kinds of diagnostics. These facilities may include complete routines within the program to carry out the diagnostics, or merely parameters and control instructions to enable the diagnostics to be more smoothly carried out. Some

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methods possible are: integrating diagnostic routines into the programs; incorporating certain jumps in programs in order to enter diagnostic routines held by a supervisor; placing parameters in specified parts of the program which a standard diagnostic routine can easily find when it is used during the debugging. Incorporation of these aids in the translator may be inconvenient when doing production runs or large scale trials because of the time and space consumed. It is therefore important to know if the facilities can be removed or suppressed easily.

.451 Tracers

These are diagnostic routines which provide a listing dynamically during the run of a program to trace the path that the sequence control has followed through the program. To do this completely would require a tabulation of all the jumps that were executed in the program. Other tracers print out the occurrences of the sequence passing certain checkpoints in the program or confining the facility to certain areas of the program. Tracers are frequently combined with snapshots.

.452 Snapshots

Snapshots, which exist in many forms, are listings of the contents of selected registers or other storage locations at different times during the execution of the program. Some are like tracers in that each time the program sequence control passes through a specified checkpoint, a printout is made of selected registers and locations. The selection may differ for each checkpoint. In an alternative scheme, it may be that certain registers and locations are marked for snapshotting and then, each time the contents of such a register or location changes, its value is printed out. This does not provide a trace of the program but does provide a dynamic picture of how certain quantities alter during the progress of the program.

.453 Dumps

Dumps are printouts of the state of a program and the contents of many of the locations in the store at a time when a program has stopped either because the trial is completed or has hung up. Dumps are normally on a much larger scale than snapshots. In many cases complete dumps of the store may be taken at the end of a trial. In general, the adjective dynamic is associated with snapshots, and the phrase post-mortem associated with dumps. Snapshots are usually far more selective than dumps.

.46 Translator Library

Where a library of different categories of information is available for use in programs and is controlled by the translator, the important characteristics are its contents, the method of insertion of the contents into the library, the mechanism of calling entities from the library and the different types of library that can be used.

.461 Identity

This is the particular name, if any, given to the library.

.462 User restriction

The more common restrictions concern the ability of various classes of users to make insertions into a library. Occasionally, there may be restrictions upon the classes of users who may call entities from the library.

.463 Form

The storage medium used is of major interest. The most usual medium is magnetic tape; sometimes, auxiliary storage. The organization includes the language and style of entities as well as the grouping in serial access stores.

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.464 Contents

Libraries vary widely in the kinds of entities they may contain. The most usual contents are subroutines, although complete routines, production, service, and diagnostics are often held. With the use of process oriented languages libraries are becoming more important, and now sometimes contain data and environment descriptions.

.465 Librarianship

There are three facilities which the translator may be able to control. First, a mechanism for the insertion of new entities into the library is needed, This is often accomplished by a separate routine. Except for automatic inclusion of entire programs, the source language must provide a means of designating entities to be inserted.

Second, there may be a means of altering entities in the library. Usually, only deletions are possible. Third, there must be a calling procedure. The most automatic way is to call by noting all the cues in a routine and thence establish a call list. More frequently, each program must contain its own call list, especially when a cue, say for a sine routine, is ambiguous because there are various sine routines for different degrees of precision or ranges of the argument.

.5 TRANSLATOR PERFORMANCE

The performance of a translator can be measured in three different ways: first, the amount of space the object routine occupies in the target computer; second, the time that it takes to perform the translation; and third, the time that the object routine takes in running, compared with some standard. The performance of the translator in each of these ways may be affected by the competence of the programmer, the environment in which the translator runs, and the environment in which the object program is required to run.

.51 Object Program Space

In spite of the complexity of space allocation, there are normally three particular areas which can be considered.

.511 Fixed overhead

In some cases, there are definite areas of storage set aside for supervisors, monitor routines, loaders, overlay controls and other executive routines. Storage may also be reserved for special registers, constants, or work areas for the central processor and input-output controllers. The space for each of these, where it is significant, is stated, as are any comments as to the variability of the space or the optional inclusion of the feature.

.512 Space required for each input-output file

In the cases where data is recorded on magnetic tapes in large blocks, the amount of space that must be allocated in internal storage to maintain input and output areas, and if necessary alternating areas to allow simultaneous input-output, may be considerable.

.513 Approximate expansion of procedures

This may vary from the case - in simpler translators - of one to one expansion, to the most sophisticated compilers in which it is very difficult to give any firm estimate; however, some estimate is usually given, based on elementary statements. Such an estimate must be interpreted as being only an indication of the order of magnitude of expansion ratio. This estimate may be stated for different kinds of statements, where this is possible, particularly for algebraic statements and pseudo-English statements.

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.52 Translation Time

The time quoted here is for a given number of elementary statements where "s" is the number of elementary statements. The time is given as "a + bs" where "a" is a fixed overhead and "b" is an increment for each statement. The total units are expressed in minutes. There are sometimes several different cases to consider, depending upon the mode in which the translator is working. The three given here are for normal translation, checking only, and unoptimized translation.

.53 Optimizing Data

In some languages it is possible to make statements that are useful to the translator in improving the efficiency of the object program. A list is given here of those that are used by the translator. Some may be ignored to simplify the translator or because they would not be useful for the target computer. These may be statements about the procedures. The statements about procedures might give the translator some information about the relative frequency of the execution of given procedures. These may be used to optimize instructions or to allow the translator to make decisions about the level of storage in which to hold different parts of the program or associated data. In some cases, as in COBOL, the whole program may be divided into segments which are in fact potential overlay segments and these may be arranged in some priority order which is considered in allocating segments to the fastest areas of internal storage.

.54 Object Program Performance

For simple assembly systems, of course, the object routine performance is largely unaffected by the translator. The evaluation of the performance of object routines produced by a compiler must usually be highly subjective, unless a large range of problems, against which object routines of the translator can be compared, have been prepared by standard programmers.

Estimates are given in which the performance of the translator is compared with good hand coding based on the judgment of the editorial staff unless otherwise indicated. It is important to note that good hand coding is not the same as average hand coding. In general, there may be a large or small disparity between these two standards of hand coding, depending upon the complexity and sophistication of the features available in the computer and the particular problem under consideration. Good hand coding means careful attention to the optimization of the object routine and a certain amount of polishing, but not at the expense of clarity in the understanding of the program by other users, and is to be contrasted with "clever" hand coding. The rating of the program translator is compared with the space or time that would be taken by a good hand coder, and the following terminology is used:

Halved is about 0.5 of the space or time.
Decreased is about 0.7 of the space or time.
Unaffected is about 1.0 of the space or time.
Increased is about 1.4 of the space or time.
Doubled is about 2.0 of the space or time.

Where possible, different estimates are given for different kinds of procedures such as elementary algebra; complex subscripts, which may be especially difficult on certain machines; data editing, which varies tremendously because of the particular hardware facilities provided in the target computer; or the overlapping of operations, which also depends to a certain extent upon the hardware facilities provided in the target computer.

.6 COMPUTER CONFIGURATIONS

There are two computers concerned in any translation of a program: the translating computer on which the translation is performed, and the target computer on which the object routine is to run. The configurations of these computers are often important because there are at least minimum requirements for their configurations. Of course,

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in many instances they are, in fact, exactly the same computer.

.61 Translating Computer

This is the computer on which the program is translated. There are usually two salient factors to consider: the minimum configuration for translation, and whether or not the translator can take advantage of any larger configurations.

.62 Target Computer

This is the computer on which the object routine is to run. This may also have a minimum configuration which is more likely to be dictated by the program itself rather than by the translator, although the translator may provide certain facilities for which it is essential to have at least, perhaps, a typewriter input-output. If a program translator is to be generally useful, it must be able to take advantage of all the common facilities possible in target computer configurations, and this paragraph states the usable extra facilities. The facilities may be stated on an exception basis such as "everything except MICR reader", when the translator has not been extended to cover such a feature.

7. ERRORS, CHECKS AND ACTION

This paragraph lists all the major types of error that may occur in the translation, and states the types of checks or interlocks provided to detect or protect against these errors. In some cases, particular types of errors are not possible because of the mode of operation of the translation. If, when the check fails or an interlock is applied, some action is automatically taken, this is also stated. The most common types of errors are as follow:

Missing Entries - Only when all the input statements to the program translator are serially numbered can any missing entry be noted; however, there may be a check for missing or unspecified labels or data names which come under "incomplete entries" or "inconsistent program".

Unsequenced Entries - Where it is important that the data submitted be sequenced in some proper order, a monotonic check on labels may be used. There may be checks to insure that the data is in proper sequence, it may be that the data can be accepted in any sequence and is reordered internally, so that there cannot be a sequencing error.

Duplicate Names - It may be that by mistake several separate and unique items of data in a program have been given the same name. Confusion would therefore arise in the translator whenever the name was used in procedures.

Improper Format - Particularly where sophisticated syntactic construction rules are used, it may be that a translator does not examine a program for proper format in all cases, and makes only a limited check.

Incomplete Entries - In certain syntactic arrangements, it is mandatory that certain entities be mentioned, such as three operands to go with a multiplication statement; and the translator may check to see that they exist.

Target Computer Overflow - Due to the fact that expansion during translation is not always easy to estimate, the translator may check that the storage space in the object computer has not been exceeded.

Inconsistent Program - Inconsistent program errors can occur, for example, when a data name is improperly used as a destination, floating point operations are illegally prescribed for fixed point operands, or where references are made to files that have not been opened.

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Particular types of action are:

Stop - The translator is stopped and cannot continue until some action is taken by the operator. This may be used in order to let the operator resequence cards, or because the translation must be abandoned.

Abandon - This implies that it is impossible to continue with the translation.

Continue - This may be an optional feature and implies that the program continues either ignoring the fact that an error has occurred, or executing some built-in rule for an arbitrary resolution of the error; or even, perhaps, leaving it undecided.

Offer Options - The translator stops and offers options to the operator from which he may make a choice. The choice offered is usually rejecting an item in error, continuing in spite of the error, abandoning the translation, or continuing after some other action.

Reject - The particular item under consideration is rejected and the translation continues, ignoring that item.

The checks or interlocks that may be applied include the following:

Not possible - This means that because of the way the translator or the language is constructed, this type of error is not possible and therefore need not be considered.

None - This means that there is no check or interlock to discover when such an error occurs, and its effect may, therefore, be uncertain or unusual, depending upon the particular behavior of the translator under such conditions. Where the behavior of the error is important and easily stated, it will be given in the action column.

Check - Often it is not possible to describe simply a check that is provided to discover sophisticated errors. The word "check" is used either when the form of the check is obvious from context or when there is a check whose description would be lengthy or difficult. A check may not always be complete, but the name of the check usually gives a good idea of its coverage. A check discovers an error after it has occurred.

.8 ALTERNATIVE TRANSLATORS

In addition to the standard translator provided to allow a given language to be translated for a given target computer, there may be alternative translators which enable the same target computer to be used with the same source language. These translators are usually run on translating computers that are different from the target computer. Sometimes the translating computers are larger computers which enable more efficient target routines to be produced for a small computer than might be possible using the target computer as the translating computer. On the other hand, the translating computers may be smaller computers which enable the preparation and debugging of programs for later use on a larger computer. Sometimes a translator runs on an existing computer to prepare routines for a computer which is not yet available. In many cases alternative translators may also be associated with simulators of the target computer.

OPERATING ENVIRONMENT

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.1 GENERAL

The operating environment can be loosely defined as all the facilities that contribute to the efficient and convenient running of routines on a computer. It covers both production runs and debugging. In the most sophisticated systems, these facilities may be provided within the computer as a number of special purpose routines automatically controlled by a master routine.

The important functions of operating are:

the loading of programs into the computer.

the allocation within the computer of storage, input-output and other units.

the running supervision of programs.

the simultaneous working of units.

multi-running or multi-sequencing.

the handling of errors and restart facilities and the control of program diagnostics for trials.

the particular facilities for manual operator control (particularly where the general supervision is being done automatically).

the communication between the operator and any automatic control.

the logging of progress showing all the important events as far as operating is concerned.

the enhancement of the performance of the system because of the special facilities provided for operating.

the repertoire of special problem oriented routines that are available to assist in the running of an installation

The special routines used to help the operator in the running or debugging of routines are called executive routines. There are three kinds - service routines, monitor routines, and supervisor routines.

Service routines are those that provide a service to another routine. Typical examples are overflow control, input-output blocking and unblocking, control of typewritten messages, and program loading. They are normally used as subroutines of the routine they serve.

Monitor routines are those whose principal task is to monitor the progress of work. One example is a trace or snapshot routine used in debugging. Another example is an automatic log-writer.

Supervisor routines are those that control and organize the running of many routines, either the automatic sequencing of loading, initiating, and unloading of one routine at a

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time, or multi-running. They should require manual action only to load and unload input-output units, state the jobs required to be done, and intervene in unusual cases.

There are many cases in which the different kinds of executive routine are not clearly differentiated; for example, a trace routine may have varying degrees of control - some are almost supervisors.

.11 Identity

These are the names and code numbers of the important executive routines referred to in this part. Where it is appropriate, the originator, if it is not the equipment manufacturer, and the current maintainer, if it is not the manufacturer, are given, and also any important dates, such as first pilot or first regular universal use.

.12 Description

This is an over-all description of how the majority of the features provided are integrated into one system - whether by a comprehensive supervisor routine or individual service routines in each program, or by operator manipulation at the console. The description indicates the degree to which the system is automatic, the strong and the weak points of the system. It should be noted that in many cases, the provision of facilities that exist in the system may be controlled by the translator or even the data description of the program, and it is sometimes difficult to allocate the control of each of the various facilities to one authority. Where possible, cross-references are made to those facilities which are controlled by the source program or the translator. At one level, a facility may be automatically provided in a supervisor regardless of, or in addition to, anything that the translator or the program may try to control. At a second level, the translator may insert into programs either service routines or entries into a supervisor routine to provide the individual facilities. At a third level, parameters in a program or even special coding in a program may be allowed to control certain of these facilities.

.13 Availability

The major executive routines are listed here together with the dates on which they are first available for regular operational use in a properly-documented form.

.2 LOADING OF ROUTINES

The three important aspects of loading are: first, the sources from which routines may be obtained; second, the ability of being able to call a subroutine from a library at the time of program loading; and third, the sequence in which the routines are loaded and the control over a queue if one exists.

.21 Source of Routines

In general, there are two major sources from which routines may be taken to be loaded into a computer - first, special libraries, and second, the set of independent routines which have not been organized in any library. The various alternatives for each of these sources are listed. The alternatives may be those of the storage media, language, or form in which the programs are submitted, such as relocatable or absolute code. The control that calls the particular routines is stated.

.22 Library Subroutines

These are the library routines that are cued within programs being run, and, in the operating environment under discussion, are not incorporated into the routines at translation time, but are called at loading time. In typical cases, the calls may be made automatically upon an on-line library or by operator selection from a card file.

.23 Loading Sequence

In the simplest case, the sequence of loading routines is determined by the physical

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sequence in which the operator places them in an input hopper or in which they are recorded on a magnetic tape. When using magnetic tapes with a supervisor routine, it may be possible to specify a priority sequence for the routines by loading control data into the computer, and it may even be possible to make later changes. A supervisor routine may apply certain rules for determining the sequence in which routines should be loaded. When multi-running is possible, there must also be rules and procedures for the relative precedences of routines that are to be run during the same period.

.3 HARDWARE ALLOCATION

Programs are sometimes prepared in such a way that by the time they are ready for loading the particular input-output channels, units and storage for each instruction and item of data are already determined and fixed. It is more convenient, in many cases, to leave a routine in what is called relocatable form. This means that a routine can be moved, as is convenient, to different places in the storage. This flexibility is particularly useful when a routine may be used as a subroutine, because it can then easily be moved to fit in with other routines with which it may be associated. When multi-running is possible, it is necessary for several routines to be located together easily in the storage.

.31 Storage

When a routine is in relocatable form, it is possible to place its segments in different locations as required. This is useful for overlay procedures and essential for multi-running.

.311 Segmenting of routines.

.312 Occupation of working storage

Many routines run in computers with more than one level of storage require dynamic allocation of storage. This means that as a routine is running, it is necessary from time to time to allocate some storage to different parts of the program - in particular, to each overlay segment which is moved between auxiliary storage and working storage, There are two separate decisions to be made: first, the decision as to how to divide the program into individual overlay segments at the time of loading; second, the decision as to which segments shall occupy working store all the time and which segments shall from time to time be moved from one level to another.

.313 Choice of location

In the simplest case, there is the choice of the particular locations within a level of storage to be allocated for each routine.

.32 Input-Output Units

If it is possible to make the allocation of the input-output units at run time instead of when the program is written, an operating system can make choices so that an operator can set up input and output files in advance on idle equipment, and generally can choose the most convenient input and output units for any particular run of the job.

.321 Initial assignment

This is the assignment of the individual input and output units to different files at the beginning of a job. Such an assignment enables the files to be set up in advance, convenient input-output units to be chosen, and faulty input-outputs to be avoided.

.322 Alternation

This is the technique of making dynamic changes to the allocation of the input-output units even when the particular allocations may have been pre-set. This is sometimes referred to as tape-swapping when it is used on magnetic tape units. The principle

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involved is that, instead of allocating one magnetic tape unit to a master input file, two units are allocated. Then by the technique of mounting the second reel on the second unit while the first unit deals with the first reel, it is possible to switch quickly between units at the ends of reels to avoid having to wait for unloading and reloading. Alternation is normally applied only to very active files, and may take a variety of sophisticated forms.

.323 Reassignment

This is a general facility to change dynamically the input-output unit associated with any file. It enables the operator to change units conveniently in the event of a breakdown or to simulate alternation if he wishes, or to over-ride a pre-set alternation if there are not enough units available.

.4 RUNNING SUPERVISION

There are five important areas in the supervision of a running routine. These are:

(a) the organization of the simultaneous working of various units.

(b) the intermingled running of independent routines (called multi-running).

(c) the running of interdependent sequences of one routine, called multi-sequencing.

(d) the control of errors and the actions taken.

(e) the organizing of restarts in routines.

Many of these facilities may not be provided by supervisor routines but are built into the operational routines either when writing the original source program or during translation. There may well be some control left to a human operator, however, or an automatic supervisor routine at running time.

.41 Simultaneous Working

Usually the control of simultaneous working of many hardware units is a direct function of the way the source program is written or the way the translator implements the program, unless it is possible that there be dynamic allocation of individual channels to input-output units, or some special form of sharing is built into the hardware that can be dynamically controlled by a control routine. The control routine may, in fact, be incorporated into each program by a translator.

.42 Multi-Running

This is the running together of several independent routines in the computer in an intermingled way. There must be rules which specify whether a particular unit shall work for one routine or another. There are usually practical limitations on the number of routines allowed in the operating system, even if in theory there are no limitations.

.43 Multi-Sequencing

This is the ability for several processors, not necessarily of the same kind, in one computer to operate separately on different sequences of one routine and to be interdependently interlocked at check-points in specified places.

.44 Errors, Checks, and Action

This shows all the major types of error concerned with the running of routines as opposed to unusual hardware faults or programs errors. In some cases, particular types of error are not possible because of the mode of operation of the system. If, when a check fails or an interlock is applied, some action is automatically taken, this is also noted. The most common types of errors are as follow:

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Loading Input Error - A loading error occurs when, for example, the wrong data is loaded into an input unit, the data is loaded in improper sequence, console controls are not properly set, or certain control cards are missing or in error.

Allocation Impossible - This is an attempt to load a routine which it is not possible to place in the computer. This may be because the other routines do not leave enough space or because certain features are not available due to faults in them, or because the capacity of the computer would be exceeded.

Input-Output Errors - Although input-output errors are often built into routines by the translator or the programmer, all routines in a given installation usually use a consistent and common set of service routines for input-output error control. There are two cases that normally have to be considered. The first case is that of a single isolated error which may be overcome automatically by re-reading or some such recovery procedure. The second case is that of a persistent error which resists automatic recovery.

Overflow - This covers the particular types of arithmetic errors that may be detected in the computer control, or in a routine, when numbers or other items exceed the limits that have been allowed for them.

Invalid Instructions - These are invalid instructions that are encountered in the program; e.g., constants that are obeyed as instructions by mistake or an instruction which is used that does not apply to a particular configuration because of lack of equipment or because the optional facility which it controls is not available.

Program Conflicts - These include situations in which the following types of conflicts may occur in the system: first, a routine, which has the responsibility of insuring that timing is correct, does not properly cover its responsibilities - a timing conflict; second, a division operation is attempted in which the divisor is zero - a logical conflict.

Particular types of action which may result upon detection of an error are:

Stop, which means that the execution of the program is immediately stopped and cannot continue until action is taken by some control, usually an operator.

Alarm, which means that a light or other signal is given to the operator to indicate a check has failed; e.g., a typewriter, buzzer, or lamp may be used to tell the operator of an error.

Automatic Recovery, which means that there is a service routine or hardware facility which attempts to overcome the situation.

Automatic Rejection, which means a special limited kind of automatic recovery that just rejects the incorrect item and proceeds without considering it.

These actions are not necessarily mutually exclusive.

.45 Restarts

Restarting is the ability to establish certain points during the running of a routine as "restart points", and to be able later to abandon the work done since a restart point was established, return to that restart point, and resume running from there. This enables a faulty part of a job to be re-run with little wasted time, when only some parts of the work are faulty. If there are no restart points, a job has to be restarted from the beginning. On a long job, a few errors could involve a large amount of unnecessary rerun time. There are two important things to control in restarts: establishing the restart points, and initiating the restart process when it is required.

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.451 Establishing restart points

There are normally conventional rules, procedures or criteria which determine restart points, either specified in the source program itself, imposed by the translator, or imposed by a service routine. Sometimes the restart points are linked to logical groups of the data used in a run which are batches of work of some kind, or they may be associated with physical properties of the file; e.g., at the start of new reels. The best reason for having restart points at least at the beginning of each reel is to avoid changing reels when restarting. This is particularly useful when a restart is automatically controlled. On many tape systems, it is not easy to rewind tapes to any position other than the start except by relatively slow techniques.

When establishing a restart point, there may be a selective procedure for dumping important totals that are to be picked up again when a restart occurs, or there may be a full dump in order to cover all possible cases, thus avoiding special parametric control of the areas to be dumped.

.452 Restarting process

This describes how a restart is initiated when it is required. There may be either an automatic or a human decision to restart; the latter is more common. Once the operator has decided on a restart, however, the more automatic the control, the better.

.5 PROGRAM DIAGNOSTICS

In addition to production runs in a computer installation, there is often a wide variety, if not a large volume, of debugging runs. When there are many debugging runs and each one may be relatively short in duration a sophisticated debugging system can provide substantial savings in computer time and operating convenience.

Diagnostic routines are an important part of an operating system. They may be built into a routine by a translator or the programmer or they may be imposed by a supervisor routine or an operator. There are two basic types of diagnostic facilities: first, the dynamic facilities that operate while a routine is running; second, the post-mortem facilities that are carried out after a run has come to a halt for some reason or other.

.51 Dynamic

There are two basic kinds of dynamic diagnostic facilities, trace and snapshot, which are sometimes combined in different degrees. These facilities normally produce either printed results as a run progresses or a tape for later printing off-line. The results may sometimes be interspersed with the ordinary output of the run, and be disentangled later by the person investigating the run.

.511 Tracing

Tracing is a facility which shows the sequence of execution of parts of a routine. It is usually done by indicating the jumps in sequence that occur as a run progresses. The results may be restricted to only certain kinds of jumps, or certain specified jumps. It may be possible to switch the tracing facility on and off dynamically as a routine is running.

.512 Snapshots

Snapshots are selective printings of the contents of certain registers and locations at times when specified points in a routine are reached. The control may be set so that the value of a certain variable is printed out each time it alters, or a set of variables may be printed out each time a certain path or loop in a routine is executed. To some extent, a snapshot gives a trace of the progress of individual variables, whereas tracing provides a picture of the logical route executed through program. In many cases, the facility provided is a mixture of tracing and snapshots.

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.52 Post-Mortem

The normal post-mortem facilities are dumps; i.e., print-outs or other output of large areas of storage containing either procedures or data or both. A dump shows the state of the routines and data when a run stops.

.6 OPERATOR CONTROL

Even when an operating system is almost completely automatic, there must from time to time be communication between the human operator and the supervisor routine. There are normally three kinds of communication. First, there are signals from the executive routines to the operator. Some of these signals ask for decisions to be made by the operator. Usually the operator must make a choice from among several options that a routine offers him. Second, there is the method by which the operator can signal his choices. Third, there are the methods used when the operator wishes to signal to an executive routine on his own initiative, at times when the executive routine is not necessarily expecting any signals from him.

.61 Signals to Operator

The important fact is the manner in which the executive routine is able to signal each of the kinds of messages it may want to send.

.611 Decision required by operator

Operator decisions are necessary when an executive routine has several alternative courses open to it, but is not able to decide for itself which alternative to take and asks the operator to make the decision.

.612 Action required by operator

This occurs when it is necessary for the human operator to intervene in the running of the system in some way which an executive routine cannot itself control, but which the routine specifies must be done before it can proceed. The most usual cases are attention to the input hoppers or output stackers of input-output units and removing of interlocks.

.613 Reporting progress of run

This is a logging facility whereby an executive routine reports the times at which important events occur, such as the time a run begins and finishes, errors on which automatic recovery was taken and any decisions the operator made.

.62 Operator's Decisions

This is the method by which the operator chooses between the various operations that a routine may have offered him.

.63 Operator's Signals

These are the signals given by the operator without any request from a control routine. There are two major kinds - inquiry and change of normal progress.

.631 Inquiry

This facility is not always restricted to the operator. It may be available to a number of users. It is a facility by which people are able to make general inquiries about the state of certain data or runs within the system. In a sophisticated system, there should be special checks to insure that specific categories of data are disclosed only to those who have the right of access to each particular category.

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.632 Change of normal progress

These are commands from the operator to a routine to change what would otherwise be the normal sequence of events, such as

the arbitrary abandonment of a run before its normal conclusion.

the altering of the sequence in which the routines in a queque are to be executed.

the altering of priorities in a mult-running scheme.

the reallocation of equipment for reasons of convenience or because of faults.

changes in the general progress such as the termination or initiation of the alternation of units while a run is in progress.

.7 LOGGING

In order to control and analyze the operation of a computer installation, it is necessary to maintain a log of the activity of the operators, the routines, and the computer itself. This section indicates how the various types of activity are logged in the operating system. In the most primitive case, everything has to be written down by the operator. In the most automatic case, nearly everything is automatically recorded by monitor routines.

.71 Operator Signals

These are events in which the operator breaks into the normal progress and running of the computer system and changes the intended sequence of events in some way or other.

.72 Operator Decisions

These are the decisions that the operator has made when asked to choose between several options in the progress of runs.

.73 Run Progress

These are events such as the starting of a new run, the conclusion of a run, faulty and rejected data and statistics of the runs carried out.

.74 Errors

These may be any kind of errors from input-output errors and overflow to operating or loading errors.

.75 Running Times

These are summaries of the progress of runs and may be essential for proper costing of different routines on the computer, especially with multi-running.

.76 Multi-Running Status

Where multi-running exists and some form of control is exercised by the human operator, it is necessary for him to understand the current status at any time in order to make decisions about changing the situation. The more important points are:

the priorities of the runs being carried out.

the space that is, or will become, available.

the next run is progressing.

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.8 PERFORMANCE

The performance of an operating system is a very complex subject but certain properties of its performance can be evaluated and are important parts of the value of any particular system.

.81 Routine Loading Time

A large overhead can occur in the loading of routines, particularly if a computer is fast or there are large numbers of small routines to be run, and the supervisor, if any, is not fully automatic. Wasted time while the operator clears the previous routine, loads data, and loads routines is important to over-all operation. The rate at which a large routine can be loaded can also be significant.

.82 Reserved Equipment

One of the important factors in any operating system is the amount of storage space that must be set aside for the various executive routines and the working space needed to carrying out the executive functions. There may be particular units that some routines reserve for themselves; e.g., the input-output console typewriter may be reserved exclusively for monitor routines.

.83 Running Overhead

The use of the executive routines may slow down the normal performance of the computer. Normally the overhead is quite low compared with the idle time that operating systems are capable of avoiding.

STANDARD EDP REPORTS

SYSTEM PERFORMANCE

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SYSTEM PERFORMANCE

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.01 Introduction

The System Performance section of a computer report is based upon estimates for specified problems on particular computer configurations that have been used in the System Configuration section of the report. Various problems have been selected, a number of which are based upon a typical activity such as updating a master file from a detail file and making reports about the changes. Other problems considered are those of reordering data into some required sequence and mathematical considerations such as matrix inversion. Where possible, timings are based upon standard available routines; otherwise, the estimating procedures are standardized and presented below. For each problem, the results are given in the form of graphs, using a common scale for all computer reports so that comparisons can be made easily. Particular attention is drawn to the remarks in paragraphs .02 to .08.

.02 General Qualifications

It cannot be over-emphasized that great care must be taken in drawing conclusions from the performance measures of this section. Apart from the cases where timings of existing standard routines are used, the figures quoted here can be regarded only as guidelines. In order for the system analyst to fully appreciate all the factors which are not included, and cannot be because they vary for every case, the major considerations are listed below in detail, giving where possible an indication of the effects they might have. If the system analyst bears these factors in mind and uses the results carefully, the estimates can prove a good guide to system performance for him.

.03 Problem Variations

In general, the problems that may be run upon any particular computer in an existing or potential computer installation may differ from the standard problems used here. Paragraphs below give specifications of the problems being considered. They include sufficient detail for the analyst to study the differences from his own problems and the effects of those differences. Particularly in the generalized file processing problems, there is the effect of the distribution of the activity of the detail file over the master file. This may vary widely and be bunched in most awkward ways for different specific problems. In all the estimates, the activity balance has been considered to be uniform throughout the files. Any imbalance tends to reduce the benefits of simultaneous operations on different channels and thus lengthen the time of any particular run.

.04 Installation Configuration

Computers can be assembled in a large variety of configurations; in this section, we consider only those enumerated in section §03. The most important considerations for business problems are usually the number of simultaneous operations, the ability to move data easily within the computer, and the editing of output data. Where a computer may have a large variety of input-output devices with different speeds, the performance can be considerably affected by the choice of one set of units rather than another.

.05 Programming Techniques

The running time of a sophisticated application or the efficient use of a sophisticated computer is largely dependent upon the ability of the programming staff or the compiling program. In this section, it is assumed that good quality programming is available to

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take advantage of the simultaneous operations in the computer, in maintaining queues if necessary, and suitably blocking and packing the input-output data to take advantage of the system. In the coding of individual routines, it is assumed that straightforward, clean, rather than tricky, coding has been used.

.06 Operating Delays

In addition to the time required for the computer and its peripheral units to run a program, there will be intervals of ineffectiveness occurring in practice. These include unavoidable delays such as reloading tape units where alternates are not being used, the replenishment of a printer with stationery, and the time to load and unload a particular job on an installation. These times vary widely depending upon the data load and the operating systems available. Details are given elsewhere in the report that may assist a user in estimating times for individual installations, but no allowance is made in this section.

.07 Faults

No allowance is made for faults in the system. Faults may not only cause down time, but also wasted time and re-run time. The amount of re-run time necessary will depend upon the operating system, and the amount of down time may well depend upon the number of spare units made available. Delays may occur due to faults in either data; program routines, machine hardware, or operator's actions.

.08 Method of Estimating

Rarely will two people making independent estimates come to the same answer, particularly if they have not agreed in advance upon the method of estimating. In paragraph .113 below, the estimating procedures are outlined. They have been chosen for the following reasons: first, they go into considerable detail in order to make the individual elements of the estimate as independent of the estimator as possible; second, by covering as much of the detail as possible in a uniform way for all computers the over-all estimating procedure has been simplified. Such a procedure cannot hope to cover all the items mentioned in .02 to .07 above and, if anything, is biased toward allowing for more overlap of operations on a computer than is justified. Any method, however, that attempted to correct for this error, other than a full-scale simulation or trial run, would be too subjective.

.09 Summary

In general, it can be expected that the system performance figures taken at their face value are considerable under-estimates of the over-all time that must be allowed on a specific configuration for similar problems. This is due to inefficiencies in the equipment, its operation, the preparation of the programs, and the fact that the problem itself is not as straightforward as the standard models being used here. The figures in general can, however, be regarded as a realistic guide-line comparison between systems.

.1 GENERALIZED FILE PROCESSING PROBLEMS

These are a series of typical commercial data processing applications. One of the most common jobs in commercial data processing is the processing of a detail file against a master file. The detail file contains data used to update the master file by inserting new records, deleting old records, and recording changes to records in the file. Usually there is a printed record of the activity. This type of activity occurs, for example, in a payroll routine in which the master file is the payroll file, the detail file contains the details from the time sheets, and the output is largely pay slips.

The application parameters which have the greatest effect on run times in generalized file processing are: record sizes; the amount of computation; the ratio of the number transactions to master records (called the activity factor); and the distribution of transactions. All but the last parameter are considered in a series of standard problems.

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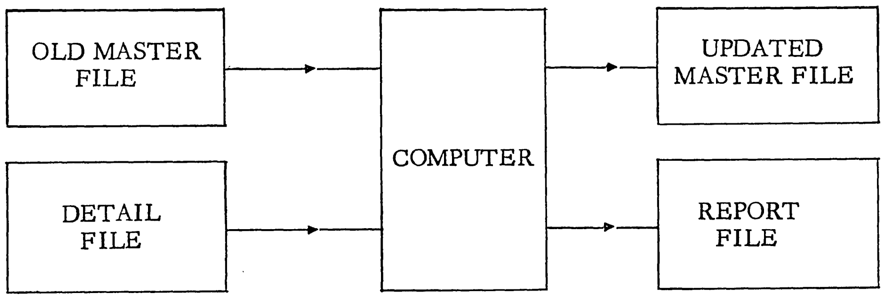
Standard problems A, B and C vary the record sizes for the master file. Standard problem D increases the amount of computation. Each problem is estimated for activity factors of zero to unity. In all cases (see paragraph .03) a uniform distribution of activity is assumed.

Low activity occurs in inventory control applications. Moderate activity occurs in cycle billing applications. High activity occurs in payroll applications.

.11 Standard Problem A

In Problem A, we use a typical inventory application as a means of making a detailed estimate of the times necessary. Problem A is a typical complete commercial data processing application and is specified in sufficient detail to enable reliable estimates to be made. (See paragraph .113 below.)

The basic form of the program run is as follows:



.111 Record sizes

File 1 is the old master stock record file, and its record layout is given in Figure 1.

File 2 is the updated master stock record file.

File 3 is the detail file read from cards. A typical record layout is shown in Figure 2.

File 4 is the report file recording the activity, and a typical output line is shown in Figure 3.

In Configuration I it is assumed that a card collator is available, and that the detail cards can be merged with the master cards before the computer run. If the master cards with no corresponding detail cards are deleted, the computer run corresponds to an activity factor of 1.0. After the computer run, the unaltered and updated master cards are merged. If all the master cards are retained and a complete new deck produced, the appropriate activity factor is used. This procedure is useful if a complete deck is required from time to time for security, audit, or re-runs. In many cases the times are independent of the activity factor being limited by the output of File 2. In such cases a single point for activity 1.0 is plotted.

When considering off-line transcription, it is assumed that Files 3 and 4 contain only one record per block.

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Figure 1

FILES 1 AND 2 RECORD LAYOUT

(Master Records)

Reference	Name	Max. Size (characters	Avg. Size or digits)	Picture (numeric unless shown otherwise)
A01	Item number	8	8	XXXX9999
A02	Description	20	15	X(20)
A03	Unit price	5	4	
A04	Average cost	5	4	
A05	Total on hand	6	5	
A06	Total on order	6	6*	
A07	Automatic reorder	1	1	
A08	Reorder level	5	3	
A09	Reorder quantity	5	4	
A10	Total sales to date	6	5	
A11	Date last transaction	6	6	
A12	Read time	3	3	
A13	Shortage status	1	1	
A14	Order number	5	5*	
A15	Warehouse code	8	8	
A16	Substitute	8	8*	
A17	Units disbursed previous to this period	5	5	
A18	Units disbursed this period	5	5	
	Totals	108	96	

* Items occur on only 5% of cases.

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Figure 2

FILE 3 RECORD LAYOUT

(Detail Cards)

Reference	Name	Size	Picture Example
C01	Quantity	5	ZZZ9 22
C02	Transaction code	1	9 4
C03	Item number	8	XXXX9999 HG439872
C04	Description	20	XXXXXXXXXXXXXXXXXXXX FIREPROOF YULE LOGS
C05	Unit cost	5	ZZZZ9 3376
C06	Transaction amount	10	ZZZZZZZZZ9 74272
C07	Date	6	999999 122662
C08	Discount code	1	9 1
C09	Order number	5	99999 01159
C10	Warehouse code	8	XXX99999 XBX12321
C11	Blank	8	BBBBBBBB
C12	Card number	3	999 013
	Total	80	

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Figure 3

FILE 4 RECORD LAYOUT

(Printed Reports)

Reference	Name	Size	Picture Example
D01	Item number	10	XXXXX99X99 HG-4398-72
D02	Description	23	B(3)X(20) FIREPROOF YULE LOGS
D03	Warehouse code	10	B(2)X(3)9(5) XBX12321
D04	Total on hand	9	B(3)Z(5)9 3215
D05	Total on order	9	B(3)Z(5)9 22
D06	Order number	7	B(2)9(5) 01159
D07	Unit price	10	B(2)$$$$9.99 $49.95
D08	Average cost	10	B(2)$$$$9.99 $32.61
D09	Total sales to date	14	B(2)$****,**9.99 $**24,945.00
D10	Total $ value	18	B(6)$****,**9.99 $*102,841.15
	Total	120	

Note: (a) Pictures for D07 to D10 are not legal in COBOL as stated. Estimators may treat Bs as separate items or extend the floating symbols.

(b) It is not possible in one COBOL picture to state the requirement for hyphens in D01.

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.112 Computation

The general computation is specified in Charts 1 to 8. The basic computation is covered by boxes 26 to 42.

WORKSHEET 1

	I	II	III	IV
<u>Assignment (identity)</u>				
File 1	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 2	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 3	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 4	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
<u>Block Layout (give units)</u>				
File 1, 2 block size	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
K = records per block	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 3 record size	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 4 record size	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
<u>In-Out Unit Block Time (m. sec.)</u>				
File 1	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 2	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 3	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 4	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
<u>In-Out Unit Switching Time (m. sec.)</u>				
File 1	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 2	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 3	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 4	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
<u>C. P. Penalty Per Block (m. sec.)</u>				
File 1	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 2	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 3	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _
File 4	_ _ _ _	_ _ _ _	_ _ _ _	_ _ _ _

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.113 Timing basis

Each standard problem estimate is based on a detailed specification of Standard Problem A. It is contained in Figures 1 to 3, Charts 1 to 8, and their accompanying notes.

The estimating process is separated into a series of steps and summarized on Worksheets 1, 2 and 3. At each step, separate answers are given for configurations I, II, III and IV. In these estimates, Configurations V and VI would give the same times as III.

First, consider Worksheet 1.

Assignment

For each configuration, the first decisions to be made are the input-output units on which the various files are to be handled. The preference for the master file, (that is files 1 and 2,) is magnetic tape and the alternative is cards. Files 3 and 4 may be on or off-line. When on-line, file 3 should preferably be on cards, alternatively on paper tape. File 4 on-line should be on a printer.

Block layout

The layouts of files 1 and 2 are exactly the same. The first consideration must be the block size. In general, there is a fixed number of records per block. The number of records per block is not allowed to expand and contract as insertions and deletions occur in the file. The blocks should be chosen to be approximately 1,000 characters in size, where space can be spared for the necessary input-output areas in the internal store, (see paragraph .115). Within each record, the data may be packed. The detailed specification of a record is shown in Figure 1. If variable sized items are used, the appropriate delimiters must be held. The items in the record may be rearranged for efficient working. For 80-column cards, the number of records per block is 0.5.

As far as the original data card of file 3 is concerned, the layout is rigorously specified in Figure 2. Where paper tape is used, variable-length items and delimiters may be used.

If the file is transcribed to magnetic tape off-line, records may not in general be blocked; i.e., only one record per block.

The layout for a record on file 4 is rigorously specified in Figure 3. Check protection and zero suppression must be allowed for. If the records are transcribed for off-line printing, then in general there must be no blocking of the magnetic tape.

In-out block times

The speeds of the input-output units used for a file may vary for the different configurations. For each of the configurations I to IV, times are entered for reading or writing one block for the various files. The times have been provided indirectly in the input-output sub-sections of the computer report. Allowances should be included for stop-start times and other delays.

Switching times

Where more than one file may share a channel or a controller, there is sometimes a delay involved when switching from one unit to another. Switching times pertinent to each file are entered and used later, as they are needed.

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C. P. penalty times

For each of the different configurations, a penalty time per block applied to the central processor is quoted for each file. This is the time that the central processor is prevented from working either because it is locked out during a specified period or delayed for a series of short intervals during which the controller accesses the input-output area.

Second, consider Worksheet 2.

Flow chart timing

In order to provide a consistent and clear set of procedures for timing the operations of the central processor on the standard problem, the relevant parts of the problem have been flow-charted.

Chart 1 shows the basic flow of the central loops. Each part of the loops is shown in detail in Charts 2 to 8. Each box on Chart 1 is cross-referenced to Charts 2 to 8. To direct the estimator, notes are provided for each box.

The time in milliseconds for the boxes on each chart is summarized for each configuration. This may vary because of any optional facilities in the central processor; the need for unblocking in different configurations; and different input-output systems for different units.

The times are noted separately to enable these basic figures to be used with different weights to estimate a variety of problems.

a1 is a time that must be weighted by the number of blocks in the master file.

a2 is a time that must be weighted by the number of records in the master file.

a3 is a time that must be weighted by the number of records in the detail file.

Third, consider Worksheet 3.

Now that the basic times have been established, many of them common to several configurations and all of them independent of the activity factor (F) and the number of master records per block (K), it is possible to make estimates for the different configurations and activity factors, using Worksheet 3.

A set of columns is used for several values of the activity factor for each configuration, identified by a Roman numeral. Usually there are four activity factors: 1.0, 0.33, 0.1 and 0.0.

One column is used for each set of activities sharing one of the simultaneous facilities. The entries in each column can then be totaled separately; e.g., in the cases where there are no simultaneous operations, all times are added together in one column; in the case of simultaneous operations, one column is used for the central processor and one for each independent channel or buffer.

The basic time period is one block of the master file. The times are in milliseconds. The same basic times are used in several sets of columns with different weights. The weight is either K, the number of records per block on the master file, or K times F, the average number of detail records per block of the master file.

a1, a2 and a3 are all charged to the central processor in one column. In the same column goes either the block time for each file, or its penalty time if the block time is in a separate column. If several files are in one column, (i.e. on one channel), switching times may have to be added.

Finally, the maximum time of each set of columns is converted to minutes per 10,000 master records, by dividing by 6K.

WORKSHEET 2

Configuration Number:			____	____	____	____
<u>Flow Chart Timing</u>						
Blocks 1 to 5	b1		____	____	____	____
6 to 9	b2		____	____	____	____
	Total	a1	____	____	____	____
Blocks 10 to 17	b3		____	____	____	____
18 to 23	b4		____	____	____	____
	Total	a2	____	____	____	____
Blocks 24 to 37	b5		____	____	____	____
38 to 42	b6		____	____	____	____
43	b7		____	____	____	____
44 to 46	b8		____	____	____	____
47 to 48	b9		____	____	____	____
	Total	a3	____	____	____	____
a3 + 2(b5 + b9) = a4			____	____	____	____

Note: a4 replaces a3 in Standard Problem D. where computation is trebled.

CHART 1

Central Timing Loops

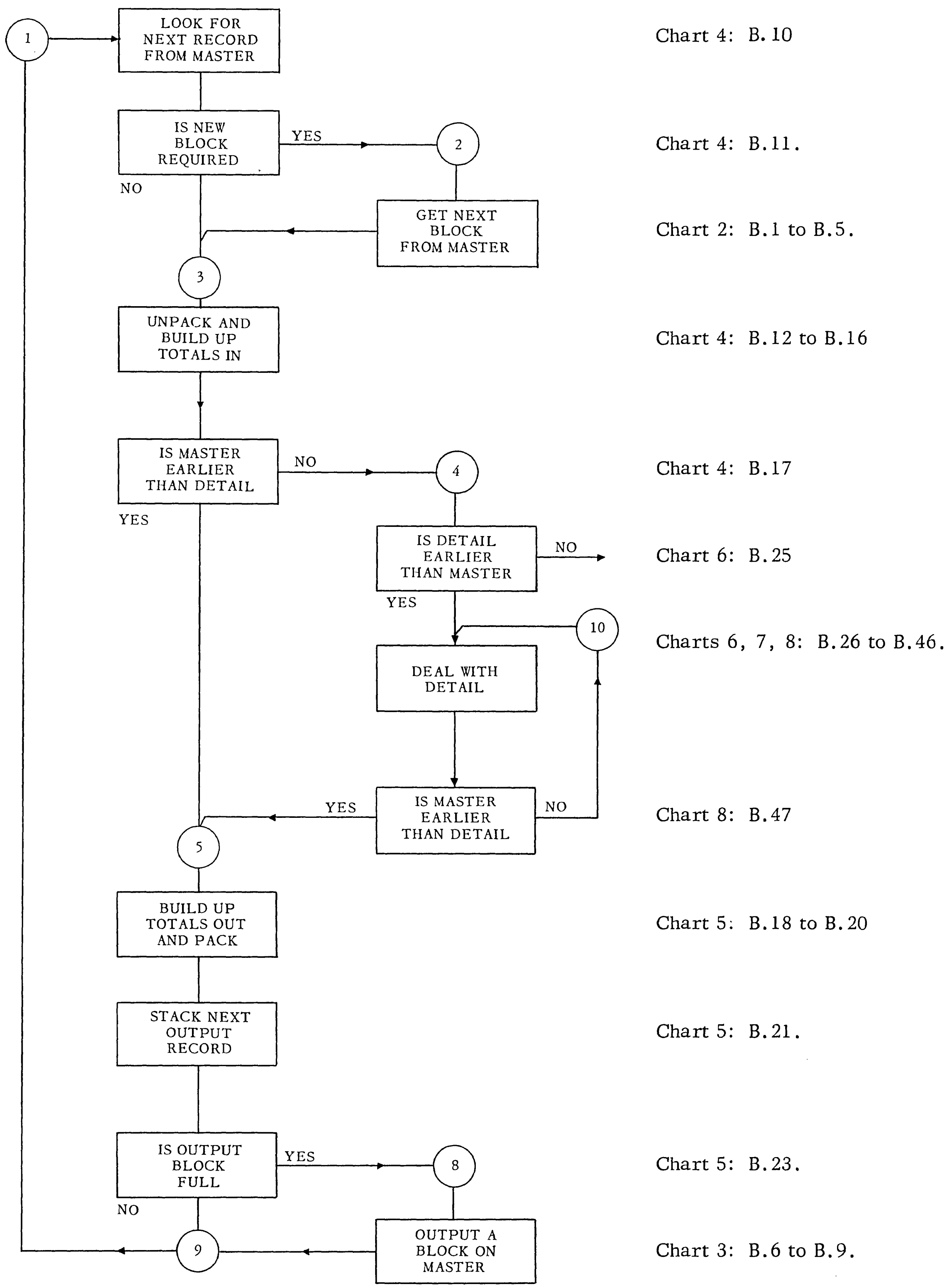
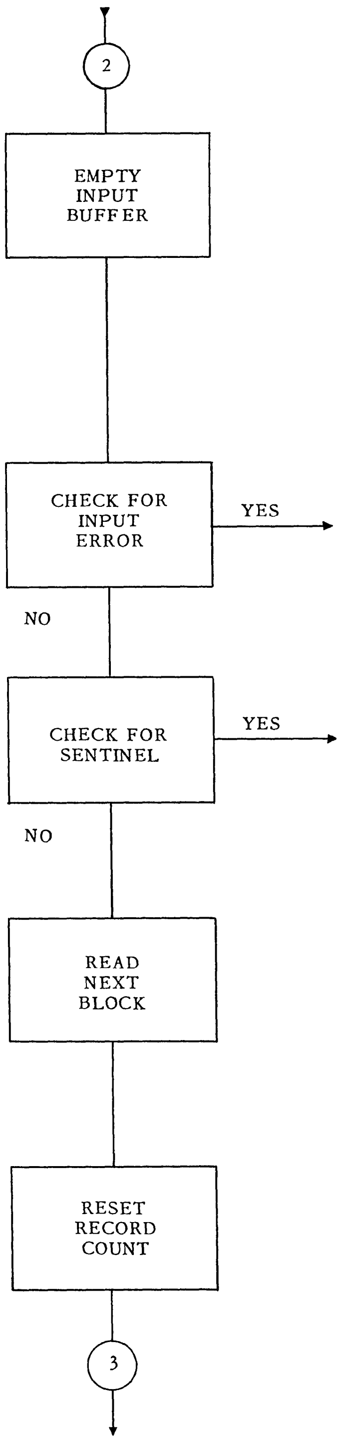


CHART 2



B.1 This is the start of a series of boxes for getting the next block of records from File 1. The sequence here assumes that there is an input buffer and that simultaneous operations are taking place. The buffer may be simulated by switching input areas. If there are no simultaneous operations, box B.1 does not apply and the order of the other boxes would be slightly different. B.1 is the operation of emptying the input buffer or the switching of areas. It may first be necessary to test that the input operation is complete.

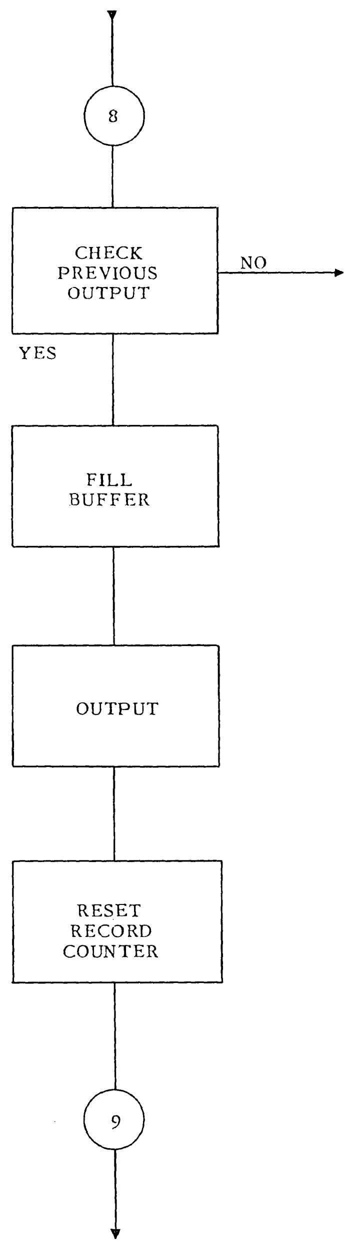
B.2 This box covers all the checks that must be performed to insure that the input was correct. We assume that all the checks are successful and are not concerned with what happens when the check fails, although allowance should be made for jumping around the error routines rather than for jumping out to error routines.

B.3 This is a test for a sentinel which would signal the end of a reel. We assume that the check does not find the sentinel.

B.4 This is the initiation of the filling of the buffer with the next block or an equivalent operation. It may require preliminary tests that the channel and/or unit are available. It does not include input time or lock-out time.

B.5 When dealing with blocks of several records, it is necessary in B.12 (q.v.) to step from record to record. When a new block is begun, this process must be initialized. It may be done by the setting of an index register or forming the addresses of certain instructions, or setting the first link of a chain when using scatter-read. (See also B.1). It is not required for Configuration I.

CHART 3



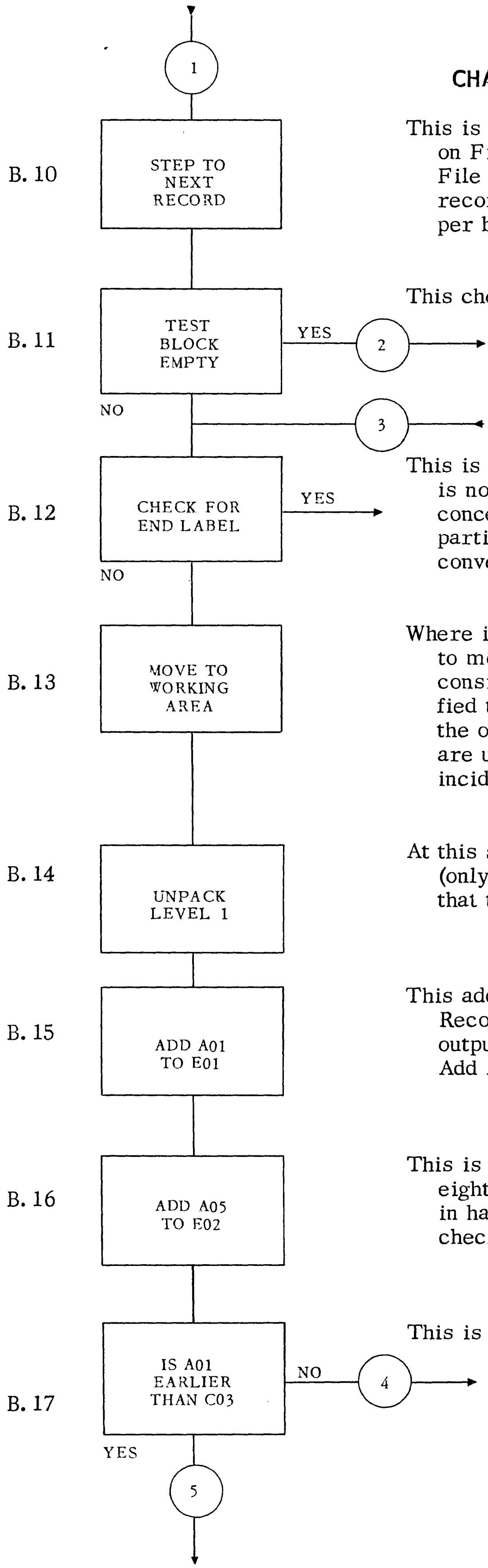
B.6 This is the start of a series of boxes to record a block on File 2. The first box insures that the previous output operation is now complete and was not in error. We are not concerned with what happens if the output was in error.

B.7 This is the operation, if necessary, of filling the output buffer or switching output areas. (See B.1).

B.8 This is the initiation of the output operation. (See B.4).

B.9 This corresponds to B.5

CHART 4



This is the start of the set of boxes dealing with a record on File 1, assuming there are no relevant details in File 3. This box arranges the stepping to the next record in sequence if there is more than one record per block.

This checks whether the current input block is exhausted and a new block required. The time allowed here should be for jumping around the sequence covered in blocks B.1 to B.5, if there is more than one record per block.

This is a check to insure that the current Master Record is not a label signaling the end of File 1. We are not concerned with failure of the check. The label is a particular key size, at least eight characters, in any convenient place in the record.

Where index registers are not used, it may be necessary to move each record into a working area as it is considered. It is required in the problem as specified that all the input data must at least be moved to the output area (unless scatter-read and gather-write are used) because we assume that there is a high incidence of insertions and deletions to the file.

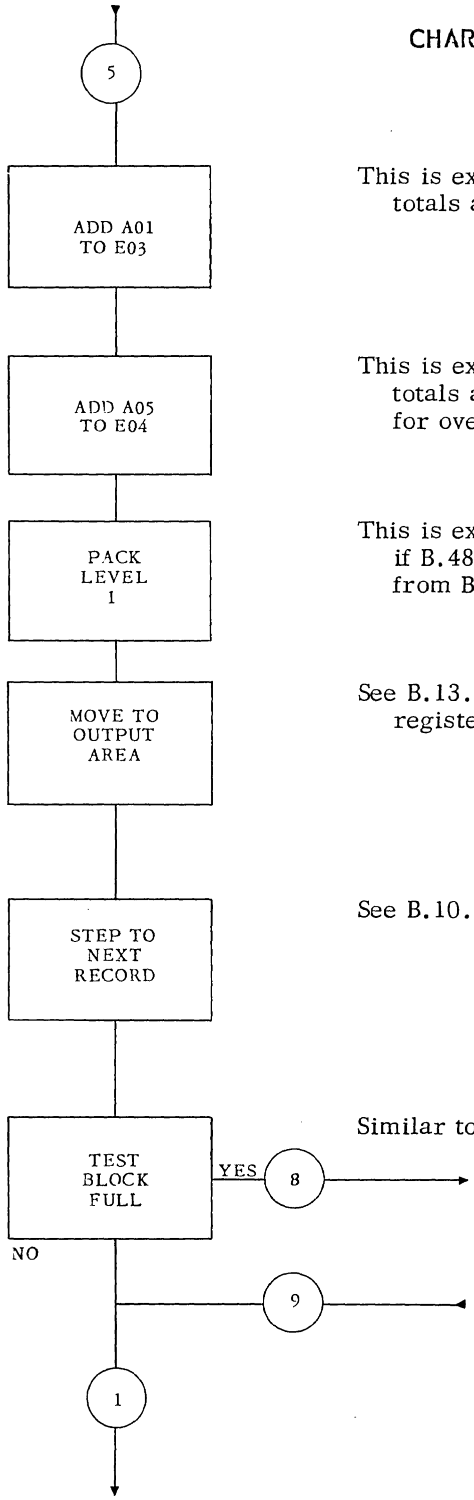
At this stage, a minimum of the record is unpacked (only enough to do boxes 15 to 19) on the assumption that there will be no relevant details in File 3.

This adds the identity number of the current Master Record to a hash total as a check that all the records output on the last occasion are read on this occasion. Add A01 to an eight character hash total.

This is a control total, not a hash total, and is held to eight digits. This accumulates a grand total of items in hand, A05, for the whole inventory, which is checked for overflow.

This is a comparison of the identity number of the current Master Record on File 1, A01, with the identity number of the detail record on File 3, C03. Three conditions are possible. Optimized coding ascertains as quickly as possible if A01 is less than C03 so that a jump can occur straight to B.18.

CHART 5



B. 18 This is exactly the same as B.15 except that output totals are being accumulated.

B. 19 This is exactly the same as B.16 except that output totals are being accumulated. They are checked for overflow.

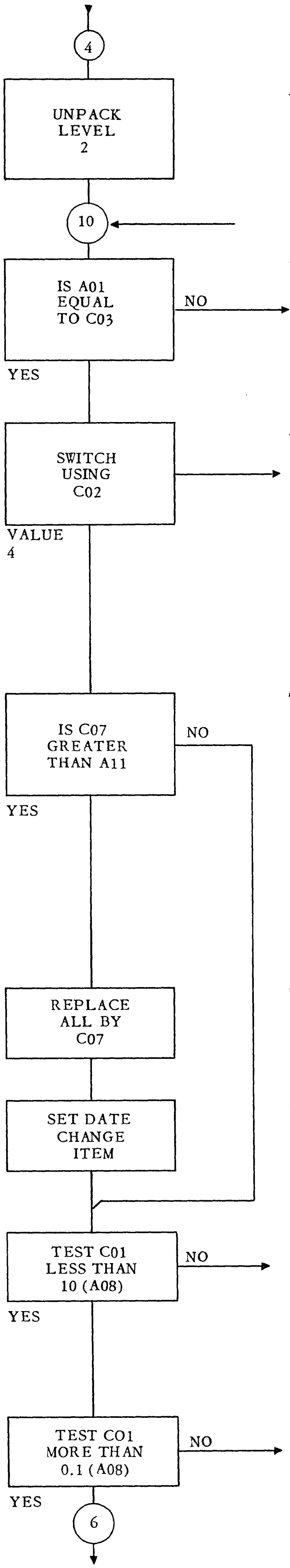
B. 20 This is exactly the opposite of B.16. It is not necessary if B.48 packs all the levels because the direct path from B.17 to B.18 does not alter a record.

B. 21 See B.13. Not necessary as well as B.13 if index registers are used in B.24 to B.48

B. 22 See B.10.

B. 23 Similar to B.11

CHART 6



B. 24 — At this stage, we allow for enough unpacking of the record to perform the operations in boxes 25 to 37.

B. 25 — If the test that was performed in B.17 did not deal automatically with the separate cases of "equal to" and "greater than", this box tests for "greater than", in which case the detail record on File 3 would be an insertion. For timing purposes, we assume that at this stage there is always equality.

B. 26 — At this point in the program, there are six alternative paths depending upon the six different types of transactions that may be on the detail file. A six-way switch is controlled by values one to six of the transaction code C02. A check must insure that it is not zero nor greater than six. For timing purposes we assume that the value is four. If the best method is to test for each value in turn, they should be tested in the sequence 1,2,3,4,5,6. This may in some cases be better than checking that the code lies between 1 and 6. Code 4 is a delivery to stock.

B. 27 — This is the first of three boxes concerned with noting whether the date of the previous delivery on the Master File has to be altered . The first box checks to see whether the date of the amendment from File 3 is later than the date already held in File 1. Care must be taken here to test the three parts with the year in the most significant place, the month in the next significant place, and the day in the least significant place. It is assumed for timing purposes that years are equal, months are equal, and that days differ, in that sequence. Ignore the end-of-century effects.

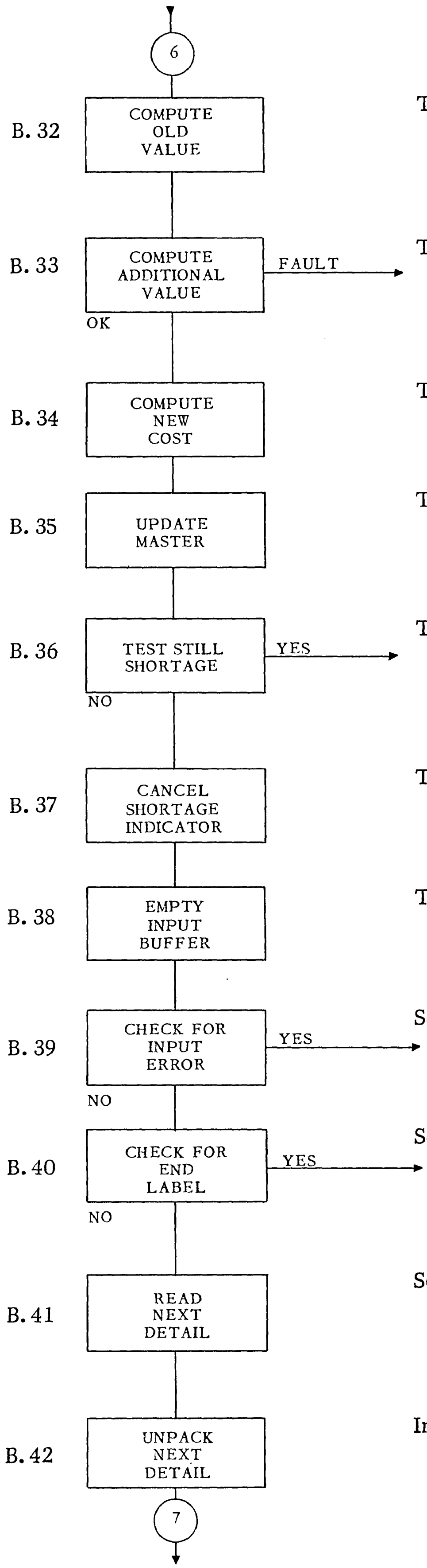
B. 28 — This is copying the previous date into a location from which it will be printed in the report.

B. 29 — This is updating the Master File.

B. 30 — This is the first of two boxes concerned with verifying that the quantity of the delivery is reasonable. In this box, a check is made that the delivery is not excessively greater than the re-ordering amount. In both this box and the next a factor ten or eight may be used, as is most convenient in the particular computer.

B. 31 — In this box, a check is made that the delivery is at least a significant portion of a re-ordering amount.

CHART 7



This is the first of a series of boxes which calculate a new average cost for the stock held. This box computes the value of the stock before the delivery by multiplying the quantity, AO5, by the old average cost, AO4. The product is no more than twelve digits.

This box computes the additional value of stock made in this delivery, which is the quantity, CO1, times its unit cost, CO5, and checks that the product is the same as the amount on the detail record, CO6. The product is no more than 10 digits.

This computes the new average cost by dividing the sum of the two values by the sum of the two quantities.

This box updates the master record by inserting the new cost, increasing the total on hand, AO5, decreasing the total on order, AO6, and inserting the new ordering number, CO9, in A14.

This box checks that having had a delivery, the quantity on hand, AO5, is now greater than the ordering level, AO8. It is assumed that the check succeeds.

This box sets the shortage indicator, A13 to zero.

This is the first of a series of boxes which gets the next record from File 3. They are similar to B. 1 to B. 5 except that there is no blocking and therefore B. 5 is not appropriate. For this box, see B. 1.

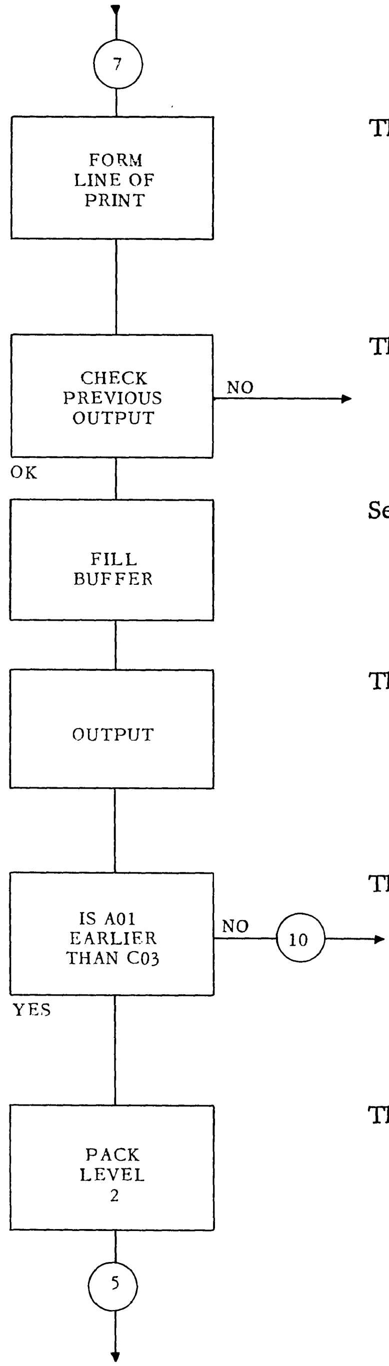
See B. 2.

See B. 3.

See B. 4

In this box any conversion, de-editing and unpacking that may be necessary is performed on the next record from File 3.

CHART 8



B. 43 — This is the first of a series of boxes dealing with the output on File 4. In this box, a line of print is formed. Note that many items can be copied from File 3, with no editing required. This can be assumed to have been done before B. 38.

B. 44 — This is the first of a series of boxes similar to boxes B. 6 to B. 8. This one corresponds to B. 6.

B. 45 — See B. 7.

B. 46 — This one corresponds to B. 8 and the necessary line spacing is set at one inch.

B. 47 — This is exactly the same as B. 17 and allows for the fact that it is necessary to check that there are no further details for this Master Record.

B. 48 — There being no further details, it is necessary to repack all the parts of the Master Record that were unpacked in B. 24 and have subsequently been altered.

§ 200.

.114 Graph

The estimated times, quoted in minutes and plotted on a graph against the activity factor, are for a master file of 10,000 records. The activity factor is the ratio of the total number of records in the detail file to the total number of records in the master file. Separate plots are made for each computer configuration.

WORKSHEET 3

PROBLEM: ____________ K = ____________

Config.											
Activity F											
Unit											
a1	1										
a2	K										
a3 or a4	KF										
File 1	1										
File 2	1										
File 3	KF										
File 4	KF										
m.sec/block minutes/file											

Config.											
Activity F											
Unit											
a1	1										
a2	K										
a3 or a4	KF										
File 1	1										
File 2	1										
File 3	KF										
File 4	KF										
m.sec/block minutes/file											

Config.											
Activity F											
Unit											
a1	1										
a2	K										
a3 or a4	KF										
File 1	1										
File 2	1										
File 3	KF										
File 4	KF										
m.sec/block minutes/file											

§ 200.

.115 Storage space required

An estimate, elaborated below, is made of the working storage required to carry out Problem A. The appropriate units may be words or characters. Separate estimates may be required for different configurations as they make use of large blocks, and to allow for any subroutines to be used instead of some optional facilities.

Standard routines

Allowance is first made for standard routines. If any lengthy routine is used, it is assumed that it is stored once as a closed subroutine, and is not counted in the parts of the program. Unless known to be otherwise, the following estimates are used for the routines in terms of single address instructions:

Input-Output Control:	150.
Multiply:	30.
Divide:	45.

Two- and three-address instructions are treated as equivalent to 1.5 and 2.0 single address instructions, respectively.

Fixed overheads

These are areas set aside for operating procedures or special registers.

Program

An estimate of the total space required by the program is obtained from a count of the instructions used for timing in paragraph .113 after removing subroutines. Allowance is made for six detail transaction procedures and three times the space counted for the other procedures.

Data areas

For each of the input-output files, there will be areas of storage that have to be set aside. Areas must be set aside for the current input block and the current output block that is being formed. There may also have to be areas for the next input block and for the previous output block to be held while simultaneous input-output operations are in progress. If several files have to share one input-output channel, it may be necessary to have a short queue of blocks in order to obtain properly overlapped operations. The storage needed for input-output and working areas may severely limit the possible block sizes on some configurations.

WORKSHEET 4

Unit of measure: _______________

Configuration	____	____	____	____
Standard Routines				
Input-Output Control	____	____	____	____
Multiply	____	____	____	____
Divide	____	____	____	____
Editing	____	____	____	____
_____________	____	____	____	____
Fixed Overheads	____	____	____	____
Program	____	____	____	____
(Boxes 1 to 23) times 3	____	____	____	____
(Boxes 24 to 48) times 6	____	____	____	____
Data areas				
File 1	____	____	____	____
File 2	____	____	____	____
File 3	____	____	____	____
File 4	____	____	____	____
Working	____	____	____	____
Sums	____	____	____	____

§ 200.

.12 Standard Problem B

This problem is one in which the master record size is only half the size of that in problem A. No block sizes are changed and Worksheet 3 is used with all values of K (the number of master records per block) doubled.

.13 Standard Problem C

This problem is one in which the master record size is double that in problem A. No block sizes are changed and Worksheet 3 is used with all values of K (the number of master records per block) halved.

.14 Standard Problem D

This problem is one in which the computation is trebled in order to represent the amount of work carried out in a typical payroll run. The time for a3 is replaced by a4.

.2 SORTING

Times are presented for typical sorting problems which are estimated by standard procedures and also, if available, as quoted for existing standard sorting routines.

Discrepancies between standard estimates and quoted times for standard routines usually indicate either the general accuracy of the estimates, or the advantages of sophisticated routines. The standard estimates allow for no advantage in internal sorting or polyphase and other techniques.

Standard estimates facilitate comparison of potential equipment performance of computer systems.

.21 Standard Problem

Times are estimated for straightforward merging on magnetic tapes. Two-way merging on Configuration II and 3-way merging on Configurations III and IV. Times for Configurations V and VI would be the same as that for Configuration III.

.211 Record sizes

A record size of 80 characters is used in the standard problem. For large volumes of data the times as estimated would be in direct proportion to record size.

.212 Key size

A key size of eight alphabetic characters is used in the standard problems. Key size is not usually a significant factor for reasonable sizes of the key.

.213 Timing basis

The times are based on the details obtained in Standard Problem A. The basic time is taken for the case of activity factor 0.0. This is taken as the time for one merge pass of 10,000 records. This time is multiplied by one plus the integer value of the logarithm of the number of records to base p, where there is a p-way merge.

For a 2-way merge, multiply the basic time by 10.4 and 0.74 for 10,000 and 1,000 records, respectively.

For a 3-way merge, multiply the basic time by 6.7 and 0.52 for 10,000 and 1,000 records, respectively.

§ 200.

.214 Graph

A graph of time in minutes against number of records is plotted for Configurations II, III and IV. These are straight lines.

In general the estimates are probably within 10 per cent of a straightforward standard routine, with no own coding.

.22 Standard Routines

Times are presented for any standard routines which are available and whose times are known.

Discrepancies between standard estimates and quoted times for standard routines usually indicate either the general accuracy of the estimates, or the advantages of sophisticated routines. The standard estimates allow for no advantage in internal sorting or polyphase and other techniques.

.3 MATRIX INVERSION

Two types of times are presented, first as estimated by a standard procedure, and second as quoted for standard routines.

Discrepancies between the two types of times usually indicate either the general accuracy of the estimates, or the advantages of sophisticated routines.

Standard estimates facilitate comparison of potential equipment performance of computer systems.

.31 Standard Problem

A straightforward inverse is required of a non-symmetric, non-singular matrix.

.311 Basic parameters

Elements are held in floating point form to a precision of at least 8 decimal digits.

.312 Timing basis

The time for the central loop is taken from the Central Processor performance (see :051.42). The time used is either that for cumulative multiplication or for addition and multiplication added together. The central loop time is multiplied by $(N + 1)^3$, where N is the size of the matrix. This allows for overheads.

.313 Graph

A graph is plotted of time in minutes against size of matrix. The straight line plot is probably within 10 per cent of a straightforward standard routine.

.32 Standard Routines

Times are presented for any standard routines which are available and whose times are known.

§ 200.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A

This is a straightforward application in which there is one stream of input data, a fixed computation to be performed and a stream of output results.

The input is a series of records. Each record contains 10 numbers:

X_1 X_2 X_3 X_4 X_5

Y_1 Y_2 Y_3 Y_4 Y_5

The basic computation is to form

$$Z_i = \sum_{j=0}^{5} A_j X_i^j$$

$$\text{e.g., } Z_2 = A_0 + A_1X_2 + A_2X_2^2 + A_3X_2^3 + A_4X_2^4 + A_5X_2^5$$

and

$$W = \sqrt{\left[\sum_{i=1}^{5} (Z_i/Y_i)\right]}$$

The output is a series of records. Each record contains 10 numbers:

X_1 X_5

Y_1 Y_5

Z_1 Z_2 Z_3 Z_4 Z_5

W

The time quoted is for one input record.

Two variables are introduced to demonstrate how the time for a job varies with different proportions of input, computation, and output. First, the computation per input record is varied from 0.1T to 100T where T is the time required to compute W. Second, there are three separate curves on the graph. They correspond to the cases of one output record for each, every tenth, and every hundredth input record.

The times are normally quoted for single-length floating point operations. Where floating point is only provided by slow subroutines, fixed point times are also given. Where single-length precision is less than eight decimal digits, double length times may be given.

.411 Input and Output Records

Each record must be separate from the others, either on separate cards, or on separate lines of print, or delimited on punched tape.

Each number may be up to eight digits in size but the average size is only five digits.

Editing style is not critical; the provision of minus signs is essential, but non-significant zeroes do not need to be suppressed.

§ 200.

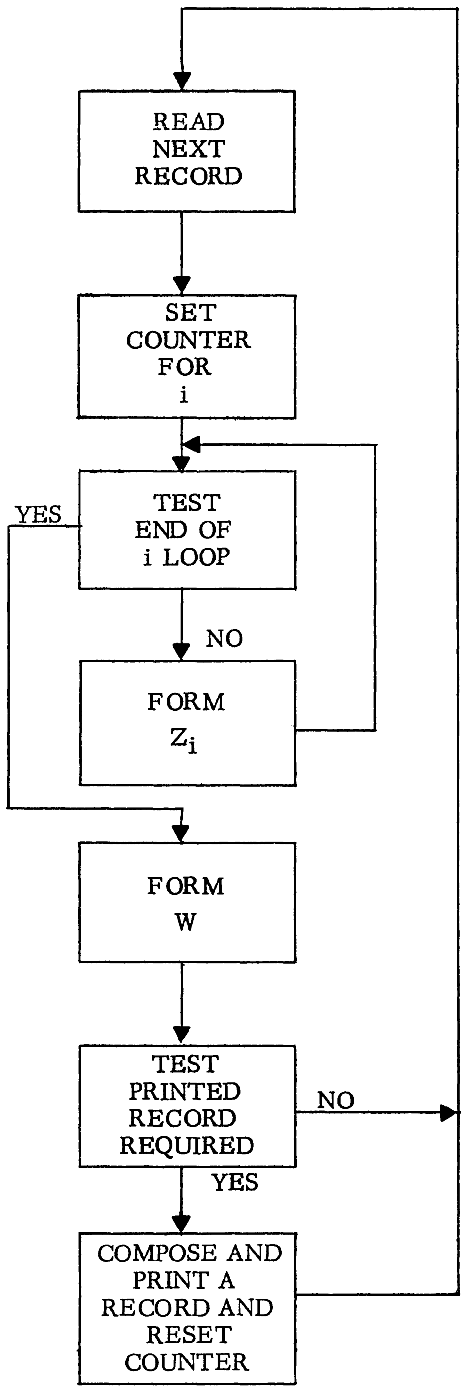
.412 Computation

The computation procedure is shown in the flow-chart. When operating in fixed point it can be assumed that:

all the input items are less than one in absolute value and of the form .91, .00734, etc.;

the absolute values of Z_i are less than 100, and W lies between 5 and 20.

.413 Flow Chart



B. 1 Records may not be blocked. Input error checks should be performed. Advantage should be taken of simultaneous operations. Use standard routines for radix conversions.

B. 2 The routine is written to handle values of i up to 10. For timing, i is assumed to be 5.

B. 3

B. 4

B. 5

B. 6 Use a counter to control an output each 1, 10, or 100 input records.

B. 7 Use a rapid output, often off-line printing where significantly advantageous; but for Configuration IX print on-line.

§ 200.

WORKSHEET 5
BASIC PARAMETERS
Standard Mathematical Problem A

Configuration		_____	_____	_____	_____
Fixed/Floating		_____	_____	_____	_____
Assignment (identity)					
Input Unit		_____	_____	_____	_____
Output Unit		_____	_____	_____	_____
Record Size (give units)					
Input		_____	_____	_____	_____
Output		_____	_____	_____	_____
Record In-Out Time (m.sec.)					
Input	T_1	_____	_____	_____	_____
Output	T_2	_____	_____	_____	_____
C.P. Penalty Times (m.sec.)					
Input	T_3	_____	_____	_____	_____
Output	T_4	_____	_____	_____	_____
Computing Time (m.sec.)					
Box B1	T_5	_____	_____	_____	_____
Boxes B2 to B6, counted the appropriate number of times per record.	T_6	_____	_____	_____	_____
Box B7	T_7	_____	_____	_____	_____

§ 200.

WORKSHEET 6
EFFECTIVE TIMES
Standard Mathematical Problem A

Configuration _____

Fixed or Floating _____

Precision _____

R = Output Ratio _____

	Times in Seconds Per Input Record					
	Input	Output	Central Processor			
			C=0.1	C=1.0	C=10.0	C=100.0
T_1		/	/	/	/	/
T_3	/	/				
$R(T_2)$			/	/	/	/
$R(T_4)$	/	/				
T_5	/	/				
$C(T_6)$	/	/				
$R(T_7)$	/	/				
Totals						
Effective Time			____	____	____	____

For one value of R (0.01, 0.1, or 1.0), enter input-output record time in left hand columns and central processor penalty and computing times in right hand columns for each value of C. Sum right hand columns for effective time unless input-output time is greater.

C = weighting factor, computation/input.

R = weighting factor, output/input.

§ 200.

.5 GENERALIZED STATISTICAL PROBLEMS

.51 Standard Statistical Problem A

Problem A is a computer run that reads a file of records and compiles a number (N) of cross-tabulation tables. Each input record is one set of 2-digit numerically-coded answers numbered 1 through 30 to 30 questions used in a survey.

At the start of a run the number of tables N is input and, for each table, the identity of the pair of questions concerned, A and B, and the identity of the question to be used as a weighting C.

The file of answers has been pre-edited and if necessary converted and all answers coded into integers less than 100; e.g., day of week into the numbers 1 to 7.

If the largest-possible answers to questions A_i and B_i are X and Y, then a series of locations is allocated to hold XY values, considered as a table of X rows and Y columns.

If for any record the answers to the three questions A, B, and C for a particular table are x, y, and r, then it is required to add the weight r into the location in column y row x of the table.

As a check, each weight is added into a check total for each table.

.511 Input Records

Each input record consists of thirty 2-digit numbers: the answers to thirty questions. Items may be packed and records may be blocked into convenient arrangements.

.512 Computation

It is assumed that negligible time is consumed at the start of a run to generate a sequence of instructions to update each table for any record.

The procedure is to add the answer to question C(r) to the location

$$(x-1) + X(y-1)$$

positions from the start of the table and to another fixed location.

Each table entry must be able to hold a value of 10,000.

The performance is quoted as a time per input record. The only variable is the number of tables produced in one run.

§ 200.

WORKSHEET 7
BASIC PARAMETERS
Standard Statistical Problem A

Configuration		_____	_____	_____
Assignment (identity)				
Input unit		_____	_____	_____
Block Size		_____	_____	_____
Input-Time per Block (m.sec.)	T_1	_____	_____	_____
C.P. Penalty (m.sec.)	T_3	_____	_____	_____
Computing Time (m.sec.)				
Get next block	T_5	_____	_____	_____
Get next record	T_6	_____	_____	_____
Update next table	T_7	_____	_____	_____

§ 200.

WORKSHEET 8
EFFECTIVE TIMES
Standard Statistical Problem A

Configuration _____

Fixed or Floating _____

Precision _____

	Times in Seconds Per Input Block				
	Input	Central Processor			
		N=1	N=10	N=100	N=1000
T_1		/	/	/	/
T_3	/				
T_5	/				
$B(T_6)$	/				
$BN(T_7)$	/				
Totals					
Effective Time		--	--	--	--

B = records per block

N = tables per run

PHYSICAL CHARACTERISTICS

§ 210.

The physical characteristics of the units of the system are summarized in a table which provides details of the over-all physical size of the system and permits estimates of the site requirements to be made.

.1 IDENTITY

Each unit available within the system is identified by its name and model number.

.2 PHYSICAL CHARACTERISTICS

The dimensions of each unit are given in inches. The weight of each unit is given in pounds to facilitate shipping and floor loading estimates. The restriction on cable lengths among units is given to assist in developing feasible equipment layouts.

.3 ATMOSPHERIC CONDITIONS

In this paragraph, the thermal and atmospheric conditions are summarized. The heat dissipated in BTUs per hour may be converted into preliminary estimates of cooling requirements by the following formula:

tons of air conditioning required = total BTUs per hour/12,000.

Permissible temperature and humidity ranges for storage of equipment and for working conditions are given.

.4 ELECTRICAL REQUIREMENTS

This entry in the table summarizes the requirements of voltage, frequency of the power supply, the type of connection, the regulation requirements, and the electrical load.

.5 NOTES

Certain over-all system requirements in relation to physical environment are specified.

The maximum floor loading gives for typical configurations, the maximum loading that the floor must support. This assists the user in choosing the location site.

With magnetic-tape systems in particular, the dust in the computer room must be limited. If available, the type of filtering required or the permissible maximum particle size and density are stated.

GLOSSARY

AUERBACH

STANDARD EDP REPORTS

AUERBACH INFO, INC.

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STANDARD EDP REPORTS GLOSSARY

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EDITOR'S NOTE

.1 INTRODUCTION

The purpose of this Glossary is to define in as precise a manner as possible the meanings of words and phrases as used in Standard EDP Reports. The definitions are particularly applicable to the Computer System Reports and are amplified and supplemented by the User's Guide.

.2 BACKGROUND

The extremely rapid growth of the computer industry has resulted in a great diversity in the usage of words. Not only have series of synonyms appeared for one concept, but often one word is chosen at different times to represent similar, but distinctly different, concepts. In order to prepare standardized reports, it has been necessary to choose and publish a consistent set of terms for use in the Reports. The introduction to the IBM Glossary (ref. 2) describes the more general problem.

.3 GENERAL PRINCIPLES

In compiling this glossary, we have considered our particular needs first. Second, we have consulted the authoritative English dictionaries (refs. 4 and 5) and then considered the general usage of terms by the industry. Our requirements are that all definitions given in the Glossary be mutually consistent, that each of the concepts we wish to discuss in the Reports have an adequate vocabulary, and that the Glossary be immediately available. While we would prefer to use accepted international standards, these are not presently available.

Whenever possible, our usage has been made to conform with Webster's and O. E. D. For example, a word such as "system," which is used in many different ways in EDP (e.g., Business System, Computer System and Operating System) has been defined in a particularly wide sense, to embrace all these different concepts. Any particular kind of system should then be qualified by an adjective or by its context. Therefore, we have also defined the meanings of such words as "concept," "idea" and "thing" in the way in which they are used both within the Reports, and in particular within the Glossary as the basis of other definitions.

Having satisfied our own particular needs and conformed to "preferred" English usage, we have avoided conflicts with general EDP usage where they would cause confusion to the reader.

.4 ORGANIZATION

The terms in the Glossary have been arranged in logical groups in order to keep related terms close together. A Cross-reference table at 7:103 provides a list in alphabetical sequence of the words and phrases and may be used as an index to the Glossary.

Editor's Note — Contd.

.5 SOURCES

Our prime sources have been the Draft Standard Glossary produced by B.S.I. (ref. 1), the IBM Glossary (ref. 2), and those working papers of the IFIP Committee TC-1 that have been available to us. A list of our most useful sources is given below.

1. BSI Subcommittee eds.
   Glossary of Terms Used In Automatic Data Processing
   British Standards Institute, Oct., 1960.

2. Reference Manual, Glossary for Information Processing
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    A Glossary of Computer Engineering and Programming Terminology.
    Ballistic Research Labs., Aberdeen Proving Ground, April, 1957.

NOTE: Reference 3 contains an extensive bibliography of national and international glossaries.

.6 COPYRIGHT

AUERBACH/BNA has no proprietory interest in the definitions set forth in this Glossary and permission to use or reproduce them is hereby freely granted.

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GLOSSARY

111 GENERAL

.01 acronym

n. a word formed from the first letter or letters of the words in a name, term or phrase; e.g., SAGE from semi-automatic ground environment, and ALGOL from algorithmic language.

.02 annotate

v. Add explanatory notes and comments.

.03 automation

n. Originally formed by contracting "automatization", this term now denotes intensive mechanization comprising the co-ordinated automatic control of machine systems, and the automatic transport testing and treatment of materials and products throughout a sequence of operations. It also includes automatic data processing when this is employed to monitor and regulate a group of linked activities.

Note: "Automation" is commonly used to represent
(1) the theory, art and techniques of automatic systems for industry or commercial use.
(2) the processes of investigation, design, and conversion to automatic methods.

.04 category

n. 1. A natural classification.
2. A logical grouping of associated documents.

.05 cybernetics

n. The science of exploring the parallelism between organic and machine processes.

.06 device

n. 1. That which is devised, invented or formed by design.
2. A mechanical contrivance or appliance.

.07 facility

n. A ready ability.

.08 mistake

n. Incorrect programming, coding, data transcription, manual operation, etc. Syn.: human error.

.09 mnemonic

a. Pertaining to a technique used to assist the human memory. A mnemonic code resembles the original word and is usually easy to remember; e.g., mpy for multiply and acc for accumulator.

.10 monitor

v. Warn of faults or inform of duty.

.11 mode

n. 1. A method of operation; e.g., the binary mode, the interpretive mode, the alphameric mode, etc.
n. 2. The most frequent value in the statistical sense.

.12 millisecond

n. One thousandth of a second.

.13 microsecond

n. One millionth of a second.

.14 nanosecond

n. One thousand millionth of a second.

.15 pico second

n. One million millionth of a second.

.16 identify

v. Attach a unique code or code name to an entity.

.17 service

n. Assistance given to another; work performed for a master or superior.

.18 dynamic

a. Pertaining to change, as contrasted with static.

.19 servo-mechanism
servo

n. A control device automatically actuated by the difference between the measured and desired values of the controllable quantity, and containing a power amplifier.

.20 electronic

a. Related to that branch of science which deals with the motion, emission and behaviour of currents of free-electrons (and, by extension, of certain ions), especially in vacuum tubes or phototubes and in semiconductors and superconductors.

Note: Electronic is often contrasted with electrical, but this distinction is simply a matter of usage, and precise rules cannot be laid down. Equipment would not normally be described as electronic unless it depended essentially for its operation on the use of one or more of: thermionic valves, gas tubes, phototubes, cathode-ray tubes or such solid-state equivalents as crystal diodes, transistors, etc.

.21 solid-state components

n. In data processing, loosely used to denote components that depend on electric or magnetic phenomena in solids; e.g., in semiconductors and ferrites.

Note: Used to distinguish such components from those depending on phenomena in a vacuum or a rarefied gas.

.22 ferro-magnetic materials

n. 1. Materials having a permeability considerably greater than that of a vacuum, and varying with the flux density, as in the case of iron.

Note: Certain ferro-magnetic materials can be permanently magnetized; e.g., by passing a signal current through a coil of wire surrounding the material. The magnetization remains after the removal of the signal but can be cancelled or reversed by applying large enough signals in the opposing sense. These are often referred to as "hard".

n. 2. Electrical insulating materials which can be permanently electrically polarized; e.g., by applying a signal voltage across a pair of electrodes attached to the material. The polarization remains after the removal of the signal, but can be cancelled or reversed by applying large enough signals in the opposing sense.

.23 pulse

n. An electrical disturbance whose duration is short in relation to the time scale of interest and whose initial and final values are the same.

.24 pulse repetition rate (P. R. R.)

n. The average number of pulses in unit time.

Note: When the pulse repetition rate is independent of the interval of time over which it is measured, it may be called the pulse repetition frequency (P. R. F.).

.25 transducer

n. A device which converts signals from one kind of energy into another.

.26 machine

n. A device consisting of a framework and various fixed and moving parts for doing some kind of work.

112 CONCEPTS

.01 concept

n. A generalized idea of a class of entities, or potential entities.

.02 entity

n. That which has real and individual existence, in reality or the mind.

.03 idea

n. An entity that has existence only in the mind.

.04 thing

n. An entity that has physical existence.

.05 problem

n. A situation or question proposed for solution or consideration.

.06 task

n. A logical part of a problem.

113 STRUCTURE

.01 dichotomy

n. A division into two subordinate classes; e.g., all white and all non-white, or all zero and all non-zero.

.02 hierarchy

n. A specified rank or order of items. A series of items classified by rank or order.

.03 nested

a. Pertaining to a structure which is contained within another structure of the same form.

.04 nestable

a. Describing a structure that may be nested.

.05 basic

a. Referring to the concept of a structure that is the innermost part of a nested structure; e.g., a statement is a basic form of a procedure, but a procedure is nestable.

.06 open-ended

a. Having the capability of being extended or expanded.

.07 interface

n. A common boundary; e.g., the boundary between two systems or two devices.

.08 catena

n. A chain, a series, especially a connected series.

.09 fixed size

n. A size that may not vary.

.10 variable size

n. A size that may be varied within a system.

.11 level

n. The property of a class of entities of equal rank in a hierarchy: e.g., levels of nesting, recursion, subroutines, loops, etc.

112 CONCEPTS

.01 concept

n. A generalized idea of a class of entities, or potential entities.

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116 LOGIC

.01 logic

n. In ADP technology. The systematic scheme which defines the interactions of signals in the design of an ADP system.

.02 formal logic

n. The study of the structure and forms of valid argument without regard to the meaning of the terms in the argument.

.03 symbolic logic
mathematical logic

n. 1. The study of formal logic and mathematics by means of a special written language which seeks to avoid the ambiguity and inadequacy of ordinary language.

n. 2. Mathematical concepts, techniques and languages originating or used in the study of logic, whatever their particular application or context.

.04 logic design
logical design

n. The specification, derived from the logic of the working relations between the parts of the equipment, without primary regard for the forms of circuit that could be used.

.05 functional design

n. The practical specification of the working relations among all parts of the system, taking account of the equipment used and of the logic design.

.06 logic element

n. A device which from the present or previous value of a specific number of input signals determines the value of one or more output signals and which serves, with other logic elements, a particular logic design. The relation between the input and output signal values is usually simple and can be briefly and conveniently specified; e.g., an adder.

.07 logic diagram
logical diagram

n. A graphical representation of the logic design.

.08 functional diagram

n. A graphical representation of the functional design.

.09 block diagram

n. A conventional drawing of a system, instrument, computer or program in which all portions are represented by annotated boxes.

117 COMPUTATION

.01 computation

n. A process mainly involving arithmetical operations.

.02 array

n. An arrangement or pattern of things.

.03 matrix

n. In mathematics, a two-dimensional rectangular array of quantities which is manipulated according to defined rules. By extension, any two-dimensional rectangular array. By further extension, any multi-dimensional array of items of any kind.

.04 argument

n. In computation, an independent variable; e.g., in looking up a table, the key (or any of the keys) which identifies the location of the required result.

.05 modulo

n. A mathematical operator which yields the remainder function of division. Thus 39 modulo 6 = 3.

.06 parameter

n. A quantity that is a constant within a system but a variable outside the system.

.07 range

n. All the values which a quantity may have.

.08 span

n. The difference between the highest and lowest values in the range of a variable.

.09 random numbers

n. 1. Numbers obtained entirely by chance.

n. 2. A sequence of numbers which satisfies various statistical tests which are thought to be appropriate.

n. 3. A sequence of numbers which does not simulate the effects of any unwanted causes or hypotheses. (See Note 2).

Note 1: Sequences of random numbers are required in various types of calculation; e.g., simulation by calculation of real situations containing an element of uncertainty, methods of integration which use formulae derived from statistical theory (sometimes called Monte Carlo or Random Walk method).

Note 2: The "unwanted" effects are those which might bias the result of the calculation. Thus, in this sense, a sequence of numbers may be satisfactorily random for one type of calculation but not for another; e.g., a slight tendency for a very small number in the sequence to be followed by a large one may affect the result only in some types of calculation.

.10 truncate

v. Omit certain terms of an expression. In computation, for example, it is common to omit terms at the end of a series, or digits of a number, in positions the significance of which is less than some assigned value.

.11 expression

n. A collection of symbols representing a quantity.

.12 normalize

v. Multiply a variable or one or more quantities occurring in a computation by a numerical coefficient in order to make an associated quantity assume a nominated value; e.g., maximum member of a set of quantities equal to unity.

.13 round-off
rounding-off

n. Any method of reducing the bias introduced by a process of truncation; e.g., to round off the last figure to be retained of a result, one-half of the radix may be added into the next (less significant) digit position before truncation.

.14 linear optimization
linear programming

n. Any procedure for locating the maximum or minimum of a function of variables which are subject to linear constraints and inequalities.

121 SIGNALS

.01 signal

n. A physical entity representing data.

.02 character set

n. A set of quantized, mutually distinct, signals, used to form words in a system of communication.

.03 character (+)

n. A member of a character set.
Note: This particular meaning of the word character and the one following are important and distinct. Within this glossary, the meaning of each use of the word character is distinguished by the suffix (+) or (++).

.04 character (++)

n. The occurrence of a character (+), as in characters per second.

.05 graphic

a. Representing a particular character (+) in a printed, or similar, form legible to humans.

.06 alphabet

n. Those characters (+) in a character set that are used in the written representation of spoken words.

.07 alphabetic

a. Pertaining to an alphabet.

.08 letter

n. An alphabetic character (+); a member of an alphabet.

.09 figure

n. A numeric character (+).

.10 digit

n. The occurrence of a figure; usually, when unqualified, a decimal digit.

.11 numeral

n. A word representing a number.

.12 numeric

a. Pertaining to numbers.

.13 special character

n. A character (+) that is neither a letter nor a figure.

.14 alphanumeric
alphameric

a. Pertaining to both numeric and alphabetic things.

.16 blank

n. A character (+) used to denote the presence of no data rather than the absence of data.

.17 space

n. One or more blanks.

.18 caret

n. A symbol (^) used to indicate the location of a decimal point.

.19 symbol

n. A character or word taken as the conventional representation of some entity: e.g., letters or mnemonics representing operations in an instruction; △ representing a blank.

.20 functional symbol

n. A symbol used in a functional diagram.

.21 logic symbol

n. A symbol used in a logic diagram.

.22 ignore character
erase character

n. A symbol used to indicate either
1. that the character (++) itself is to be ignored,
2. that a preceding or following item be ignored, or
3. that some specified action is not to be taken.

.24 word

n. An arrangement of characters (++) which has at least one assigned meaning in a language.

.25 vocabulary

n. The set of words of a language.

.26 dictionary

n. A vocabulary together with the meanings of the words arranged in alphabetical sequence.

.27 glossary

n. A vocabulary, with annotations, for a particular topic.

.28 operator symbol

n. A symbol representing an operation.

122 DATA

.01 data

n. A representation or a record, using known conventions, entities, especially magnitudes of quantities, but also for example, instructions, descriptions, or messages. The representation may be more suitable either for human interpretation (e.g., printed text) or for interpretation by equipment (e.g., punched cards or electrical signals).

.02 information

n. The meaning for a human assigned to data by the known conventions used in its representation.

.03 quantity

n. An entity that has the property of being measurable or being expressed in numbers.

.04 number

n. The mathematical idea of a number; e.g., an integer, a rational number, a real number.

.05 variable

n. A quantity whose value may vary.

.06 constant

n. A quantity whose value does not vary.

.07 item

n. An arbitrary quantity of data, treated as a unit.

.08 figurative

n. A data item that is descriptive of its value and undefined in size, code, or format; e.g., five, four hundred and three, zero, ones.

.09 record

n. A collection of related items.

.10 file

n. A collection of related records.

.11 grouped records

n. Two or more records contained in one group, and usually identified by a key associated with all of the records.

.12 string

n. A set of records which is in ascending (or descending) sequence according to a key contained in each record.

.13 detail file

n. A temporary reference file of records, usually containing current data to be processed against a master file.

.14 master file

n. A main reference file.

.15 table

n. 1. One or more lists containing organized data.

n. 2. A collection of data, each item being uniquely identifiable by a combination of one or more keys.

.17 format

n. A predetermined arrangement of characters, fields, lines, punctuation, page numbers, etc.

.18 record layout

n. The arrangement, regarding both sequence and size, of the items in a record.

.19 padding

n. A technique used to fill out a section of storage with dummy items.

.20 load

n. The quantity of data transferred in a single input-output operation.

.21 card image

n. A representation in storage of a punched card; e.g., a copy of the original card matrix where one represents a punch and zero represents a no-punch.

.22 chaining

n. A system of storing records in which each record belongs to a set or group of records and has a linking field for tracing the chain.

.23 home record

n. The first record in a chain of records used with the chaining method of file organization.

.24 blocking

v. Combining two or more records into one block.

.25 block

n. The data held in a section of a store.

123 DATA DESCRIPTION

.01 identifier

n. A thing by which an entity may be identified. This may be a unique name, a location in which the entity exists, or the name of a parameter which has the value of that entity, or an indirect address which will lead to that entity.

.02 name

n. A direct identifier.

.03 label

n. A name attached to or written alongside its entity. For example, a label record on a tape or a label written alongside a statement on a coding sheet.

.04 key

n. An item of data in a record which for a certain specified process is used to classify the various records in a file; e.g., an item on which records in a file are to be sequenced, or the key to be used in a table look-up operation.

.05 tag

n. A key or classifier attached to an item of data.

.06 literal

n. A data item that is its own identifier.

.07 designator

n. A property of an entity, or a part of an entity which classifies the entity.

.08 delimiter

n. An item that marks an end of a string of items, and therefore cannot be a member of the string.

.09 mark

n. A character (+) used as a delimiter.

.10 group mark

n. A delimiter of a group.

.11 sentinel

n. A data delimiter usually marking the end of a file or the end of a group of records in a file, or the last record on a reel.

.12 location delimiter

n. A delimiter which is a part of a store.

.13 data delimiter

n. A delimiter which is a data item.

.14 begin

n. A procedure delimiter in ALGOL.

.15 end

n. A procedure delimiter in ALGOL.

124 TRANSFERS

.01 transfer

v. Copy, exchange, read, record, store, transmit, transport or write data.

.02 read
sense

v. Extract or copy data from a record or signal.

.04 write

v. To record data in a store.

.05 copy

v. Reproduce data in a new location or other destination, leaving the source unchanged. The representation remains the same.

.06 preserve
hold

v. Retain data in one location after transferring it to another.

.08 transmit
overwrite

v. Reproduce data in a new location or other destination, destroying whatever data was previously there.

.10 transform

v. Change data in representation or layout without significantly affecting the meaning.

.11 load of data

n. The volume of input or output data that can be read or recorded as a single operation. It may be specified as a number of units of data, or marked by a delimiter. A load of input or output may be many blocks. When a partly-full section is read, some systems may arrange to cut off the empty part from the input area.

.12 highway
trunk
bus

n. A major path along which signals travel from one of several sources to one of several destinations.

.15 channel

n. A path or aggregate of related paths for carrying signals between a source and a destination.
Note: In data transfer in which the elements of each item are sent in parallel, a channel comprises several parallel paths.

.16 multiplexing

v. Division of a transmission facility into two or more channels.

125 CODES

.01 code

n. An agreed representation of a character set or a vocabulary.

.02 alphabetical code

n. A code whose characters (+) are letters.

.03 numerical code

n. A code whose characters (+) are numerals.

.04 binary-coded decimal representation

n. A method of number representation in which each decimal numeral is represented by some designated binary number.

Example: In the 8-4-2-1 binary-coded decimal notation, the number 21 is represented by 0010: 0001 standing for 2 and 1 respectively.

.05 excess-three code

n. A binary-coded decimal representation in which the decimal numeral "n" is represented by the binary equivalent of n+3.

Note: In this notation, the nines complement of a decimal digit is simply formed by changing all ones to zeros and all zeros to ones. The generation of carries is also simplified.

.06 two-out-of-five code

n. A binary-coded decimal representation in which a decimal numeral is represented by five binary digits of which, for example, two are ones and three are zeros.

.07 biquinary code

n. A code in which a decimal numeral "n" is represented by the pair of numbers a and b where

$n = 5a + b$

in which a = 0 or 1 and b = 0, 1, 2, 3 or 4.

.08 signal distance
Hamming distance
distance

n. 1. The number of places in which the corresponding digits of two binary words of the same length are different.

2. By extension, the number of places in which the corresponding digits of two words of the same length in any radix are different. For example, the signal distance between 21415926 and 11475916 is three.

Note: If the two n-bit words in definition 1 are taken as the co-ordinates of two points of an n-dimensional hypercube of unit size (in signal space), the signal distance is then the geometrical distance between the points, measured along edges of this cube. This model is not serviceable, however, for the concept of definition 2.

.11 unit-distance code

n. An arrangement in a sequence of some or all of the words of a given length, such that the signal distance between consecutive words in the sequence is 1.

.12 reflected binary code
gray code

n. A type of cyclic unit-distance binary code built up from the four-word two-bit unit-distance code (00, 01, 11, 10) according to the following rule:

To construct an (n+1)-bit reflected binary code from an n-bit reflected binary code, write the n-bit code twice in sequence, first in forward and then in reverse sequence of code words. Prefix an extra bit to each word, taking the value 0 for the forward version of the n-bit code, and the value 1 for the backward version.

.14 error detecting code

n. A code in which each representation of a character conforms to specific rules of construction, so that for certain errors the mutilated representation corresponds to no valid character; the presence of these errors can be detected without reference to the original message.

Note 1: Such codes require more than the minimum number of code elements to be detected which could represent the message.

Note 2: When an error occurs which the code has not been designed to detect, the error may escape detection.

.15 error correcting code

n. An error detecting code which uses additional code elements so that for certain errors the mutilated representation resembles more closely the original than any other valid representation. This enables these errors to be corrected.

Note: When an error occurs that the code has not been designed to correct, the "correction" may be erroneous.

.16 minimum-distance code

n. A code in which the characters of an alphabet are represented by words such that the signal distance between any two words does not fall below a specified minimum value.

Note: If the minimum distance is (2e+1), then errors in up to 2e digit places in a word can be detected; alternatively, errors in up to e digit places can be corrected.

.17 systematic error detecting or correcting code

n. A form of minimum distance code in which a valid representation comprises a set of "data digits" just sufficient to identify and distinguish the representation, and a set of "check digits" arranged to give the required minimum signal distance between any two valid representations.

Example 1. A systematic error-detecting code for detecting single-bit errors may be derived from a binary positional representation by appending a parity bit to each character.

Example 2. Table 3 shows a systematic error detecting or correcting code for two ternary data digits (a and b). The two check digits (c and d) are respectively the sum and difference of the data digits (modulo 3).

.18 chain code

n. An arrangement in a cyclic sequence of some or all of the different n-bit words, in which adjacent words are linked by the relationships that each word is derived from its neighbor by displacing the bits one place to the left (or right), dropping the leading bit and inserting a bit at the end. The value of the inserted bit needs only to meet the requirement that a word must not recur before the cycle is complete.

.19 instruction code

n. A code used to represent the elementary operations of a process.

.20 computer instruction code
computer code

n. A code used for representing the basic instructions that a computer has been built to execute.

.22 macro code

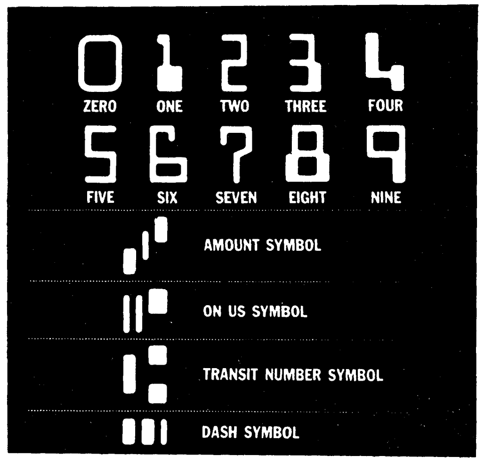
n. An operation code that designates a macro instruction.

.23 pseudo code

n. An operation code that designates a pseudo instruction.

.24 MICR code

n. Magnetic Ink Character Recognition code. A set of 10 numeric symbols and 4 special symbols standardized as Font E-13B of the American Bankers Association. These characters are imprinted by standard printing techniques and are readable visually and by magnetic sensing heads in Magnetic Character Recognition equipment. The special symbols are: amount, on us, transit number, and dash. Refer to ABA Publication 147 and 149.



126 ENCODING

.01 encode

v. Apply a code.

.02 decode

v. Apply a code so as to reverse some previous encoding.

.03 convert

v. Change data from one representation to another.

.04 transcribe

v. Reproduce data in a new location or other destination, with a change of representation: e.g., a transcription of typescript into punchings on a tape.

.05 quantization

n. A process in which the range of values of a variable is divided into a finite number of distinct sub-ranges (called quanta), not necessarily equal, each of which is represented by an assigned or "quantized" value within the sub-range; e.g., a person's age is quantized for most purposes with a quantum of one year.

.06 digitize

v. Obtain from an analog representation of a physical quantity a digital representation of the value of the quantity.

.07 edit

v. Arrange, delete, select, or add to a record to conform to the style and conventions of a later process, particularly input or output operations.

.08 zero suppression

n. That part of editing concerned with the elimination of non-significant zeros to the left of a prescribed point.

.09 data compression

n. A process that reduces the number of locations required to hold a message.

.10 zero compression

n. A data compression technique that eliminates the storage of non-significant leading zeros.

.11 protection character

n. A character (+) which replaces a suppressed zero, usually an asterisk.

.12 floating character

n. A character (+) which is positioned in the position one place more significant than the otherwise most significant character.

.13 standardize
normalize

v. Replace any given floating-point representation of a number with the representation in standard form: that is, to adjust the exponent and fixed-point part so that the new fixed-point part lies within a prescribed standard range.

127 NUMBER REPRESENTATION

.01 number representation

n. Any system for the representation of numbers.

.02 positional representation
positional notation

n. Number representation by means of an ordered set of digits, such that each digit makes an independent additive contribution to the number represented.

Note 1: The different sites in the ordered set where digits are located are known as digit positions, and are distinguishable from each other by reference to a datum position.

Note 2: The contribution from a digit having the value 1, in a given position, is known as the significance or weight of the position. The contribution from a digit having another value is in proportion to that value.

Note 3: The digit positions are usually ordered in increasing or decreasing significance.

.04 significant digits
significant figures

n. 1. Digits which contribute to the precision of a number.

n. 2. That part of a radix notation which expresses the number as a multiple of the smallest unit appearing in it; i.e., a sequence of adjacent digits of a number starting at the most significant position occupied by a non-zero digit and proceeding either for a predetermined number of digits or to the limit of accuracy or of required precision.

Example 1. If the last two digits are considered irrelevant or inaccurate, the representation 73524 may be replaced with 73500 to three significant digits.

Example 2. In a system where all numbers are carried to two significant digits, product of 1200 and 0.0012 is 1.4.

.06 radix notation
radix scale

n. A positional representation in which the ratio of the significance of a digit position (n) to the significance of the previous digit position (n-1) has the same integral value for each pair of adjacent digit positions. This ratio is called the radix or base of the notation, and the significances of successive positions are successive integer powers of the radix.

Note 1: In the radix notation known as decimal notation, the radix is ten and 5762, for example, represents:-

$$5 \times 10^3 + 7 \times 10^2 + 6 \times 10^1 + 10^0$$

.08 mixed radix notation

n. A positional representation in which more than one radix is used.

.09 radix point

n. In a number expressed in a radix scale, the location of the separation of the digits associated with the integral part of the number from those associated with the fractional part.

.10 binary

a. Of, or appertaining to, two.

n. A characteristic or property involving a selection, choice or condition in which there are two possibilities.

.11 binary notation
binary scale
scale of two

n. A radix notation with radix two.

.14 binary number

n. The representation of a number expressed in binary notation.

Example: The binary number 10011 represents nineteen (i.e., $1 \times 2^4 + 1 \times 2^1 + 1 \times 2^0$).

.15 binary digit

n. 1. A digit in the representation of a number in binary notation; i.e., 0 or 1.

n. 2. A digit from any two-character alphabet; e.g., 0 or 1.

.16 bit

n. 1. An abbreviation of binary digit.

n. 2. The unit of selective information; i.e., the amount of information derived from knowledge of the occurrence of one of two equiprobable, exclusive and exhaustive events.

.17 equivalent binary digits

n. The number of binary digits needed to represent a given number of digits in some alphabet.

.18 sign digit

n. A digit, normally located at one end of a digit sequence, which is used to indicate the algebraic sign of the number represented by the digit sequence.

Note 1: The name is also applied to the digit in the most significant position in binary numbers in which negative numbers are expressed as their complements.

.19 sign bit

n. A binary sign digit.

.20 true complement
radix complement

n. A number whose representation is derived from the representation of another in a radix notation, by subtracting each digit from one less than the radix, then adding 1 to the least significant digit, executing all carries required. Thus 830 is the true complement of 170 in a decimal number representation using three digits.

.22 diminished radix complement
radix-minus-one complement

n. A number whose representation is derived from the representation of another in a radix notation, by subtracting each digit from one less than the radix; e.g., 829 is the nines complement of 170 in a number representation using three decimal digits.

Note 1: In many computers, the absolute value of a negative number is represented as a complement of the corresponding positive number.

Note 2: The term radix-minus-one complement is a general term and is seldom used. The normal usage is, e.g., nines complement (decimal notation), and ones complement (binary scale).

.23 zero

n. 1. Nothing.

n. 2. A numeral normally denoting zero magnitude.
Note: In some computers, there are distinct and valid representations for positive zero and for negative zero.

.24 fixed-point representation

n. Radix notation in which each number is represented by a single set of digits, the position of the radix point being implied by the manner in which the numbers are used.

.25 floating-point representation

n. A number representation using two sets of digits, of which one (the fixed-point part) represents the significant digits and the other (the exponent) indicates the position of the radix point; the number represented is equal to the fixed-point part multiplied by the radix raised to the power of the exponent. Algebraically, the relationship is

$$x = a(r^b)$$

where x is the number represented, a and b are the fixed-point part and exponent, and r is the radix (not represented explicitly).

.26 standard form

n. A floating point representation in which the fixed point part has a value within some prescribed standard range.

.27 mantissa

n. The positive fractional part of the logarithm of a number.

131 PROCESSORS

.01 processor

n. A system able to accept data, perform processes upon the data, and output the results.

.02 black box

n. A generic term used to describe a processor which performs a specific process but whose detailed operation is unspecified.

.03 computer

n. A processor which can input, store, execute, and modify its routines. A computer without a routine is a trivial processor.

.04 digital computer

n. A computer in which digital representation is used.

.05 analog computer

n. A computer in which analog representation is used.

.06 computer configuration

n. A specific set of equipment units arranged together to form a particular computer.

.07 computer system

n. The complete repertoire of things from which a given computer installation is selected.

.08 hardware

n. A colloquial term for the things in a system that are units of equipment.

.09 software

n. The things in a computer system that are not units of equipment; e.g., programs; routines; services and facilities.

.10 computer installation

n. A computer configuration and the procedures and programs used with it.

.11 computer department

n. One or more computer installations together with their staff.

.12 open shop

n. A computer installation which is operated by people who are not on the staff of the associated computer department.

.13 closed shop

n. A computer installation which may not be operated by anyone not on the staff of the associated computer installation or department.

.14 simulator

n. 1. A device or processor that is arranged to perform simulation.

n. 2. A computer so arranged that there exists a direct correspondence between the units and interconnections of the physical system being studied and the units and interconnections of the computer.

.15 generator

n. A processor which produces a result by following an algorithm.

.16 recognizer

n. A processor used for deciding if a thing or its description satisfies a specification.

132 PROCESSES

.01 process

n. A system of operations designed to solve a problem.

.02 recursive process

n. A process that contains itself as a part of itself: e.g., a recursive subroutine contains a cue to itself.

.03 application

n. The problem to which a process is applied.

.04 simulation

n. The representation of one system by means of another. In particular, the representation of physical phenomena by computers, other equipment or models, to facilitate the study of such systems or phenomena, to train operators, etc.

.05 translation

n. The process of changing a message from one language to another without affecting the meaning.

.06 data reduction

n. The process of transforming masses of raw test or experimentally-obtained data, usually gathered by automatic recording equipment, into a useful, condensed or simplified form.

.07 update

v. To modify a master file according to current data, often that contained in a detail file.

.08 file maintenance

n. The updating of a master file because of the non-periodic changes; e.g., changes in number of dependents in a payroll file; the addition of new checking accounts in a bank.

.09 report generation

n. A technique for producing complete data processing reports given only a specification of the desired content and format of the output reports, and a description of the input file.

.10 tape-to-card

a. Pertaining to equipment or methods which transfer data directly from tape to cards, usually off-line.

.11 table look-up

n. A process of using a known value (the argument) to locate an unknown value (the function) in a list or table.

.12 concatenate

v. To unite in a series. To link together. To chain.

.13 scan of data

n. A process in which only some items in a collection of items are examined.

.14 pass of data

n. A process that involves the input of a complete file.

133 PROCESSING

.01 data processing

n. A systematic sequence of operations performed on data; e.g., merging, sorting, computing or any other transformation or rearrangement with the object of extracting information, of revising it or of altering the representation.

.02 information processing

n. The processing of data representing information and the determination of the meaning of the processed data.

.03 automatic data processing

n. A.D.P. - Data processing largely performed by automatic means.

.04 in-line processing

n. The processing of data without preliminary editing or rearrangement; real-time operation is one form of in-line operation.

.05 batch processing

n. A process in which a file of records is processed as a batch for operating convenience and efficiency.

.06 active

a. Pertaining to a record in a file which is used, modified, or referred to.

.07 activity ratio

n. When a file is processed, the ratio of the number of records in that file that have activity to the total number of records in that file.

.08 initialize

v. To set the values of the variable items of a process at initial values before the process is initiated.

.09 fixed-length record system

n. A system in which all records contain the same number of characters, and by extension, a system offering a choice between a few pre-determined record lengths.

.10 variable-length record system

n. A system in which the number of characters in a record is not fixed.

.11 off-line working

n. The performance of part of a data-processing procedure by equipment not connected to the main part of the system. For example, data on punched cards may be transferred off-line to magnetic tape on an off-line card-to-magnetic-tape transcriber and subsequently read on-line into the main system from an on-line magnetic-tape reader.

Note: Off-line working may avoid spending the time of a large system on an operation that could be performed by a much smaller one.

.12 pseudo-off-line working

In a multi-running system, the performance of a peripheral operation, using equipment connected to the main system, by a separate routine, possibly running concurrently with another stage of the processing. For example, the operation concerned might be the transfer of data from punched cards to magnetic tape for subsequent use by another routine.

.13 run

n. A specific performance of a process by a computer on a given set of data.

.14 rerun

v. Make another attempt to complete a job by executing all or part of the process again with the same or corrected inputs.

.15 job

n. A completed run without unresolved errors.

.16 end

n. The proper completion of a process.

.17 halt

n. An occasion when a processor pauses in its progress.

v. Cause a halt to occur.

.18 restart

v. Resume a process from a halt.

.19 stop

n. An instant when a process ceases in such a way that it is unable to restart.

v. Cause a process to come to a stop.

.20 operator options

n. The set of alternative sequences of operations from which an operator must choose at a halt before a process restarts.

141 ANALYSIS

.01 analysis

n. Resolution of any whole into its parts to discover their nature, proportion, function, relationship, etc.

.02 analyst

n. One skilled in analysis.

.03 systems analysis

n. The analysis of a system, usually a processing system.

.04 flow diagram
flow chart

n. A conventional drawing of a program or process intended to illustrate the sequence of individual steps.

.06 problem statement

n. A specification for a process.

.07 algorithm

n. A procedure or process for the solution of a problem in a finite number of steps; e.g., a full statement of an arithmetical procedure for evaluating sin x to a stated precision.

.08 heuristic

a. Describing an exploratory method of tackling a problem, in which the solution is discovered by evaluations of the progress made toward the final result in contrast with a purely algorithmic method; e.g., guided trial and error.

.09 system

n. A set or arrangement of entities to form, or be considered as, a unity, or organic whole.

.10 business system

n. A collection of operations and procedures, men and machines, by which business activity is carried on.

151 PROGRAMMING

.01 programming

n. The act of producing a program.

.02 program

n. A message formally describing a structure of procedures to solve a problem and the structure of the data involved.

.03 automatic programming

n. The use of an automatic data processing system to perform some stages of the work directly involved in preparing a program.

.04 flow diagram
flow chart

n. A conventional drawing of a program or process intended to bring out the sequence of individual steps.

.06 statement

n. A basic procedure.

.07 cue

n. A statement containing a key which initiates entry to a closed subroutine at a specified entry point.

.08 entry point

n. The identifier of the first obeyed statement in a routine or program. A routine may have a number of different entry points, each of which corresponds to a different function.

.09 entry conditions

n. The conditions to be specified (e.g., location of operands) before entering a sub-program or subroutine.

.10 exit

n. The last obeyed statement of a routine. A routine may have more than one exit.

.11 loop

n. A sequence of statements which may be obeyed repetitively; each repetition is called a cycle. Cycling is interrupted when a specified criterion has been satisfied; e.g., when a counter has returned to zero or when an iterative process has converged.

.12 self-resetting loop

n. A set of statements, including a loop, such that at each entry to the loop, any altered items have been initialized.

161 EQUIPMENT

.01 equipment

n. Those things that are available to be used in performing work or providing a service.

.02 unit of equipment

n. 1. A part of a data processing system consisting of a physically separate set of hardware or a logically distinct set of hardware; e.g., magnetic tape unit, arithmetic unit, auxiliary storage unit.
n. 2. One of the things from which a computer configuration may be composed.

.03 module

n. A standard measure, usually the sizes or increments in the sizes that are available for a specific store or any other unit that is composed of a variable number of similar sub-units or modules.

.04 peripheral equipment

n. All the input-output units and auxiliary stores of a computer system.

.05 control unit

n. Equipment that directs the sequence and timing of operations, and stimulates the proper circuits to execute the instructions.

.06 central processor

n. A unit of a computer system which selects, interprets and initiates the execution of instructions, and/or performs operations of computation and/or data manipulation.

.07 arithmetic unit

n. A section of a computer where arithmetic operations are performed.

.08 indicator

n. A device which may be set into a prescribed state according to the results of a previous operation and which subsequently may be used by the routine to determine a selection from alternative operations. For example, an overflow indicator is one which is set when overflow occurs. The state of an indicator may or may not be displayed.

.09 control panel

n. An assembly of displays, manual controls, etc., for use by the operator of a computer.

.10 console

n. A desk incorporating a control panel.

.11 monitor unit

n. Equipment used to observe the state of a system and indicate significant departures from the norm.

.12 manual input unit

n. A set of manual controls in which an operator can set a word for input.

.13 plug

n. A device usually connected to the conductors of a flexible cord and used to make connection to a socket.

.14 socket
hub
jack

n. A device used generally for terminating the permanent wiring of a circuit, access to which is obtained by the insertion into the socket of a plug.
Note: The term "hub" is restricted to punched card machines and "jack" to telecommunication.

.17 patchcord
patchplug

n. In ADP, a connector used to interconnect the sprockets of a plugboard. The patchcord may include passive electrical elements.

.19 plugboard
patchboard

n. A component of some data processing machines, similar in principle to a manual telephone exchange switchboard. The input and output terminals of the units in the machine are permanently connected to sockets on the plugboard, and the interconnections between units dictated by the problem or job are made by patchcords or by short-circuiting plugs (termed cordless plugs).
Note 1: In some punched card usage, the term "control panel" is used for this component.
Note 2: Where the interconnections are made by cordless plugs in the form of pins, the term "pinboard" is used.

.21 detachable plugboard
removable plugboard

n. A plugboard which allows the removal for storage and subsequent refitting of all patchcords and cordless plugs without disturbing their positions. This allows the machine to be quickly changed from one job to another.

.23 master clock

n. The unit which generates clock signals.

.25 clock

n. 1. A timing device used for automatically recording and controlling the usage of ADP equipment.
n. 2. A timing device used to regulate the operation of ADP equipment in accordance with a defined time scale. (This is also called a digital clock). For example, when a digital computer is used as a logger, the clock serves to initiate operations at the required time intervals.

.26 comparator

n. 1. A device for comparing two different transcriptions of the same data to verify the accuracy of transcription.

n. 2. A device for comparing two signals and giving an output dependent upon some relation between them; e.g., of numerical quantities, whether one is larger than, equal to, or less than, the other.

.27 converter

n. A unit which changes the representation of data from one form to another to make it available or acceptable to another machine; e.g., a unit which changes data punched on cards to data recorded on magnetic tape. A converter may also edit the data.

.28 decoder

n. 1. A device capable of decoding a group of signals and generating other signals which may initiate an operation.

n. 2. In data-processing equipment. A device with a number of input and output lines in which a specified combination of input signals causes a particular output line to give a signal.

.29 encoder

n. In data-processing equipment. A device with several inputs in which only one input is excited at a time and each input produces a specified combination of outputs.

.30 data logger

n. A device which records events and physical conditions automatically, usually with respect to time.

.31 scanner

n. In data-processing. A device which automatically samples the state of various processes or physical conditions and transfers the quantities obtained to a recorder or control device.

.32 character reader

n. In ADP, a device which converts data represented in one of the fonts or scripts read by human beings into machine language.

.33 curve follower

n. A device for reading data represented in the form of a graph.

.34 plotting table
output table

n. A unit for recording the relationship between two variables (e.g., the output from a simultaneous computer) in the form of a graph. The variables are used to control the displacements of a wiring point in Cartesian or other co-ordinates.

171 INPUT-OUTPUT

.01 input-output

n. A term which may be interpreted as either "input", "output", "input or output", or "input and output".

.02 input

v. To transfer data from an external store or peripheral equipment to an internal store.
n. The data that is being input.

.03 output

v. To transfer data from an internal store to an external store or to peripheral equipment.
n. The data that is being output.

.04 input-output area

n. An area of internal storage into which input data is written from other storage or from which output data is transmitted into other storage not accessible to instructions. There are two major cases, the first in which the areas are parts of working storage or auxiliary storage and the second in which the areas are special stores addressable only as a single location in an input-output instruction.

.05 output area

n. A storage area used for the release of output; the area occupied by output data at the time when an output instruction is initiated.

.06 input area

n. An internal storage area used for the receipt of input data as the immediate result of an input instruction.

.07 display

n. A special form of output in which the recording is intended to be read and acted upon, or answered before some future action is taken during the current run; e.g., a reply to query made by the operator of any inquiry station. It is often of a transient nature and not recorded in a permanent form; e.g., an illuminated panel or screen.

.08 character recognition

n. The act of reading, identifying and encoding a printed character by optical or other means.

.09 cut-off

n. A facility provided in input-output operations to limit the volume of data transferred should it otherwise exceed a pre-set limit; e.g., to prevent an overflow from an input area or to cut off any characters after the first 80 when punching a card.

.10 reservoir

n. A buffer on an input-output device which holds a variable volume of external storage medium. It enables the feed or take-up drive to be loosely linked to the drive past the heads, and is usually found on devices that handle a continuous strip of external storage medium.

.11 rewind

v. Return to the beginning of a magnetic tape or punched tape, ready to read or record from its beginning.

.12 clutch cycle

n. The time interval in a clutch-operated input-output device between basic input-output operations on fixed size sections when running at maximum speed.

.13 clutch points

n. The number of instants in a clutch cycle at which it is possible to engage the clutch. Thus in a 5-point clutch which has a cycle time of 0.10 secs. it is possible to operate with one clutch cycle every 0.10, 0.12, 0.14, 0.16, 0.18, 0.20 . . . secs., instead of only 0.10 or 0.20 secs. with a 1-point cycle.

.14 backspace

v. Move a tape or other medium backwards by a unit distance; e.g., a punched tape by one row, a magnetic tape by one record.

.15 inquiry station

n. An input and output unit used by a human to request specific low volumes of data to be displayed or recorded for his use.

.16 disable

v. Put a unit into a condition in which it is unable to respond to signals from its control unit.

.17 unload

v. Rewind and disable, sometimes by unthreading.

172 CARD FEEDS

.01 card feed

n. The mechanism which causes punched cards to be transferred from the hopper to the card track.
Note: Various terms are used to indicate the attitude in which a card is placed in the hopper and enters and traverses the card track. Examples of mutually-exclusive pairs are vertical feed and horizontal feed, face-up feed and face-down feed, endwise feed and sideways feed, 9-edge leading and Y-edge leading.

.02 card reader

n. A machine that senses the holes in a punched card.

.03 card punch

n. A machine which punches holes in a card.

.04 chip

n. A piece of cardboard that used to be where the hole is in punched cards.

.05 hopper
magazine

n. That part of a machine where the punched cards are placed immediately prior to being fed into the machine.

.06 card track
card bed

n. That part of a machine which moves and guides the punched card during its passage through the machine.

.07 punching station

n. That part of a card track where a punched card is punched.

.08 sensing station
reading station

n. That part of a card track where the data on a punched card is sensed.

.09 card stacker
receiver

n. A part of a machine where cards are deposited after passing through the machine.

.10 pocket

n. One of the card stackers in a sorter.

.11 misfeed

n. The failure of a punched card to pass through a machine in the manner specified. This may result in holes being incorrectly sensed or punched or in damage to cards (card wreck).

.12 index point

n. In certain punched card machines containing rotation machinery driven by a main shaft, one of a number of equally-spaced reference positions of the main shaft. These reference positions are usually chosen to include those at which successive card rows or columns are opposite the sensing or punching station; one or more extra positions may be required to allow for the gap between cards traversing the card track. An index point is commonly named after the row or column, if any, to which it corresponds.

.13 column split

n. A facility provided on some punched card machines to read a column in two parts and to treat the two parts independently.

.14 mark sensing

n. Of punched cards, a process in which data represented by marks on a card is automatically sensed and converted into punchings in that or another card.
Note: When the sensing is performed optically, the process may be termed "mark scanning".

173 PAPER TAPE UNITS

.01 tape reader

n. A machine which senses the rows of holes in a paper tape and moves the tape as necessary.
Note: When the sensing is performed mechanically, the sensing member is sometimes called a pecker.

.02 tape punch

n. A machine which punches holes in tape.

.03 automatic tape punch
output punch

n. A tape punch which automatically transcribes coded electrical signals into rows of holes in a tape and moves the tape as necessary.

174 PRINTERS

.01 printer

n. A machine which produces a printed record of the data with which it is fed.

.02 character printer

n. A printer in which only a single character is composed and determined within the device prior to printing.

.03 line-at-a-time printer
line printer

n. A printer which prints a line of print during each cycle of its action. The whole line may appear instantaneously or it may be assembled by a processor spread over the cycle.

.04 page printer

n. A printer in which an entire page of characters is composed and determined within the device prior to printing.

.05 hit-on-the-fly printer

n. A printer in which the type does not stop moving during the impression; at a time in its movement appropriate to the desired character, the paper and type are forced together.

.06 wheel printer

n. A printer which prints its characters from the rim of a wheel, (the print wheel) around which is disposed the type for the alphabet available.

.07 stylus printer
matrix printer
wire printer

n. A printer which forms each printed character by a pattern made by a stylus or selected styli.

.08 chain printer

n. A hit-on-the-fly printer in which the type is carried on a chain or belt moving across the paper.

.09 print member

n. A generic term for the component responsible for the form of the printed character; e.g., print bar, type bar, print wheel. An interchangeable type bar is a print member which allows the operator to change the alphabet available.

.10 automatic carriage
tape controlled carriage

n. A stationery guiding or holding device which is automatically controlled by program and data to feed forms or continuous paper to a set of print members and to provide the necessary movements; e.g., spacing, ejecting or tabulating.

.11 paper throw
paper slew

n. The movement of paper in a printer, without printing, through a distance greater than the normal line spacing. The speed of movement is usually greater than in a single-line feed.

.12 single-sheet feeding

n. The use of a printer to produce results on separate sheets of stationery either by automatic or manual feeding of each sheet.

175 MAGNETIC TAPE UNITS

.01 tape unit
magnetic tape unit

n. A tape transport mechanism together with reading and writing heads and associated electrical circuits used with magnetic tape.

.02 tape transport mechanism
tape transport

n. A mechanism for the controlled movement of tape.
Note: This mechanism is commonly used to move magnetic tape past a reading or writing head or for automatic rewinding.

.03 magnetic tape reader

n. A tape transport mechanism together with a reading head and associated electrical circuits used for reading magnetic tape.

181 AUXILIARY EQUIPMENT

.01 auxiliary equipment

n. Equipment not under direct control of the central processing unit.

.02 key punch

n. A card punch controlled by keyboard operation.

.03 verifier

n. A machine for checking the accuracy of a transcription of data usually by comparison with a retranscription.

.04 card reader

n. A machine which senses the holes in a punched card.

.05 sorter

n. A machine having sensing facilities and several pockets. According to the data sensed, the card is fed to the corresponding pocket.

.06 collator
interpolator

n. A machine which feeds and compares two packs of punched cards in order to match or to merge them or to check their sequence. The cards which match can be separated from those that do not match, thereby making it possible to select as well as file cards automatically.

.07 tabulator

n. A machine which reads data from a medium - e.g., cards, punched tape, magnetic tape - and produces lists, tables or totals.

.08 summary punch

n. A card punch which is directly connected to and controlled by a tabulator, and which punches certain data processed by the tabulator. So called because originally such a machine punched a summary of part of a tabulation for carry-forward purposes.

.09 gang punch

n. A machine having a single card track with a punching station followed by a sensing station. It is used to copy punching from the first card of a pack into all the succeeding cards. As each card passes the sensing station, it is used to control punching into the succeeding card, which is at that time passing the punching station.

.10 tape verifier

n. A verifier for checking the accuracy of a paper tape in which the data recorded is automatically compared, row by row, with a second manual punching of the same data as this second punching proceeds.

.11 tape comparator

n. A machine which automatically compares two supposedly identical paper tapes row by row and stops when there is a discrepancy.

.12 keyboard punch
keyboard perforator

n. A tape punch provided with a bank of character keys, such that the manual depression of any one key causes the holes representing the corresponding character to be punched in one row of a tape and moves the tape as necessary.

.13 hand punch
perforator
unipunch

n. A tape punch operated directly by hand, which may also include facilities for tape splicing.

191 STORES

.01 store

n. 1. A device into which data can be inserted, in which it can be retained and from which it can be obtained when desired.
n. 2. A specific, usually homogeneous, storage facility.
v. To record data in a location.

.02 waiting time
latency

n. (Of a store). The time interval between the instant the control unit calls for a transfer of data to or from the store and the instant the transfer commences.

.03 transfer time

n. (Of a store). The time interval between the instant the transfer of data to or from the store commences and the instant it is completed.

.04 access time

n. (Of a store). The time interval between the instant the control unit calls for a transfer of data to or from the store and the instant this operation is completed; thus the access time is the sum of the transfer time and the waiting time.
Note: In some kinds of store, the access time depends upon the location specified or upon preceding events.

.05 minor cycle

n. 1. In serial operation, usually synonymous with word time.
n. 2. In parallel operation, the standard least operation time of which the equipment is capable.

.06 major cycle

n. In a cyclic store, the time interval between successive occurrences of a given digit.
Note: A major cycle is usually an integral number of word times.

.07 cycle time

n. The minimum time interval between the starts of successive accesses to a location.

.08 immediate access store

n. A store consisting of one or more locations whose waiting time is negligible in comparison with other operation times.

.09 random access store

n. A store designed to reduce the effect of variation of access time for an arbitrary sequence of addresses.

.10 buffer store

n. A store used to compensate for a difference in rate of flow of data or time of occurrence of events, when transmitting data from one device to another.

.11 fast store
quick-access store

n. An imprecise term referring to a store whose access time is relatively short.

.12 push-down store
nesting store
cellar

n. A store which works as though it comprised a number of registers arranged in a column, with only the register at the top of the column connected to the rest of the system. As data is transferred into the store, each word in turn enters the top register and is then "pushed down" the column from register to register to make room for subsequent words as they arrive. As a word is transferred out of the store, again only from the top register, other data in the store moves back up the column from register to register to fill the space vacated.

.13 magnetic store

n. A store using remanent magnetization for the representation of data.
Note: The term embraces two categories of stores: those in which there is relative movement between the head and the magnetic medium (e.g., magnetic drum store) and those in which there is no relative movement (e.g., core store).

.14 erase

v. (In a magnetic store). Obliterate stored data by returning the magnetic state of a cell to a uniform null condition.

.15 magnetic drum store
magnetic drum
drum

n. A magnetic store in which the magnetic medium is on the curved surface of a rotating cylinder.

.16 magnetic disc store
magnetic disc
disc

n. A magnetic store in which the magnetic medium is on the surface of a rotating disc.

.17 magnetic tape store

n. A magnetic store in which the magnetic medium is carried by a moving tape or ribbon called a magnetic tape.

.18 electrostatic store

n. A store using electric charges for the representation of data. Examples are cathode-ray-tube store and capacitor store.

.19 cathode-ray tube store

n. An electrostatic store where the charges are disposed on an insulating surface within a cathode-ray tube.

.20 cathode-ray tube
C.R.T.

n. An electronic tube in which a well-defined and controllable beam of electrons is produced and directed on to a surface to give a visible or otherwise detectable display or effect.

.21 capacitor store

n. An electrostatic store in which an individual capacitor is provided for each bit.

.22 delay line store

n. A cyclic, regenerative store using a delay line. The delay line output is fed back to the input through a signal regeneration circuit, so that the signals circulate indefinitely without progressive change.

.23 core store

n. An array of storage cores used as a magnetic store.

.24 core
magnetic core

n. A small piece of magnetic material, often toroidal in shape.

.25 storage core

n. A core of magnetic material with a high ratio of residual to saturated flux density, and a threshold value of magnetizing force below which switching does not occur.

.26 magnetic cell
static magnetic cell

n. A binary storage cell in which the two values of a binary digit are represented by different magnetic flux configurations, and in which means of setting and sending the contents are stationary with respect to the magnetic material.
A magnetic cell may consist of one or more cores, or of small regions of a larger piece of perforated ferromagnetic material (termed an aperture plate), other small regions of which constitute other cells.
Note: A transfluxor is a core with more than one hole.

.27 digit plane

n. In an array of cells ordered in three dimensions, the plane containing corresponding bits of every word.

.28 coincident-current selection

n. In an array of magnetic cells, the selective switching of one cell in the array by the simultaneous application of two or more drive pulses to the array which have an additive effect in one cell only (the selected cell).
Note 1: In coincident-current selection, each cell of the array must have a threshold value of magnetizing force below which switching does not occur. It is then possible to arrange that the magnetizing force exceeds the threshold only in the selected cell. Other cells in the array, which undergo a change of magnetizing force but are not switched, are termed partially selected cells.
Note 2: Coincident-current selection may also be used in arrays of switch cores.

.29 delay line

n. A component or circuit specifically designed to introduce a desired delay in the transmission of a signal.

.30 acoustic delay line
sonic delay line

n. A delay line in which signals are carried by mechanical waves. The frequencies used for this purpose are commonly in the ultrasonic range.

.31 mercury delay line

n. An acoustic delay line in which mercury is used to carry the waves.

.32 quartz delay line

n. An acoustic delay line in which quartz is used to carry the waves.

.33 nickel delay line

n. A magnetostrictive delay line in which nickel or a nickel alloy is used in the transducers and in carrying the waves.

.34 cyclic store
circulating store

n. A store in which access to any given location is only possible at specific, equally-spaced times. Examples are magnetic drum store, delay line store.

.35 regenerative store

n. A store in which data are retained for as long as required, by periodic signal regeneration. This compensates for undesirable changes which would otherwise ensue.
Note 1: For example, in a delay line store, pulses are attenuated and distorted, and in electrostatic stores, the charges decay.
Note 2: In a regenerative store using a track on a magnetic drum, regeneration is used to improve access time.

.36 volatile store

n. A store whose content is lost when the power supplies are removed. An example is a delay line store. A non-volatile store is one that retains its content when the power supplies are switched off normally, but the content may be lost if power failure occurs.

.37 erasable store

n. A store whose content can be changed because the storage medium can be used repeatedly. For example, magnetic tape is erasable.

.38 permanent store
non-erasable store

n. A store which is not erasable, that is, one in which the stored data is changed (infrequently) by replacing the storage medium with new medium bearing the new data. For example, a store using microfilm.

.39 fixed store

n. A store, the content of which cannot be changed automatically by a routine but which may be changed by an alteration to the construction of the store. For example, a store in which data is represented by the presence or absence of magnetic cells.

.40 changeable store

n. An internal store, parts of whose medium and the data recorded thereon can be removed and replaced by other parts, and on which the data is not destroyed.

.41 destructive reading
destructive readout

n. A reading process which inherently destroys the record of the data which has been read; e.g., in some core stores, reading changes the state of the core to some prescribed (normally reset) state.

.42 hard copy

n. An external storage system that is tangible, is permanent and can be sensed by humans: e.g., printed pages or punched cards as contrasted with magnetic tape recording or transient displays.

192 STORAGE

.01 storage

n. 1. The retention of data for subsequent reference.

n. 2. The collection of stores in a system.

.02 memory

n. A non-physical organization of storage elements, primarily for the retrieval of data on demand. Examples are list memory, tree memory, associative memory, etc.

.03 internal storage

n. Storage within the computer whose locations are addressable by instructions.

.04 external storage

n. Storage that may during normal operation of a computer be made accessible or not, at the choice of the operator. Access is usually via input-output units but may also be changeable internal storage.

.05 working storage

n. Any locations that can be accessed directly for instructions or operands used in arithmetic and logical operations.

.06 auxiliary storage

n. Internal storage that supplements the working storage.

193 REGISTERS

.01 register

n. A store, usually of one-word capacity and intended for some special purpose or purposes in a computer.

.02 register length

n. The capacity of a register.

.03 index register

n. A register which holds an index.

.04 arithmetic register

n. A register associated with an arithmetic unit which holds the operands of arithmetical and other operations.

.05 accumulator

n. 1. A device including an arithmetic register which stores a number (the augend) and which on receipt of a second number (the addend), adds them and stores the sum in place of the augend.

n. 2. More loosely, an arithmetic register holding one operand, with means for performing various operations involving that operand and (where appropriate), another; the result does not necessarily remain in the accumulator.

.06 shift register
shifting register

n. A register adapted to perform shifts; e.g., a delay line register whose circulation time may be increased or decreased to shift the content; or a register composed of binary cells in which bits are transferred from one cell to the next by the application of a pulse common to all cells.

.07 instruction register

n. A register in the control unit which stores the current instruction of a routine so that it may be interpreted by the control unit.

.08 sequence control register
sequence counter

n. A register from the content of which the address of the next instruction is derived.

.09 sub-sequence counter

n. A counter subordinate to a sequence counter. It may be used to step through micro-operations.

194 HEADS

.01 head

n. A device for recording data on a storage medium, or for reading data so recorded.

.02 magnetic head

n. A device for recording electrical signals on a magnetic medium, usually moving, and for reading signals so recorded.

.03 writing head
write head
record head

n. A head used to write.

.04 reading head
read head
playback head

a. A head used to read.

.05 read/write head

n. A head used to read or write.

.06 stack

n. Several heads used together to record or sense one band at a time.

.07 yoke

n. Several stacks of heads rigidly connected to each other and moved together when access by any one stack to a chosen band needs movement of the stack. Usually the arrangement associates only one stack with any band but allows one stack to access many bands.

.08 track

n. That part of a storage medium that is influenced by (or influences) one head; e.g., the ring-shaped portion of the surface of a drum associated with one head.

.09 band

n. A logical group of tracks, usually read or recorded together.

195 MEDIA

.01 storage medium

n. The form of material upon which data is stored.

.02 station

n. That place at which a storage medium resides while data is written on it or sensed from it.

.03 image

n. An exact logical duplicate stored in a different medium.

.04 cartridge

n. The smallest changeable unit of medium of a changeable store.

.05 location

n. A position in a store which holds a word or part of word. A register is also a location.

.06 protected locations
isolated locations

n. Locations whose contents are protected against accidental alteration; e.g., due to program errors in routines or certain machine faults.

.07 capacity

n. The number of digits, or words of a store, that can be stored.

.08 section

n. A portion of external storage arranged so that the block of data that it contains is physically separated from other data in order to permit each block to be treated as a single load; e.g., a card, a line.

.09 intersection gap

n. The distance between sections on a tape. The tape can be stopped and brought up to speed again in this distance, and reading or writing is not permitted in the gap because the tape speed may be changing.

.10 packing density

n. The number of storage cells per unit length of track.

.11 row pitch

n. The distance, measured along the tape, between the centers of adjacent rows.

.12 track pitch

n. The distance between corresponding points on adjacent tracks.

.13 interleave

v. 1. Assign successive addresses to locations separated physically or in time by other locations.

v. 2. Allocate digits to cells on a track so that cells allocated to successive digits of a particular word are separated by a specific number of intermediate cells which may be allocated similarly to the digits of other words.

.14 interlace

v. Assign adjacent tracks to separate bands.

.15 guide margin

n. The distance, measured across the tape, between the guide edge and the center of the nearest track.

.16 clock track

n. A track upon which a pattern of marks has been recorded, to provide a means for recognizing rows of data.

.17 sprocket holes

n. Holes punched in a tape to enable it to be driven longitudinally by a toothed wheel or other mechanism, and to provide a clock track for data recorded on the tape.

.18 tape core

n. A cylinder on which a spool of tape may be wound.

.19 bore

n. The diameter of a hole.

.20 leading end

n. 1. The outer end of a spool of paper tape.
n. 2. The first end of a tape to be processed.

.21 trailing end

n. The end of a tape opposite the leading end.

.22 guide edge

n. In some tape equipment, the edge of a tape which is used to determine its transverse position.

.23 feed holes
sprocket holes

n. Holes punched in a tape to enable it to be driven or indexed longitudinally.

.24 form

n. A printed or typed document which usually has blank spaces for the insertion of data items.

201 PUNCHED CARDS

.01 punched card
card

n. A card of known dimensions capable of being punched with a pattern of holes or notches.

.02 edge-notched card
edge-punched card

n. A card in which notches representing data are punched around the edges. It is usually associated with manual systems.

.03 verge-perforated card
verge-punched card

n. A card in which holes, similar to those for punched tape, are punched near one edge.

.04 card leading edge

n. That edge which is leading when the card passes along the card track.

.05 card trailing edge

n. The edge of a card opposite the leading edge.

.06 punching positions

n. The sites on a punched card where holes may be punched.

Note 1: A card is divided parallel to its longer edges into a number of card rows, and parallel to its shorter edges into a number of card columns. The intersection of a row and a column defines a punching position.

Note 2: In order to describe the location of punching positions on the card, conventions must be adopted which have precise meaning only in relation to a particular installation; thus the major surfaces of the card are distinguished as the card face and the card back, and the longer edges are distinguished by naming them after the nearest rows.

Note 3: A given row or combination of rows is usually associated with a specific character (+); a single character (++) is usually represented by one or more holes punched in a single column.

.07 deck

n. A collection of punched cards bearing data for a particular run.

.08 curtate

n. A horizontally-divided portion of a punched card. See zone.

.09 card field

n. A group of adjacent card columns (or parts of columns) whose punchings represent an item. For example, a field having three columns, each capable of representing one decimal digit can have punchings which are representative of numbers from 0 to 999 inclusive.

.10 zone

n. A group of characters (+) chosen by the punching in the upper curtate of a punched card; the final choice of an individual character within the zone is made by the punching in the numeric part of the card; i.e., the lower curtate.

.11 double punching

n. The punching of two holes in a card column.

Note: The double punching may be intentional or may arise from a fault condition.

.12 multiple punching

n. The punching of three or more holes in a card column.

.13 designation punchings
control holes
control punchings
function holes

n. Punchings which determine how the data on a punched card is to be treated within a machine, or which functions the machine is to perform.

.14 control field

n. The field in the punched cards of a deck according to whose punchings the cards have been placed in sequence. For a given deck, this is not always the same field; e.g., a deck with fields for man number, labor cost and job number would be in man number sequence for wages calculation but in job number sequence for job costings.

202 PUNCHED TAPES

.01 <u>paper tape</u>
<u>punched tape</u>
<u>perforated tape</u>

n. A tape of known dimensions in which data may be recorded by means of a pattern of holes.

.02 <u>chadless tape</u>

n. Tape which has been punched in such a way that the holes are only partially perforated, the chads or cuttings remaining attached to the tape as hinged lids.

Note: Chadless perforation is used to make the full surface of a perforated tape available for printing; e.g., to print the characters (+) represented by the punching.

.03 <u>paper tape codes</u>

n. Codes used to represent data on paper tape, each character normally occupying one row.

211 CODING

.01 coding

n. The process of translating a program into a routine for a particular model of computer.

.02 automatic coding

n. A technique by which a machine translates a program into machine instructions.

.03 absolute coding

n. Coding which uses machine instructions.

.04 relative coding

n. Coding which uses machine instructions in which relative addresses are wholly or partly employed.

.05 symbolic coding

n. Coding which uses symbolic addresses or a symbolic representation of other parts of the instruction.

.06 pseudocode

n. Any code in which a routine may be written but which is not a computer code.

.07 autocode

n. A pseudocode intended to simplify coding.

.08 modify

v. Alter an instruction (called the presumptive instruction or unmodified instruction), in a prescribed way to produce the instruction actually executed (called the effective instruction or the actual instruction.)

.09 address modification

n. Modification in which only the address part of the presumptive instruction is modified. This is the only form of automatic modification in many computers.

.10 count
tally

n. An integer variable that has associated with it a special operation to either add or subtract the value 1, to or from, the count.

.11 index

n. An integer variable that is used to indicate the value of a control variable in a loop. It often has special operations associated with it to step its value.

v. To modify an address by adding an index to the address.

.12 cumulative indexing

n. The addition of more than one index to an address.

.13 increment

n. A quantity to be added to or subtracted from an index.

.14 step

v. 1. To add 1 to, or subtract 1 from a count.
2. To add an increment to, or subtract it from, an index.

.15 end value

n. A value which is compared with that of an index, count, or control variable to determine if the end value has been attained and/or passed by the variable.

.16 test

v. Examine an index or count to determine if it has attained or exceeded its end value.

.17 overlay

v. Transfer segments of routines into working storage from auxiliary storage for execution, so that several segments will occupy the same locations at different times.

.18 segment

v. Divide a routine into parts so that each part can be stored completely within the internal store of the computer and contains the necessary instructions to jump to the next part. These parts are called segments.

.19 relocate

v. Move a routine from one location in storage to another, changing addresses so that the routine can be executed in its new location.

.20 trigger

v. Initiate operation of a routine, for example, by means of a manually-controlled jump to the entry point. If a routine is so arranged that its operation commences automatically as soon as the routine has been placed in the computer, it is said to be a self-triggering routine.

.21 link

n. An instruction or address for leaving a closed subroutine on its completion in order to return to some desired point in the routine from which the subroutine was entered.

.22 housekeeping

n. Operations in a routine which do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

.23 loop

n. A coding technique whereby a group of instructions is repeated with modification of some of the instructions in the group and/or with modification of the data being operated upon. This technique usually consists of the following steps:

(1) Loop Initialization: The instructions immediately prior to a loop proper which set addresses, counts, and/or data to their desired initial values.
(2) Loop Execution: Those instructions of a loop which actually perform the primary function of the loop, as distinguished from loop initialization, modification, and testing, which are housekeeping operations.
(3) Loop Modification: Those instructions of a loop which alter instruction addresses, counts, or data.
(4) Loop Testing: Those instructions of a loop which determine when the loop has been completed.

.24 infinite loop

n. A loop from which there is no final exit other than by manual intervention.

.25 loop stop

n. A small closed loop usually used to indicate an error or for operating convenience.

.26 dynamic stop

n. A loop stop consisting of a single jump instruction.

.27 branchpoint

n. A point in a routine where one of two or more choices is selected under control of a routine; e. g., a conditional transfer or conditional jump.

.28 breakpoint

n. A point in a routine at which special action is taken, such as a stop or a jump, either as the result of the insertion of a special instruction or the setting of a console switch. Usually used in debugging.

.29 checkpoint

n. A point in a routine at which the results of a number of checks are examined.

.30 rerun point

n. A point in a routine at which sufficient information can be stored to permit rerunning the routine from that point.

.31 switch

n. An instruction or number planted in a routine to select one of a number of alternative paths. The selection, once made, persists until altered, in contrast to that made at a branchpoint, where the selection is made at each passage.

.32 pre-store

v. Store data required by a routine before the routine is entered.

.33 plant

v. Place an instruction, or other item which has been formed during the operation of a routine, in a location so that it will be effective at some later stage in the operation.

.34 quasi-instruction form

n. The representation of data in the form of instructions.

Note: Quasi-instruction form is convenient for the representation of small amounts of data occurring in a routine; e.g., parameters, which may thus be read as if they were instructions, although they are subsequently treated as data.

.35 control word

n. 1. A word containing the values of one or more parameters which specify the action of the subroutine, or

2. A word containing the address of such value.

.36 scale

v. Alter the units in which a quantity is expressed to bring all magnitudes within the capacity of the equipment or method being used.

.37 scale factor
scaling factor

n. A numerical coefficient used in scaling to multiply one or more quantities occurring in a calculation.

.38 dump

v. Preserve by storage elsewhere the contents of a set of locations which are temporarily required for another purpose.

.39 unwind a loop

v. State explicitly and in full, without the use of counts, modifiers, etc., all the instructions in the repeated execution of a loop of instructions.

.40 minimum delay coding
minimal latency coding

n. A method of coding for those computers in which the waiting-time for a word depends on its location: locations for instructions and data are so chosen that access-time is reduced or minimized.

.41 multiple-length working
multiple-length arithmetic

n. The use of two or more words to represent a number to enhance precision; hence, double-length working, triple-length working, etc.

.42 patch

v. Correct or change the coding at a particular location by inserting transfer instructions at that location and by adding elsewhere the new instructions and the replaced instructions. Usually used during checkout.

.43 working area

n. Locations used by routines for temporary storage; e. g., of intermediate results.

.44 alternation

n. A technique in which one or more extra input-output units are used in a run so that loading and unloading of the units do not hold up progress of the run.

.45 scalefactor

n. A coefficient that relates the problem value of a quantity to the machine value.

.46 scaling

n. The process of determining scalefactors.

.47 source program
source routine

n. The program or routine that is translated.

.48 object routine
object program

n. The routine or program composed by a translator corresponding to the source routine or program.

.49 object language

n. The language in which the output of the translator is composed.

.50 target computer

n. The computer configuration on which a routine is to be run.

221 ROUTINES

.01 routine

n. A message describing a structure of operations, for a class of processors, that performs a particular process.

.02 standard routine

n. A routine which conforms to a standard or whose use within another routine insures that the latter routine conforms to a certain standard.

.03 library routine

n. A routine which is a member of a routine library.

.04 independent routine

n. A routine which can be run on a computer other than as a subroutine.

.05 production routine

n. A routine designed to perform a process for a customer outside the computer department.

.06 executive routine

n. A supervisor, or service or monitor routine.

.07 service routine

n. A routine that provides a service to another routine, usually as a subroutine, often as a standard routine: e.g., an overlay routine; input-output control routine; loading routine.

.08 utility routine

n. A standard production routine.

.09 relocatable routine

n. A routine designed so that it can be relocated.

.10 fixed routine

n. A routine that cannot be modified by the computer

.11 skeletal coding

n. The outline of a routine that is used as a framework by a generator.

.12 segment

n. One of the parts into which a routine is divided for the purposes of transfer from auxiliary to working storage for execution of one segment at a time.

.13 input routine

n. A routine, sometimes stored permanently in the computer, to control the input of data.

.14 output routine

n. A routine which organizes the output process of a computer; e.g., starts the output equipment, presents data to it at suitable intervals of time, and specifies format.

.15 loader
loading routine

n. An input routine for reading programs.

.16 bootstrap

n. A form of loader in which simple preset computer operations are used to read in the loader, which in turn causes further instructions to be read until the complete routine is loaded.

.17 main routine

n. A term used to distinguish those parts of a routine that do not comprise subroutines or other self-contained sections.

.18 subroutine

n. A part of a routine that is used at more than one point in a particular routine or that is available for inclusion in other routines.

.19 closed subroutine

n. A subroutine whose entry conditions determine the point at which the routine using it is re-entered.

.20 open subroutine

n. A subroutine which has fixed re-entry points into the routine using it.

.21 interlude

n. A small routine designed to do some preliminary computation or organization; e.g., to calculate the value of a parameter or to clear parts of the store. It is normally overwritten when it has served its purpose.

.22 supervisor
supervisory routine

n. A routine designed to organize and regulate the flow of work in an automatic data processing system, e.g., such a routine might change over automatically from one run to the next and record times of runs.

.23 monitor routine

n. A routine designed to indicate the progress of work in an ADP system.

.24 translator
translating routine

n. A routine which translates a program or a routine, into another language, or into machine instruction code without executing it.

Note: There are several classes of translating routine; terms have been coined or adapted for the various classes, but there is no generally-agreed precise meaning for each term. The definitions below represent an attempt by B.S.I. based on current usage to introduce an element of standardization.

.25 assembler
assembly routine

n. A translating routine which accepts or selects required subroutines, assembles parts of a routine and makes the necessary adjustments to cross-references.

.26 compiling routine
compiler

n. Any complete translating routine. The operations of a compiling routine may include code-conversion assembly and the adaptation of parts of the routine according to the requirements of the original specification of the program.

.27 generating routine
generator

n. A translating routine, or part of such a routine, often part of a compiler, designed to construct other routines for performing particular types of operation; for example, sorting routine generator, output routine generator. The generator may select among various broad methods of performing a task such as sequencing data, and adjust the details of the selected method to provide the most efficient routine for the characteristics of the data to be handled by the generated routine.

.28 interpretive routine
interpreter

n. A routine which executes a routine in a pseudo language by translating each pseudo language expression separately into machine instruction code immediately before execution.

Note 1: A characteristic of an interpretive routine is that where instructions or expressions are repeated, as in a loop, the translation is performed once for each execution. This contrasts with the operation of a translating routine in which the translation of each expression is performed once only, irrespective of the number of repeated executions either of the loop or of the whole program.

Note 2: An interpretive routine that allows routines written for one type of computer to be run on a different type is called a simulator routine.

.29 report generator

n. A routine that performs the process of report generation.

.30 routine library

n. A collection of coded routines with descriptive material, especially a systematic collection of tested routines for a particular model of computer made generally available to its users.

.31 dating routine

n. A routine that computes and/or stores, where needed, a date such as current day's date, expiration date of a tape, etc.

.32 own coding

n. Instructions that are incorporated into standard routines to modify or extend the routine to cover particular tasks of an otherwise "standard" problem.

.33 load and go

n. A computer operation and compiling technique in which the pseudo language is directly converted to machine language and run without an output machine language routine being created.

231 CHECK OUT

.01 check out

v. Apply diagnostic or testing procedures to a routine or to equipment.

.02 program testing

n. Running a routine on a computer in order to discover errors in its program.

.03 debug

v. Colloquially, trace and eliminate errors from a routine. The process is usually assisted by a trace or post-mortem routine.

.04 diagnostic routine

n. A routine designed to locate either a fault in the equipment or an error in a program or a routine.

.05 post-mortem routine

n. A diagnostic routine that is used after a run has stopped.

.06 trace routine
tracer

n. A routine designed for demonstrating the operation of a routine. Its output is arranged in the sequence in which the instructions are executed, and may include instructions of the routine which is being checked and immediate results of those instructions.

.07 selective trace routine

n. A trace routine that considers only a selection of the instructions executed: e.g., only jump instructions.

.08 snapshot

n. A dynamic printout of selected data in storage at specified times or points in the running of a routine.

.09 dump

v. Record the contents of a store as a part of computer-operating technique rather than as part of an operational routine; e.g., for check-out or rerun purposes.

.10 checking routine

n. A routine that examines a routine for obvious errors, such as mis-punching, without executing the routine itself.

222 INSTRUCTIONS

.01 instruction

n. A statement that specifies one of the operations which can be performed by a computer either directly or by a programming system, such as an interpretive routine.

.02 machine instruction

n. An instruction which can be obeyed by the computer directly.

.03 macro instruction

n. In a computer instruction code an instruction written that has no equivalent operation in the computer, and is replaced in a routine by a predetermined set of machine instructions.

.04 pseudo instruction

n. A group of characters having the same general form as an instruction.

.05 instruction format

n. The allocation of the characters comprising an instruction between the component parts of the instruction; e. g., the address part, operation part.

.06 function

n. Any operation for which the computer instruction code provides; e.g., multiplication, transfer of data to store.

.07 operation part

n. The part of an instruction that specifies the operation to be performed.

.08 address part

n. The part of an instruction that normally specifies the address of an operand or of the next instruction.
Note: An instruction may have several address parts.

.09 multiple address
multi-address

n. An instruction containing more than one address.

.10 one, two, ..., N address instruction format

n. An instruction format containing one, two, ..., N address parts.

.11 one-plus-one, two plus-one, ..., N-plus-one address instruction format

n. An instruction format containing two, three ... (N + 1) address parts respectively, the "plus-one" address being that of the instruction to be obeyed next, in normal sequence.

.12 instruction address

n. The address of the location where an instruction word is stored.

.13 address

n. An expression, usually numerical, that designates a particular location in the store or some other data source or destination.

.14 content

n. The data held in a location.

.15 absolute address

n. (Of a location.) An address inherent in the design of the computer.

.16 relative address

n. An address that indicates the excess of the absolute address over a particular absolute address which is being used as a reference point. The reference point is often the address of the first word in the routine.

.17 symbolic address

n. An address, in a form chosen for convenience by a programmer, which requires conversion into an absolute address before it can be used in the computer.

.18 synthetic address
generated address

n. An address generated by instructions in the routine in which it is used.

.19 directory
symbol table

n. A list of addresses used as reference points in a routine; for example, in relative coding.

.20 indirect addressing

n. A method of addressing where an instruction contains the address of a location where a further address is stored; the location designated by this second address may contain either the operand or a third address.

.21 interpretive language

n. A language used in writing a routine for execution by an interpretive routine.

.22 arithmetic instruction

n. An instruction in which the function part specifies an arithmetic operation.

.23 logical instruction

n. An instruction in which the function part specifies a logical operation.

.24 jump
transfer of control

n. A departure from the normal sequence of obeying instructions in a computer.

.25 jump instruction

n. An instruction that may cause a jump.

.26 unconditional jump instruction

n. An instruction that always causes a jump.

.27 conditional jump instruction

n. An instruction that may cause a jump dependent on the result of some arithmetic or logical operation or on the state of some indicator(s).

.28 table look-up instruction

n. An instruction to facilitate reference to systematically arranged data; e.g., to search for a specified argument in a table.

.29 optional stop instruction

n. An instruction which includes the possibility of stopping the execution of instructions immediately before or after the instruction is obeyed, there being some means of enabling or inhibiting this facility as required.

.30 dummy instruction

n. An instruction which has no functional or organizational significance. It is generally used to provide scope for future changes in a program or to fulfill some prescribed condition; e. g., the completion of a block of instructions.

.31 branchpoint

n. An instruction that may cause a change of sequence.

231 CHECK OUT

.01 check out

v. Apply diagnostic or testing procedures to a routine or to equipment.

.02 program testing

n. Running a routine on a computer in order to discover errors in its program.

.03 debug

v. Colloquially, trace and eliminate errors from a routine. The process is usually assisted by a trace or post-mortem routine.

.04 diagnostic routine

n. A routine designed to locate either a fault in the equipment or an error in a program or a routine.

.05 post-mortem routine

n. A diagnostic routine that is used after a run has stopped.

.06 trace routine
tracer

n. A routine designed for demonstrating the operation of a routine. Its output is arranged in the sequence in which the instructions are executed, and may include instructions of the routine which is being checked and immediate results of those instructions.

.07 selective trace routine

n. A trace routine that considers only a selection of the instructions executed: e.g., only jump instructions.

.08 snapshot

n. A dynamic printout of selected data in storage at specified times or points in the running of a routine.

.09 dump

v. Record the contents of a store as a part of computer-operating technique rather than as part of an operational routine; e.g., for check-out or rerun purposes.

.10 checking routine

n. A routine that examines a routine for obvious errors, such as mis-punching, without executing the routine itself.

241 OPERATIONS

.01 operation

n. A well-defined act performed by a machine or a human.

.02 operator

n. A human directly operating various controls and controlling the insertion or extraction of external storage medium into or from a data processor.

.03 execute

v. Carry out an instruction or an operation.

.04 machine word

n. A quantity of data which is commonly treated as a unit; e.g. items for the purpose of data transfers.

.05 word length

n. The size of the machine word.

.06 instruction word

n. A word, part or all of which is obeyed by the computer as an instruction.

.07 program step

n. The execution of a single instruction.

.08 complete operation

n. The operation of fulfilling a machine instruction completely. This includes obtaining access to the instruction word and operands.

.09 instruction time

n. The time taken to select, prepare and initiate an instruction, and step on to the next instruction, including access to storage for both instruction and data.
Note: The over-all time to complete the operations initiated by an instruction may be related only indirectly to the instruction time; for example, the interval between initiating successive instructions may be much less than the operating time.

.10 list

v. Print every relevant item of input data on the general basis of one line of print per record.

.11 tabulate

v. Print totals, differences, or like information on the general basis of one line of print per group of records.

.12 table control

n. A method of specifying a volume of data that is held in many locations, not necessarily sequential. It is used for special input-output operations such as scatter-read and gather-write. The table contains the locations of the various parts of the data. Sometimes the size of each part is also held in the table, sometimes in the data, and sometimes implied by a delimiter. The data is addressed indirectly via the address of the first location holding the table.

.13 load key

n. A manual control whose operation initiates the input of a routine and data into a computer.

.14 single-step operation

n. A method of operating a computer manually in which a single instruction or part of an instruction is obeyed in response to a single operation of a manual control.
Note: Single-step operation is used mainly in detecting faults.

.15 digit period
digit time

n. The time interval between the occurrence of successive digit signals.

.16 word time

n. The time interval between the occurrence of digits occupying corresponding positions in successive words.

.17 control sequence

n. The normal order of selection of instructions for execution. In some computers, one of the addresses in each instruction specifies the control sequence; in others, the sequence is consecutive except where a jump occurs.

.18 sequential control

n. A method of operation of a computer permitting instructions to be stored in the sequence in which they are normally obeyed.

.19 set

v. 1. Place a binary storage cell in the state representing 1.
2. Place a binary storage cell in a prescribed state.

.20 reset
unset
clear

v. 1. Place a binary storage cell in the state representing 0.
2. Place a binary storage cell in the alternative state to the set state.

.21 reset to N
reset

v. Return a counting device to an initial state representing N.

.22 counter

n. A logic element, register or storage location for storing numbers, permitting these numbers to be increased by unity or by an arbitrary constant , and often capable of being reset to zero; e.g., a device with several stable states which may be triggered from one state to the next, or a cyclic store associated with a half-adder.
Note 1: Where the number stored in a counter can be increased or decreased according to a control signal, the term "reversible counter" is used.
Note 2: Where the number stored in a counter reverts to zero in the sequence of counting after reaching a maximum value N, the counter is said to count modulo N.

.23 enabling signal

n. A signal which allows an operation to take place or a state to exist.

.24 inhibiting signal

n. A signal which prevents an operation which might otherwise take place.

.25 force

v. To intervene manually in a routine and change the normal sequence of computer operations.

242 DATA OPERATIONS

.01 data operation

n. The derivation of an item or items, called the result, from one or more given items, called operands, according to defined rules which specify the result for any permissible combination of values of the operands.
Note: The term operands is also used collectively for both operands and results, since the results will often be operands in subsequent operations.

.02 dyadic operation

n. An operation on two operands.
Note: The operands and result need not be two-state variables.

.03 seek

v. Examine a set of items for any that have a desired property.

.04 search

v. Examine a set of items for any that have a desired property.

.05 dichotomizing search

n. A search in which a numerically sequenced set of items is divided into two parts, one of which is rejected, and the process repeated until the items with the desired property are found. If the number of items in the set is made even and then divided into two equal parts, the search may be known as a binary search; division of the set in accordance with a Fibonacci series produces a Fibonacci search; etc.

.06 select

v. Take one of two or more alternative devices or courses of action, perhaps according to the result of some test.

.07 extract

v. Choose from a set of items a subset including all those that meet some criterion; e.g., to obtain certain specified characters from a machine word.

.08 rearrange

v. Change the sequence of the items in a collection.

.09 pack

v. Compress data in a store by taking advantage of known characteristics of the data in such a way that the original data can be recovered: e.g., to include two or more items in one or more machine words by allocating groups of characters to the individuals items; to store only the non-zero items of a table, those not stored being assumed to be zero.

.10 unpack

v. Recover the original data from packed data.

.11 edit

v. Prepare data for a later operation. Editing may involve the rearrangement or addition of data, the deletion of unwanted data, format control, code conversion, the application of standard processes such as zero-suppression, and the control of layout for printing.

.12 pre-edit

v. To edit input data prior to processing.

.13 post-edit

v. Edit output data from a previous process.

.14 justify

v. 1. Adjust the position of words on a printed page so that the left or right hand margin is regular.
2. By extension, shift an item in a location so that the most or the least significant character is at some specified position in the register.

.15 zero suppression

n. The elimination of zeros which have no significance; e. g., those to the left of the integral part of a number.

.16 clear
erase

v. Delete all data in a store by bringing all its cells to a prescribed state.

.17 zeroize
cancel

v. Replace the content of a store with the representation of zero.

.18 mask

n. A word of characters used for the purpose of selecting or eliminating parts of other words.
v. Extract a selected group of characters from a word.

.19 standardize

v. Replace any given floating-point representation of a number with the representation in standard form.

.20 sequence

v. Arrange items so that they are in the sequence defined by some criterion of their keys. Often the keys are groups of numbers or letters and the items are arranged so that the keys of successive items are in numerical or alphabetical sequence.

.21 sort

v. Segregate items into groups according to the keys used to identify them or according to some definite rules. "Pigeonholes", pockets or storage locations are assigned in advance, and used to collect items having like keys.
Note: Sorting does not in itself involve sequencing, for the "pigeon holes" may have any arrangement whatsoever, but sorting is a common prerequisite to sequencing.

.22 merge

v. To form a single sequenced file by combining two or more similarly sequenced files.
Note 1: See also Coalesce.
Note 2: Repeated merging, splitting and remerging can be used to put items into sequence; this process is sometimes called a MERGING SORT but ought more strictly to be called "sequencing by merging". See also Sequence and Sort.

.23 coalesce

v. Combine two or more files into one file.
Note: See also Merge.

243 ARITHMETIC OPERATIONS

.01 arithmetic operation

n. An operation performed according to arithmetic rules.

.02 addition operation

n. In addition, the operands are the addend and the augend; the result is the sum. The addend and augend are distinquishable if the result appears in the storage location previously occupied by one of the operands; in this case, the displaced operand is the augend and the surviving operand is the addend.

.03 subtraction operation

n. In subtraction, the subtrahend is subtracted from the minuend to form the difference.

.04 multiplication operation

n. In multiplication, the operands are the factors or the multiplier and the multiplicand; the result is the product. The multiplier and multiplicand are distinguished in some methods of performing multiplication by the fact that the product is formed by repeated addition of the multiplicand (or simple multiples of the multiplicand) in accordance with the value of digits of the multiplier.

Note: The term multiplier is also used to mean a device for performing multiplication.

.05 division operation

n. In division, the dividend is divided by the divisor to give the quotient and the remainder.

Note: There are differences in detail among the results produced by different division processes; although quotient and remainder are always linked by the relationship "dividend = divisor x quotient + remainder" their exact values are determined by the precision required in the quotient, the rule for terminating it (i.e., whether truncated, rounded-off, etc.) and the rules governing the sign of the remainder. Thus quotient and remainder may be regarded as less precise terms than sum, difference or product.

.06 arithmetic shift

n. In radix notation, the displacement of the digits of a word relative to the radix point, the sign of the number being preserved, and round-off being provided as required.

.07 carry

n. 1. A signal, or expression, produced as a result of an arithmetical operation on one digit position of two or more numbers in positional representation, and transferred to the next more significant position for processing there.
2. A signal or expression as in 1 which arises in adding when the sum of two digits in the same position equals or exceeds the radix of that position of the number representation in use.
3. The signal which initiates the forwarding of a carry.
4. The action of forwarding a carry.

Note 1: When a carry into a digit position results in a carry-out of the same position, and the normal adding circuit is bypassed when generating this new carry, it is called a high-speed carry, ripple-through carry or, where appropriate, standing-on-nines carry. When the normal adding circuit is used in such a case, it is called a cascaded carry.

Note 2: When a carry resulting from the addition of carries is not allowed to propagate, it is called a partial carry. When it is allowed to propagate, it is called a complete carry.

.08 end-around carry

n. A carry that is sent directly from the most significant digit position to the least significant position; e.g., when using diminished radix complements.

.09 borrow

n. In direct subtraction, a signal or expression as in carry which arises when the difference between the digits is less than zero.

.10 overflow

v. In an arithmetical operation, generate a quantity beyond the capacity of the register or location which is to receive the result.

.11 underflow

n. A generated quantity that is smaller than the accepted minimum; e.g., floating point underflow.

244 LOGICAL OPERATIONS

.01 logical operation

n. 1. An operation in which the operands and result are single digits; e.g., a comparison operation on the 3-state variables A and B (each represented by -1, 0 or + 1) which yields -1 when A is less than B, 0 when A equals B and +1 when A is greater than B.

2. By extension, an operation with operands and result of any number of digits so that each digit of the result depends on not more than one digit of any one operand. Usually the same operation is performed on all corresponding digits of the operands.

.02 Boolean operation

n. An operation depending on the application of Boolean axioms. By extension, any operation in which the operands and results take either one of two values or states; i.e., any logical operation on single binary digits.

Note: A Boolean operation may involve any number of operands.

.03 compare

v. Examine the representations of two quantities to discover identity or relative magnitude.

.04 logical comparison

n. The comparison of two words, character by character.

.05 shift

v. Displace the characters of a word according to some set of rules.

.06 logical shift

n. A non-arithmetical shift, e.g.:

1. A cyclic shift in which the characters that leave from one end of a word are returned to the other in a circular fashion.
2. A shift similar to an arithmetical shift but in which the sign digit does not receive special treatment and no round-off is provided.

251 WORKING

.01 <u>working</u>

n. The mode of execution of operations.

.02 <u>serial</u>

a. Dealing with the elements of a message, one after another, in the same device.

.03 <u>parallel</u>

a. Dealing with the elements of a message concurrently, each element at its own site.

.04 <u>real-time</u>

a. Operation of a processor which proceeds
1. at the same speed as events being simulated, or
2. at sufficient speed to analyze, control or be controlled by external events happening concurrently.

.05 <u>synchronous working</u>

n. The performance of a sequence of operations controlled by clock signals.
<u>Note</u>: A sequence of operations controlled synchronously may form one of a sequence of larger operations working asynchronously.

.06 <u>asynchronous working</u>

n. The performance of a sequence of operations such that each operation starts as a result of a signal that the previous operations have been completed or that the equipment required for the next operation is now available.
<u>Note</u>: See note to synchronous working.

.07 <u>clock signal</u>
<u>clock pulses</u>
<u>clock</u>

n. The basic repetitive signal used to control the timing of all synchronous operations.

.08 <u>on-line working</u>

n. Operation of a unit of an automatic data processing system which is connected to the main part of the system and which accepts the output of another unit substantially as soon as that output becomes available.
<u>Note</u>: The term is usually applied to peripheral units and operations.

.09 <u>hesitation</u>

n. A brief suspension of a sequence of operations in order to perform all or part of an operation from another sequence. For example, during an autonomous peripheral transfer of a block of data, the periodic suspension of the operation of a simultaneous routine in order to transfer each word of the block in turn to or from the store.

.10 <u>simultaneous working</u>

n. Any method of working an ADP system in which more than one operation or sequence of operations is executed at the same time.
<u>Note</u>: The term is applied only to the working of a connected system; that is, one within which all data flow is automatic.

.11 <u>partial overlapping</u>

n. A restriction on one unit so that it cannot perform simultaneous operations during specified intervals of the operation of some other particular unit.

.12 <u>independent operation</u>

n. An operation in a system that does not inhibit the operation of any unit not directly concerned in the operation.

.13 <u>multiplexed operations</u>

n. Simultaneous operations that share the use of a common unit in such a way that they can be considered as independent operations.

.14 <u>microprogramming</u>

n. A method of working in the control unit of a computer in which each instruction, instead of being used to initiate control signals directly, is first interpreted by a "program" (the microprogram) which is inherent in the construction of the control unit (e.g., by the wiring of a ferrite core matrix holding the microprogram.) This results in the generation of control signals corresponding to the instruction.

.15 <u>multi-sequencing</u>

n. The simultaneous execution of several parts of a routine by separate central processors.

.16 <u>multi-processing</u>

n. The operation of a computer configuration using more than one central processor.

.17 <u>multi-running</u>

n. A technique for handling numerous routines simultaneously by overlapping or interleaving their execution.

.18 <u>reservation</u>

n. The allocation of part of a system exclusively to one of several routines in such a way as to inhibit its use by any other of the routines.
<u>Note</u>: The parts of a system most commonly reserved are peripheral units and locations.

.19 <u>lock-out</u>

n. An inhibition of any other reference to a particular part of an equipment during an operation which uses that part. For example, during an independent peripheral transfer, the locations concerned may be locked out to prevent reference to them until completion of the transfer.

261 RELIABILITY

.01 reliability

n. The ability of a component, device, unit of equipment or functional section of a system to perform to a specified standard when required, without remedial action.

Note 1: Great care is needed when discussing reliability to insure that comparisons are valid.

Note 2: Reliability may be measured as the probability of no failure in a specified period, with the usual difficulties of applying a statistical measure to an individual.

Note 3: Reliability is sometimes appraised in terms of the mean time between failures and the mean repair time.

.02 fault

n. The failure of a component, device, unit of equipment or functional section of a system to perform in the manner required over the specified range of environmental conditions.

.03 corrective maintenance

n. Tests, measurements, replacements, adjustments and repairs effected to clear a fault.

.04 preventive maintenance

n. Tests, measurements, replacements, adjustments and repairs carried out with the intention of preventing faults from occurring during subsequent operation.

.05 routine maintenance
scheduled maintenance

n. Maintenance work carried out in accordance with an established timetable; for example, preventive maintenance.

Note: Routine maintenance is essentially periodic; it is not intended to include occasional periods of maintenance work done to fill idle time or to correct trends toward poor performance. (See supplementary maintenance).

.06 supplementary maintenance

n. Maintenance work, other than corrective maintenance, done outside the periods of routine maintenance by prior arrangement with the operator.

Note: Supplementary maintenance is commonly done either in time that would otherwise have been classified as idle time or after normal hours, and is often used to introduce minor modifications aimed at improving reliability.

.07 proving

v. Demonstrating either that a machine is free from faults or that it is capable of performing particular tasks, usually by running a test routine.

.08 marginal testing

v. Testing normally carried out either as a part of preventive maintenance or as an aid to fault finding, where the operation of a piece of equipment is tested with its operation conditions altered to decrease the safety margin against faults; e.g., an amplifier may be required to give a certain minimum gain with reduced heater voltage.

.09 test routine

n. A routine designed to reveal the presence of faults.

Note: Some test routines are also diagnostic routines.

.10 leapfrog test

n. A test routine stored in locations which are progressively changed by the routine itself in order to test the store.

.11 proving time

n. Time spent in proving.

Note 1: Time spent in proving after fault repair should be included in repair time.

Note 2: Time scheduled for proving (e.g., once a day) should be included in routine maintenance time.

Note 3: Any other proving time (e.g., by operators prior to a run) may, for example, be counted as incidentals time. (See also Note 1 of "awaiting repair time.")

.12 productive time

n. Time spent in processing work without faults or errors.

Note 1: This category does not include time spent on the development of routines and operating procedures, or on training and demonstrations.

Note 2: See also "operating delays" and "machine-spoiled work time."

.13 program development time

n. Time used in program testing, to debug a routine, or for trials of new operating procedures.

.14 incidentals time

n. Time used for training, demonstrations and similar useful but not directly productive purposes other than program development.

Note: See Note 3 to "proving time."

.15 operating delays

n. Time lost due to mistakes by operators or users of the system: e.g., operators' mistakes.

.16 data delays

n. Time lost due to errors in data due to mistakes in the preparation or origin of the data.

.17 idle time

n. Time when A.D.P. equipment is switched on but not in use, and there is no reason to suppose that a fault is present.

Note: A test routine may be run during idle time to warn the operator should a fault occur.

.18 awaiting repair time

n. The interval between the operator reporting a suspected fault to the maintenance authority and the engineer starting to trace and repair it, plus a substantial period when the engineer is waiting for materials, equipment, assistance, or advice.

Note 1: When investigation shows the computer to have been free of faults, the time lost should count as an operating delay.

Note 2: When no engineer is on duty, the time from the occurrence of the fault until the engineer reports for duty should count as unattended time.

.19 repair time

n. Time spent outside the periods allocated to routine maintenance and supplementary maintenance in diagnosing and clearing faults, equipment testing and maintenance.

Note: See Note 1 of "awaiting repair" and Note 1 of "proving time."

.20 machine-spoiled work time

n. Time wasted on runs that are spoiled by faults. Faults may not halt a run, but merely hamper it, causing it to over-run its schedule; any such extension of running time is also machine-spoiled work time.

Note 1: See Note 2 of "awaiting repair time."

Note 2: The time lost in a run spoiled by a fault depends on the program (e.g., frequency of programed restarts) as well as on the equipment, and so it may be convenient to limit the contribution of any one fault event to machine-spoiled work time, say to 30 minutes, any remainder being counted under operating delays.

.21 routine maintenance time

n. Time spent in routine maintenance.

Note: See Note 2 of "proving time."

.22 supplementary maintenance time

n. Time spent in supplementary maintenance.

Note: See Note 2 of "installation time."

.23 external delays

n. Time lost due to circumstance outside the reasonable control of the operator or maintenance engineer; for example, failure of the public power supply, ambient conditions outside the prescribed range, tampering, fires not due to an EDP equipment fault.

.24 debatable time

n. Time lost due to unknown causes, for example, where there is insufficient evidence to show whether a transient fault, a program error, or an operating mistake is responsible.

.25 installation time

n. Time spent in installing, commissioning testing, and approving equipment intended to add facilities.

Note: Time spent in modifying existing equipment to improve its reliability without adding to the facilities offered is supplementary maintenance time.

.26 unattended time

n. Time during which the equipment is switched off and is not attended by maintenance engineers.

Note: See Note 2 of "awaiting repair time."

.27 serviceability

n. An assessment of the reliability of A.D.P. equipment.

Note 1: Use is often made of the serviceability ratio which is the ratio of serviceable time to the sum of serviceable time and fault time, or of the availability ratio which is the ratio of serviceable time to the sum of serviceable time, fault time, routine maintenance time and supplementary maintenance time.

262 ERRORS

.01 error

n. 1. A qualitative discrepancy between an item or quantity and the correct version; e.g., one due to the mutilation of a message in transmission.

2. The quantitative discrepancy by which a calculated or measured result differs from the true value.

Note 1: An error may be due to a fault.

Note 2: In statistics, the term "error" and derived terms are used in various closely defined senses which are beyond the scope of this glossary.

.02 range of error

n. All possible values of the error of a particular result.

.03 span of error

n. The difference between the highest and lowest in the range of the error.

.04 balanced error

n. 1. A range of error in which the maximum and minimum possible errors are opposite in sign and equal in magnitude.

2. A range of error of which the average value is zero.

.05 absolute error

n. The magnitude of the error, irrespective of sign.

.06 truncation error

n. That part of an error due to truncation.

.07 rounding error

n. That part of an error due to round-off.

.08 bias

n. 1. An unbalanced error, that is, an error having an average value that is not zero. Examples are results produced by a shrunken measuring tape or, in computation, by a process of truncation.

2. A measure of the unbalance of errors.

3. The non-randomness of a distribution or sequence; e.g., of a file.

.09 accuracy

n. Size of error or of range of error. High accuracy implies small error.

.10 precision

n. The degrees of discrimination or amount of detail with which a quantity is stated; e.g., a 2-decimal-digit result discriminates between one hundred possible results.

Note: A result may have more precision than it has accuracy; e.g., the true value of π to eight decimal figures in 3.1415927; the expression $\pi = 3.1415249$ is precise to eight figures but accurate only to about five significant figures.

263 CHECKS

.01 check

n. A partial or complete test for:
1. the absence of errors in a set of data, or
2. the correct performance of a group of machine operations.

v. Determine whether data or a process passes a test.

.02 verify

v. Check data, especially after a transfer or transcription involving manual processes.

.03 redundancy check

n. A check that uses extra check digits, which do not themselves fully represent the data concerned.

.04 check digit

n. A digit associated with a word or part of a word for the purpose of checking the absence of error.

.05 check bit

n. A binary check digit.

.06 summation check
sum check

n. A check in which groups of digits are summed, usually without regard for overflow, and the result compared with a previously-computed value called the check sum.

.07 sum-check digit

n. A check digit produced by a summation check.

.08 parity check

n. A summation check using modulus two; e.g., a check which tests whether the number of ones in a group of binary digits is odd.

Note 1. The number of zeros may be used in place of the number of ones.

Note 2. Alternatively, the number of ones (or zeros) may be required to be even.

Note 3. When the numbers of ones (or zeros) is required to be odd, the check is called an odd parity check, and when even, an even parity check.

.09 parity check bit

n. A check bit used in a parity check.

.10 parity bit

n. A bit appended to an array of bits to make the sum of all the bits either odd or even, as nominated.

.11 residue check
modulo 'N' check

n. A check of numerical data or arithmetical operations in which each number 'A' is divided by 'N', and the remainder 'B' accompanies A as a check digit or digits; e.g., in a modulo 4 check, B will be either 0, 1, 2 or 3, and if the remainder when A is divided by 4 does not equal B, an error is indicated.

Note: The well-known arithmetical method of 'casting out nines' is a modulo 9 check.

.12 automatic check
built-in check

n. Any facility provided in the equipment for performing a check automatically.

.13 transfer check

n. A check, usually an automatic check, of the transfer of data, e.g., by temporarily storing, retransmitting and comparing.

.14 control total
check total
check sum

n. A total of a set of items used as a check.

Note: The term check total is usually reserved for totals which have some significance independent of the checking process; e.g., in payroll, the totaled tax deductions for a group of employees. When a control total has no such independent significance, it is called a "hash total"; e.g., in payroll, the sum of the employees' pay numbers.

.15 proof total

n. One of a number of control totals which can be combined with others to check consistency, e.g., in payroll, the total gross pay of a group of employees, their totaled deductions and their total net pay may be derived as three separate control totals, and also used as proof totals by checking that total gross pay less total deductions equals total net pay.

.16 echo checking

n. A method of checking the accuracy of transmission of data in which the received data are returned to the sending end for comparison with the original data, which are stored there for this purpose.

.17 validity check

n. A checking technique based on known limits for data; e.g., a man cannot work 400 hours in one week, there is no day 32 in a month.

.18 reasonableness check

n. A checking technique based on reasonable limits for data; e.g., a man's age is unlikely to be greater than 70 years on a payroll record.

.19 alarm

n. A signal made to an operator to warn him of an interlock or check failure that has occurred; e.g., a warning lamp or buzzer.

COMPARISON CHARTS

STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

COMPARISON CHARTS
CONTENTS

STANDARD EDP REPORTS AUERBACH

QUICK REFERENCE INDEX TO THE COMPARISON CHARTS

The table below will guide you quickly to the exact pages on which you will find all the entries describing the hardware characteristics and system performance of any of the computer systems currently included in the AUERBACH Standard EDP Reports Comparison Charts. (Note that the Configuration Rentals for all systems are on Pages 11:010.102 and 11:010.103.)

System Identity	Central Processor and Working Storage	Auxiliary Storage and Magnetic Tape	Punched Card and Punched Tape Input-Output	Other Input-Output Equipment	System Performance Comparisons
Burroughs B 100/200/300	11:210.102	11:220.102	11:230.102	11:240.102	11:400.102
Burroughs B 5500	11:210.102	11:220.103	11:230.102	11:240.102	11:400.102
Burroughs B 2500/3500	11:210.103	11:220.103	11:230.102	11:240.102	—
CDC 160-A	11:210.104	11:220.104	11:230.103	11:240.103	11:400.102
CDC 1604-A	11:210.104	11:220.104	11:230.103	11:240.103	11:400.102
CDC 3000 Series	11:210.104	11:220.105	11:230.103	11:240.103	11:400.102
CDC 6000 Series	11:210.106	11:220.106	11:230.104	11:240.104	11:400.102
GE-115	11:210.107	11:220.109	11:230.104	11:240.104	—
GE-200 Series	11:210.108	11:220.109	11:230.104	11:240.105	11:400.102
GE-400 Series	11:210.109	11:220.109	11:230.105	11:240.105	11:400.102
GE-600 Series	11:210.107	11:220.108	11:230.105	11:240.105	11:400.104
Honeywell Series 200	11:210.110	11:220.109	11:230.105	11:240.106	11:400.104
Honeywell 400/1400	11:210.111	11:220.109	11:230.106	11:240.106	11:400.104
Honeywell 800/1800	11:210.111	11:220.110	11:230.106	11:240.106	11:400.104
IBM 1130	11:210.113	11:220.110	11:230.106	11:240.108	11:400.106
IBM 360, Mod 20-75	11:210.112	11:220.110	11:230.107	11:240.107	11:400.104
IBM 360, Mod 44	11:210.113	11:220.110	11:230.108	11:240.108	11:400.104
IBM 360, Mod 67	11:210.113	11:220.110	11:230.107	11:240.107	—
IBM 704/709	11:210.114	11:220.112	11:230.108	11:240.109	11:400.106
IBM 1400 Series	11:210.114	11:220.112	11:230.109	11:240.109	11:400.106
IBM 1620	11:210.116	11:220.113	11:230.112	11:240.111	11:400.106
IBM 7010	11:210.117	11:220.113	11:230.110	11:240.111	11:400.106
IBM 7040/7044	11:210.117	11:220.114	11:230.110	11:240.111	11:400.106
IBM 7070/7072/7074	11:210.118	11:220.114	11:230.111	11:240.112	11:400.106
IBM 7080	11:210.119	11:220.114	11:230.111	11:240.112	11:400.106
IBM 7090/7094	11:210.119	11:220.115	11:230.111	11:240.112	11:400.106
LGP-30	11:210.120	11:220.115	11:230.112	11:240.113	11:400.106
Monrobot XI	11:210.120	11:220.115	11:230.112	11:240.113	11:400.106
NCR 315 Series	11:210.121	11:220.116	11:230.113	11:240.114	11:400.106
PB 250	11:210.121	11:220.116	11:230.113	11:240.113	11:400.106
Philco 2000	11:210.122	11:220.116	11:230.114	11:240.114	11:400.108
RCA Spectra 70	11:210.123	11:220.117	11:230.115	11:240.115	11:400.108
RCA 301/3301	11:210.124	11:220.117	11:230.114	11:240.115	11:400.108
RPC-4000	11:210.125	11:220.118	11:230.116	11:240.116	11:400.108
UNIVAC SS 80/90	11:210.125	11:220.119	11:230.116	11:240.117	11:400.110
UNIVAC III	11:210.126	11:220.119	11:230.116	11:240.117	11:400.110
UNIVAC 418	11:210.126	11:220.120	11:230.117	11:240.117	11:400.110
UNIVAC 490 Series	11:210.127	11:220.121	11:230.118	11:240.118	11:400.110
UNIVAC 1004	11:210.126	11:220.122	11:230.117	11:240.118	11:400.110
UNIVAC 1050	11:210.127	11:220.122	11:230.117	11:240.118	11:400.110
UNIVAC 1107	11:210.128	11:220.122	11:230.118	11:240.119	11:400.110
UNIVAC 1108	11:210.128	11:220.123	11:230.118	11:240.119	11:400.110
UNIVAC 9000 Series	11:210.128	11:220.120	11:230.119	11:240.119	—

CONFIGURATION RENTALS, DOLLARS PER MONTH

CONFIGURATION RENTALS, DOLLARS PER MONTH

SYSTEM IDENTITY	Card	4-Tape Business	6-Tape Business	12-Tape Business	6-Tape Auxiliary Storage	6-Tape Business/Scientific Integrated	6-Tape Business/Scientific Paired
	I	II	III	IV	V	VI	VIB
Burroughs B 100	2,510	4,590	---	---	---	---	---
Burroughs B 200	4,525	5,895	8,840	---	12,260	---	---
Burroughs B 300	---	---	10,070	---	---	---	---
Burroughs B 2500	---	4,795	---	---	---	---	---
Burroughs B 3500	---	---	---	---	9,485	---	---
Burroughs B 5500	---	---	23,340	---	25,250	---	---
CDC 160-A	5,980	8,280	10,042	---	---	12,852	---
CDC 1604-A	---	---	---	---	---	34,525	35,107
CDC 3100	---	---	---	---	13,385	10,865	---
CDC 3200	---	---	---	---	13,925	12,695	---
CDC 3300	---	---	---	---	---	---	---
CDC 3400	---	---	---	---	---	25,555	---
CDC 3600	---	---	---	---	---	---	58,599
CDC 6400	---	---	---	---	33,895	30,565	---
CDC 6600	---	---	---	---	---	---	---
CDC 6800	---	---	---	---	---	---	---
GE-115	2,175	---	---	---	---	---	---
GE-215	4,885	6,250	7,375	---	10,075	8,325	---
GE-225	5,115	7,450	10,155	16,620	12,855	12,805	---
GE-235	---	---	11,870	18,385	14,590	15,120	---
GE-415	4,625	6,350	7,900	13,385	9,950	---	---
GE-425	5,875	7,610	8,850	14,335	10,900	---	---
GE-435	---	---	11,350	16,835	13,400	---	---
GE-625	---	---	---	---	---	---	---
GE-635	---	---	---	---	---	---	---
Honeywell 120	3,630	3,415	6,030	---	---	---	---
Honeywell 200	3,885	4,785	7,145	13,925	8,150	---	---
Honeywell 1200	4,745	5,645	7,570	14,125	8,575	10,085	---
Honeywell 2200	---	---	8,545	15,305	9,550	---	---
Honeywell 4200	---	---	15,565	21,250	16,570	---	---
Honeywell 8200	---	---	---	---	---	---	---
Honeywell 400	---	7,615	9,805	---	12,715	11,005	---
Honeywell 1400	---	11,150	12,290	20,980	---	14,530	---
Honeywell 800	---	---	---	---	25,329	20,329	---
Honeywell 1800	---	---	---	---	---	30,100	---
IBM 360, Model 20	2,300	3,475	---	---	---	---	---
IBM 360, Model 30	4,005	4,600	6,585	---	10,085	---	---
IBM 360, Model 40	---	6,890	7,800	---	11,300	11,100	---
IBM 360, Model 44	---	---	---	---	11,215	10,315	---
IBM 360, Model 50	---	---	14,785	20,565	---	14,785	---
IBM 360, Model 65	---	---	---	---	---	---	---
IBM 360, Model 75	---	---	---	---	---	---	---
IBM 704	---	---	---	---	---	28,450	---
IBM 709	---	---	---	---	---	---	---
IBM 1130	1,275	---	---	---	---	---	---
IBM 1401	4,330	5,920	10,830	11,540	13,330	---	---
IBM 1401-G	2,375	---	---	---	---	---	---
IBM 1410	6,115	8,415	12,240	19,060	15,365	15,790	---
IBM 1440	3,295	4,050	5,920	---	7,970	---	---
IBM 1460	---	---	11,735	---	13,975	---	---
IBM 1620-I	---	---	---	---	---	---	---
IBM 1620-II	---	---	---	---	---	---	---
IBM 7010	---	---	19,175	27,225	22,220	22,175	---
IBM 7740	---	---	---	---	---	20,715	---
IBM 7044	---	---	---	---	---	---	---
IBM 7070	---	---	19,400	---	24,785	23,450	---
IBM 7072	---	---	---	---	---	---	---
IBM 7074	---	---	24,700	---	29,860	34,175	---
IBM 7080	---	---	---	---	---	---	---
IBM 7090	---	---	---	---	64,060	---	---
IBM 7094-I	---	---	---	---	69,960	---	---
LGP-30	---	---	---	---	---	---	---
Monrobot XI	800	---	---	---	---	---	---
NCR 315	5,700	5,925	8,145	19,290	9,795	---	---
NCR 315-100	5,000	4,350	---	---	---	---	---
NCR 315 RMC	---	---	11,345	20,490	12,995	---	---
PB 250	---	---	---	---	---	---	---
Philco 2000-210	---	---	---	---	---	---	---
Philco 2000-211	---	---	---	---	---	---	---
Philco 2000-212	---	---	---	---	---	---	---
RCA 301	4,271	5,084	9,687	20,290	12,777	12,880	---
RCA 3301	---	---	11,390	18,940	14,865	14,265	---
RCA Spectra 70/15	3,400	4,700	---	---	---	---	---
RCA Spectra 70/25	---	5,865	6,465	12,265	---	---	---
RCA Spectra 70/35	4,830	6,305	6,905	---	9,255	9,005	---
RCA Spectra 70/45	---	---	8,450	13,950	11,275	10,250	---
RCA Spectra 70/55	---	---	13,430	18,330	16,255	13,430	---
RPC-4000	---	---	---	---	---	---	---
UNIVAC SS 80/90-I	4,325	7,125	7,400	---	9,900	---	---
UNIVAC SS 80/90-II	---	8,640	9,540	15,940	11,140	13,040	---
UNIVAC III	---	---	19,000	20,400	---	---	---
UNIVAC 418	---	---	7,125	---	11,425	---	---
UNIVAC 490	---	---	19,780	---	25,830	---	---
UNIVAC 491/492	---	---	13,345	---	18,345	---	---
UNIVAC 494	---	---	25,765	---	31,015	---	---
UNIVAC 1004	1,800	2,725	---	---	---	---	---
UNIVAC 1050	3,470	5,030	6,660	18,270	12,500	---	---
UNIVAC 1107	---	---	---	---	---	39,740	---
UNIVAC 1108	---	---	---	---	---	---	---
UNIVAC 9200	1,235	---	---	---	---	---	---
UNIVAC 9300	1,860	---	4,475	---	---	---	---

Note: The indicated rentals were those in effect when the Computer System Report on each system was last revised. Some of the older computer systems are now offered at lower prices; consult manufacturers' representatives for details.

(Contd.)

CONFIGURATION RENTALS, DOLLARS PER MONTH (CONT'D.)

SYSTEM IDENTITY	10-Tape General		20-Tape General		Desk Size Scientific	Punched Tape/Card Scientific	4-Tape Scientific
	Integrated	Paired	Integrated	Paired			
	VII A	VII B	VIII A	VIII B	IX	X	XI
Burroughs B 100	---	---	---	---	---	---	---
Burroughs B 200	---	---	---	---	---	---	---
Burroughs B 300	---	---	---	---	---	---	---
Burroughs B 2500	---	---	---	---	---	---	---
Burroughs B 3500	15,410	---	---	---	---	---	---
Burroughs B 5500	30,995	28,705	---	---	---	---	---
CDC 160-A	---	---	---	---	2,902	4,212	---
CDC 1604-A	---	38,637	---	54,265	---	---	---
CDC 3100	16,030	15,885	---	---	---	---	---
CDC 3200	18,310	17,715	---	---	---	---	---
CDC 3300	INA	INA	---	---	---	---	---
CDC 3400	30,930	31,859	---	49,330	---	---	---
CDC 3600	---	61,899	---	73,910	---	---	---
CDC 6400	34,000	---	47,145	---	---	---	---
CDC 6600	58,050	---	71,195	---	---	---	---
CDC 6800	57,740	---	70,885	---	---	---	---
GE-115	---	---	---	---	---	---	---
GE-215	---	---	---	---	---	---	---
GE-225	---	---	---	---	---	---	---
GE-235	---	---	---	---	---	---	---
GE-415	14,630	---	---	---	---	---	---
GE-425	15,780	---	---	---	---	---	---
GE-435	19,180	---	---	---	---	---	---
GE-625	34,105	---	49,165	---	---	---	---
GE-635	34,755	---	49,915	---	---	---	---
Honeywell 120	---	---	---	---	---	---	---
Honeywell 200	---	---	---	---	---	---	---
Honeywell 1200	15,080	15,125	---	---	---	---	---
Honeywell 2200	17,515	16,925	---	---	---	---	---
Honeywell 4200	21,590	21,165	---	34,895	---	---	---
Honeywell 8200	36,830	---	48,655	---	---	---	---
Honeywell 400	---	---	---	---	---	---	---
Honeywell 1400	---	---	---	---	---	---	---
Honeywell 800	36,079	28,475	54,000	46,925	---	---	---
Honeywell 1800	37,050	37,575	56,900	56,025	---	---	---
IBM 360, Model 20	---	---	---	---	---	---	---
IBM 360, Model 30	---	---	---	---	---	---	---
IBM 360, Model 40	---	---	---	---	---	---	---
IBM 360, Model 44	13,730	---	---	---	---	---	9,320
IBM 360, Model 50	18,775	20,885	---	---	---	---	---
IBM 360, Model 65	32,525	33,835	---	49,790	---	---	---
IBM 360, Model 75	46,315	46,175	---	62,130	---	---	---
IBM 704	43,600	48,157	---	---	---	---	28,150
IBM 709	49,700	53,770	63,300	69,045	---	---	---
IBM 1130	---	---	---	---	1,080	---	---
IBM 1401	---	---	---	---	---	---	---
IBM 1401-G	---	---	---	---	---	---	---
IBM 1410	---	23,560	---	---	---	---	---
IBM 1440	---	---	---	---	---	---	---
IBM 1460	---	---	---	---	---	---	---
IBM 1620-I	---	---	---	---	2,455	3,580	---
IBM 1620-II	---	---	---	---	3,090	4,275	---
IBM 7010	---	28,355	---	---	---	---	---
IBM 7040	27,190	---	---	47,145	---	---	---
IBM 7044	36,690	---	---	56,645	---	---	---
IBM 7070	---	29,755	---	45,030	---	---	---
IBM 7072	---	32,915	---	49,890	---	---	---
IBM 7074	---	40,465	---	72,840	---	---	---
IBM 7080	---	51,745	---	79,325	---	---	---
IBM 7090	---	66,770	---	89,215	---	---	---
IBM 7094-I	---	72,395	---	95,065	---	---	---
LPG-30	---	---	---	---	1,100	1,365	---
Monrobot XI	---	---	---	---	885	---	---
NCR 315	---	---	---	---	---	---	---
NCR 315-100	---	---	---	---	---	---	---
NCR 315 RMC	---	---	---	---	---	---	---
PB 250	---	---	---	---	1,675	2,455	4,745
Philco 2000-210	---	33,765	---	53,025	---	---	---
Philco 2000-211	---	38,315	---	64,475	---	---	---
Philco 2000-212	---	52,315	---	87,145	---	---	---
RCA 301	---	---	---	---	---	---	---
RCA 3301	21,265	21,604	---	---	---	---	---
RCA Spectra 70/15	---	---	---	---	---	---	---
RCA Spectra 70/25	---	---	---	---	---	---	---
RCA Spectra 70/35	12,930	---	---	---	---	---	---
RCA Spectra 70/45	13,775	15,700	---	---	---	---	---
RCA Spectra 70/55	16,830	19,080	---	32,945	---	---	---
RPC-4000	---	---	---	---	1,750	2,450	---
UNIVAC SS 80/90-I	---	---	---	---	---	---	---
UNIVAC SS 80/90-II	---	---	---	---	---	---	---
UNIVAC III	25,000	---	---	38,730	---	---	---
UNIVAC 418	17,875	---	---	---	---	---	---
UNIVAC 490	31,270	---	48,120	---	---	---	---
UNIVAC 491/492	23,715	---	41,915	---	---	---	---
UNIVAC 494	32,715	---	47,165	---	---	---	---
UNIVAC 1004	---	---	---	---	---	---	---
UNIVAC 1050	---	---	---	---	---	---	---
UNIVAC 1107	47,990	---	---	61,890	---	---	---
UNIVAC 1108	45,245	---	58,395	---	---	---	---
UNIVAC 9200	---	---	---	---	---	---	---
UNIVAC 9300	---	---	---	---	---	---	---

HARDWARE CHARACTERISTICS COMPARISON CHARTS
CENTRAL PROCESSORS AND WORKING STORAGE

System Identity			Burroughs B 100/200 Series 10-μsec Processor	Burroughs B 200/300 Series 6-μsec Processor	Burroughs B 5500
Computer System Report No.			201:	201:	203:
DATA STRUCTURE	Word Length	Binary Bits	6 + parity	6 + parity	48 + parity
		Decimal Digits	1	1	14
		Characters	1	1	8
	Floating Point Representation	Radix	---	---	Binary
		Fraction Size	---	---	39 bits + sign
		Exponent Size	---	---	6 bits + sign
CENTRAL PROCESSOR	Model Number		B 160, 170, 180, 250, 251, 260, 270, 280	B 263, 273, 275, 283, 300	B 5281
	Arithmetic Radix		Decimal	Decimal	Binary, decimal
	Operand Length, Words		1 to 12 char	1 to 12 char	1 or 2 words, or 1 to 63 char
	Instruction Length, Words		12 char	12 char	1/4
	Addresses per Instruction		3	3	1 or 0
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	690	414	17
		c = ab	6,270	3,762	44
		c = a/b	14,630	8,802	76
	Likely Floating Point Execution Times, μsec	c = a + b	---	---	17
		c = ab	---	---	44
		c = a/b	---	---	76
	Checking of Data Transfers		Parity	Parity	Parity
	Program Interrupt Facility		None	None	Yes, with priority scheme
	Number of Index Registers		None	None	3 (non-conventional)
	Indirect Addressing		None	None	One level
	Special Editing Capabilities		Good	Good	Good
	Boolean Operations		None	None	AND, INC OR, EXC OR
	Table Look-up		None	None	Good
	Console Typewriter		None	Optional	Yes
	Input-Output Channels		1 integrated non-simultaneous channel	1 integrated non-simultaneous channel	1 to 4 "floating" among peripheral device control units
	Features and Comments		Most input-output units are buffered	Most input-output units are buffered	B 5500 is faster, expanded version of original B 5000

WORKING STORAGE			Burroughs B 100/200 Series	Burroughs B 200/300 Series		Burroughs B 5500	
	Model Number		B 160, 170, 180, 250, 251, 260, 270, 280	B 263, 273 275, or 283	B 300	B 460	B 461
	Type of Storage		Core	Core	Core	Core	Core
	Number of Words	Minimum	4,800	4,800	4,800	4,096	4,096
		Maximum	4,800	19,200	19,200	32,768	32,768
	Maximum Total Storage	Decimal Digits	4,800	19,200	28,800	458,752	458,752
		Characters	4,800	19,200	19,200	262,144	262,144
	Cycle Time, μsec		10	6	6	6	4
	Effective Transfer Rate, char/sec.		48,000	80,000	80,000	353,000	444,000
	Checking		Parity	Parity	Parity	Parity	Parity
	Storage Protection		None	None		Yes, using limit registers	
	Features and Comments			B 300 uses optional Data Compress Instruction to pack decimal digits		Each of up to eight 4,096-word modules operates independently of the others	

* With optional equipment.
(s) Using subroutine.

Burroughs 500 Systems					
B 2500	B 3500	CDC 160	System Identity		
210:	210:	242:	Computer System Report No.		
16 + parity	16 + parity	12	Binary Bits	Word Length	DATA STRUCTURE
4	4	3.3	Decimal Digits	Word Length	DATA STRUCTURE
2	2	2	Characters	Word Length	DATA STRUCTURE
Decimal	Decimal	Binary or decimal	Radix	Floating Point Representation	DATA STRUCTURE
1 to 100 digits	1 to 100 digits	Varies (s)	Fraction Size	Floating Point Representation	DATA STRUCTURE
2 digits + sign	2 digits + sign	Varies (s)	Exponent Size	Floating Point Representation	DATA STRUCTURE
2501	3501	160	Model Number		CENTRAL PROCESSOR
Decimal	Decimal	Binary	Arithmetic Radix		CENTRAL PROCESSOR
1 to 100 digits or bytes	1 to 100 digits or bytes	1	Operand Length, Words		CENTRAL PROCESSOR
6 to 24 digits	6 to 24 digits	1 or 2	Instruction Length, Words		CENTRAL PROCESSOR
0, 1, 2, or 3	0, 1, 2, or 3	1	Addresses per Instruction		CENTRAL PROCESSOR
75	37.5	480 (s) or 145*	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
416	208	7,700 (s) or 250*	c = ab	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
1,810	905	10,200 (s) or 330*	c = a/b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
102*	51*	4,350 (s)	c = a + b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
462*	231*	14,200 (s)	c = ab	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
1,860*	930*	19,200 (s)	c = a/b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
Parity	Parity	None	Checking of Data Transfers		CENTRAL PROCESSOR
Yes, for many conditions	Yes, for many conditions	None	Program Interrupt Facility		CENTRAL PROCESSOR
3 per program	3 per program	1	Number of Index Registers		CENTRAL PROCESSOR
Yes, recursive	Yes, recursive	None	Indirect Addressing		CENTRAL PROCESSOR
Good	Good	None	Special Editing Capabilities		CENTRAL PROCESSOR
AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, EXC OR	Boolean Operations		CENTRAL PROCESSOR
Yes, Scan instruction	Yes, Scan instruction	None	Table Look-up		CENTRAL PROCESSOR
Optional	Optional	Optional	Console Typewriter		CENTRAL PROCESSOR
4 standard (2 low-speed Type A and 2 high-speed Type B); 6 channels max.	6 standard (3 Type A and 3 Type B); 20 maximum (10 A, 10 B)	1 integrated non-simultaneous channel	Input-Output Channels		CENTRAL PROCESSOR
Type A I/O channels transfer 1 character at a time; Type B channels transfer 2 characters in parallel		Fixed-point execution times are based on 2-word operands	Features and Comments		CENTRAL PROCESSOR
200X	300X	160	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		WORKING STORAGE
5,000	5,000	4,096	Minimum	Number of Words	WORKING STORAGE
30,000	250,000	4,096	Maximum	Number of Words	WORKING STORAGE
120,000	1,000,000	13,500	Decimal Digits	Maximum Total Storage	WORKING STORAGE
60,000	500,000	8,192	Characters	Maximum Total Storage	WORKING STORAGE
2	1	6.4	Cycle Time, μsec		WORKING STORAGE
500,000	1,000,000	44,600	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity	Parity	None	Checking		WORKING STORAGE
Yes, using limit register	Yes, using limit register	None	Storage Protection		WORKING STORAGE
Core storage is addressable by 4-bit digit positions; the first 1,200 digit positions are reserved for use by the processor			Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

			CDC 160-A	CDC 1604 and 1604-A	CDC 3100
System Identity			CDC 160-A	CDC 1604 and 1604-A	CDC 3100
Computer System Report No.			244:	241: and 243:	254:
DATA STRUCTURE	Word Length	Binary Bits	12	48	24 + parity
		Decimal Digits	3.3	14	6.9 or 4
		Characters	2	8	4
	Floating Point Representation	Radix	Binary or decimal	Binary	Binary (double-length)
		Fraction Size	Varies (s)	36 bits + sign	36 bits + sign
		Exponent Size	Varies (s)	11 bits	11 bits
CENTRAL PROCESSOR	Model Number		160-A	1604, 1604-A	3104
	Arithmetic Radix		Binary	Binary	Binary
	Operand Length, Words		1	1 or 2	1 or 2
	Instruction Length, Words		1 or 2	1/2	1
	Addresses per Instruction		1	1	1
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	480 (s) or 145*	21.6	10.5
		c = ab	7,700 (s) or 250*	39.6 to 77.2	19.7
		c = a/b	10,200 (s) or 330*	82.6	23.3
	Likely Floating Point Execution Times, μsec	c = a + b	4,350 (s) or 1,000*	33.2	220 (s)
		c = ab	14,200 (s) or 1,500*	50.4	350 (s)
		c = a/b	19,200 (s) or 1,500*	70.4	600 (s)
	Checking of Data Transfers		None	Tolerance on pulse size	Parity
	Program Interrupt Facility		Yes, multi-level	Yes, multi-level	Yes, multi-level
	Number of Index Registers		1	6	3
	Indirect Addressing		None	Yes; recursive	Yes; recursive
	Special Editing Capabilities		None	None	None
	Boolean Operations		AND, EXC OR	AND, INC OR	AND, EXC OR
	Table Look-up		None	Good	Good
	Console Typewriter		Optional	Yes	Yes
	Input-Output Channels		2, one of which is integrated and non-simultaneous	6 - 3 input and 3 output	1 to 8
	Features and Comments		Fixed-point execution times are based on 2-word operands		A slower version of the CDC 3200 with no options
WORKING STORAGE	Model Number		160-A and 169	1604, 1604-A	3103, 3108, 3109
	Type of Storage		Core	Core	Core
	Number of Words	Minimum	8,192	8,192	4,096
		Maximum	32,768	32,768	32,768
	Maximum Total Storage	Decimal Digits	108,000	458,752	226,000
		Characters	65,536	262,144	131,072
	Cycle Time, μsec		6.4	6.4	1.75
	Effective Transfer Rate, char/sec.		44,600	371,200 to 555,552	364,000
	Checking		None	Tolerance on pulse size	Parity
	Storage Protection		None	None	None
	Features and Comments			Two independent banks are used to reduce access times	Uses same peripheral equipment as CDC 3200

* With optional equipment.
(s) Using subroutine.

CDC 3200	CDC 3300	CDC 3400	System Identity		
245:	255:	246:	Computer System Report No.		
24 + parity	24 + parity	48 + parity	Binary Bits	Word Length	DATA STRUCTURE
6.9 or 4	6.9 or 4	14	Decimal Digits		
4	4	8	Characters		
Binary (double-length)	Binary (double-length)	Binary	Radix	Floating Point Representation	
36 bits + sign	36 bits + sign	36 bits + sign	Fraction Size		
11 bits	11 bits	11 bits	Exponent Size		
3204, 3205, 3210, 3215	3300	3404	Model Number		CENTRAL PROCESSOR
Binary (decimal*)	Binary, decimal	Binary	Arithmetic Radix		
1 or 2	1 or 2	1	Operand Length, Words		
1	1	1/2 or 1	Instruction Length, Words		
1	1	1 or 2	Addresses per Instruction		
8	4.8	9	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	
13	9.2	24	c = ab		
17	11.2	24	c = a/b		
19	11.9	12*	c = a + b	Likely Floating Point Execution Times, μsec	
41	15.0	20*	c = ab		
41	15.0	20*	c = a/b		
Parity	Parity	Parity	Checking of Data Transfers		
Yes, multi-level	Yes, multi-level	Yes, identity must be tested	Program Interrupt Facility		
3	3	6	Number of Index Registers		
Yes, recursive	Yes, recursive	Yes, recursive	Indirect Addressing		
None	None	None	Special Editing Capabilities		
AND, EXC OR	AND, EXC OR	AND, INC OR, EXC OR	Boolean Operations		
Good	Good	Good	Table Look-up		
Yes	Yes	Yes	Console Typewriter		
1 to 8	1 to 8	1 to 4	Input-Output Channels		
	A faster version of the CDC 3200 including all 3200 options	Double indexing; largely compatible with CDC 3600	Features and Comments		
3203, 3209	3303, 3309	3409	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		
4,096	4,096	16,384	Minimum	Number of Words	
32,768	32,768	32,768	Maximum		
226,000	226,000	458,752	Decimal Digits	Maximum Total Storage	
131,072	131,072	262,144	Characters		
1.25	0.8	1.5	Cycle Time, μsec		
1,000,000	?	1,050,000	Effective Transfer Rate, char/sec.		
Parity	Parity	Parity	Checking		
None	None	Yes, using "bounds" registers	Storage Protection		
64-word control memory has 0.5-μsec cycle time	Uses same peripheral equipment as CDC 3200	Single-bank storage	Features and Comments		

* With optional equipment.
(s) Using subroutine.

System Identity			CDC 3600	Control Data 6000 Series CDC 6400	CDC 6600	CDC 6800
Computer System Report No.			247:	263:	264:	265:
DATA STRUCTURE	Word Length	Binary Bits	48 + parity	60	60	60
		Decimal Digits	14	18	18	18
		Characters	8	10	10	10
	Floating Point Representation	Radix	Binary	Binary	Binary	Binary
		Fraction Size	36 or 84 bits + sign	48 or 96 bits	48 or 96 bits	48 or 96 bits
		Exponent Size	11 bits	11 bits plus sign	11 bits plus sign	11 bits plus sign
CENTRAL PROCESSOR	Model Number		3604	6401, 6404, 6405	6601, 6604, 6605	6801, 6804, 6805
	Arithmetic Radix		Binary	Binary	Binary	Binary
	Operand Length, Words		1 or 2	1	1	1
	Instruction Length, Words		1/2 or 1	1/4 or 1/2	1/4 or 1/2	1/4 or 1/2
	Addresses per Instruction		1 or 2	3	3	3
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	6.0	0.6	0.3	0.08
		c = ab	10.3	-	-	-
		c = a/b	20.0	-	-	-
	Likely Floating Point Execution Times, μsec	c = a + b	8.4	1.1	0.4	0.1
		c = ab	10.3	5.7	1.0	0.25
		c = a/b	19.0	5.6	2.9	0.73
	Checking of Data Transfers		Parity	None	None	None
	Program Interrupt Facility		Yes, external and internal	Yes	Yes	Yes
	Number of Index Registers		6	8	8	8
	Indirect Addressing		Yes; recursive	Not applicable	Not applicable	Not applicable
	Special Editing Capabilities		None	None	None	None
	Boolean Operations		AND, INC OR, Special	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR
	Table Look-up		Good	None	None	None
	Console Typewriter		Yes	Yes	Yes	Yes
	Input-Output Channels		1 to 32, attached 8 per Communication Module	12 standard; up to 156*	12 standard; up to 156*	12 standard
	Features and Comments			Sequential execution of one instruction at a time	Can execute up to 10 instructions concurrently	Four times as fast as CDC 6800; other-wise almost identical

			CDC 3600	Central Memory CDC 6400 & 6800	CDC 6800
WORKING STORAGE	Model Number		3609		
	Type of Storage		Core	Core	Core
	Number of Words	Minimum	16,384	32,768	32,768
		Maximum	262,144	131,072	131,072
	Maximum Total Storage	Decimal Digits	3,670,016	2,359,116	2,359,116
		Characters	2,097,152	1,310,620	1,310,620
	Cycle Time, μsec		1.5	1.0	0.25
	Effective Transfer Rate, char/sec.		2,610,000	100,000,000	400,000,000
	Checking		Parity	None	None
	Storage Protection		Yes, using "bounds" registers	Yes, for each program	Yes, for each program
	Features and Comments		Dual-bank storage	Each of 10 Peripheral Processors has 4,096 12-bit words of 1-microsecond core memory	Each of 10 Peripheral Processors has 4,096 12-bit words of 0.25-microsecond core memory

* With optional equipment.
(s) Using subroutine.

GE-625	GE-635	GE-115	System Identity		
343:	344:	310:	Computer System Report No.		
36 + parity	36 + parity	8 + parity	Binary Bits	Word Length	DATA STRUCTURE
10.5	10.5	1	Decimal Digits		
6	6	1	Characters		
Binary	Binary	---	Radix	Floating Point Representation	
7 bits	7 bits	---	Fraction Size		
27 or 63 bits	27 or 63 bits	---	Exponent Size		
CP 8030 (GE-625)	CP 8030 (GE-635)	GE-115	Model Number		CENTRAL PROCESSOR
Binary	Binary	Decimal	Arithmetic Radix		
1 or 2	1 or 2	1 to 16 digits	Operand Length, Words		
1	1	2, 4, or 6 char	Instruction Length, Words		
1	1	2	Addresses per Instruction		
9.5	6.1	296	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	
13.5	11.3	(s)	c = ab		
21.0	18.5	(s)	c = a/b		
9.5	7.0	---	c = a + b	Likely Floating Point Execution Times, μsec	
12.5	10.2	---	c = ab		
21.0	18.5	---	c = a/b		
Parity	Parity	Parity	Checking of Data Transfers		
Yes, with priority levels	Yes, with priority levels	None	Program Interrupt Facility		
8	8	AND, INC OR, EXC OR	Number of Index Registers		
Yes	Yes	None	Indirect Addressing		
None	None	None	Special Editing Capabilities		
AND, INC OR, EXC OR	AND, INC OR, EXC OR	None	Boolean Operations		
None	None	None	Table Look-up		
Yes	Yes	Good	Console Typewriter		
8 to 16 channels per I/OC; up to 28 I/OC's per system	8 to 16 channels per I/OC; up to 28 I/OC's per system	2 data channels with 4 device outlets; data transfer locks out processor	Input-Output Channels		
Master/slave modes of operation facilitate multiprogramming	Program-compatible with GE-625	Logical operands can be up to 256 characters long	Features and Comments		
MM 8031	MM 8030	GE-115	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		
32,768	32,768	4,096	Minimum	Number of Words	
262,144	262,144	8,192	Maximum		
2,760,000	2,760,000	8,192	Decimal Digits	Maximum Total Storage	
1,572,864	1,572,864	8,192	Characters		
2.0 per 72 bits	1.0 per 72 bits	8	Cycle Time, μsec		
2,400,000	3,330,000	62,000	Effective Transfer Rate, char/sec.		
Parity	Parity	Parity	Checking		
Yes, using bounds registers	Yes, using bounds registers	None	Storage Protection		
Multiple processors can access a storage module	Multiple processors can access a storage module		Features and Comments		

* With optional equipment.
(s) Using subroutine.

			GE-215	GE-225	GE-235
System Identity			GE-215	GE-225	GE-235
Computer System Report No.			320:	321:	323:
DATA STRUCTURE	Word Length	Binary Bits	19 + sign + parity	19 + sign + parity	19 + sign + parity
		Decimal Digits	5.7 + sign	5.7 + sign	5.7 + sign
		Characters	3	3	3
	Floating Point Representation	Radix	Binary	Binary	Binary
		Fraction Size	30 bits + sign	30 bits + sign	30 bits + sign
		Exponent Size	8 bits + sign	8 bits + sign	8 bits + sign
CENTRAL PROCESSOR	Model Number		215	225	235
	Arithmetic Radix		Binary (decimal*)	Binary (decimal*)	Binary (decimal*)
	Operand Length, Words		1 or 2	1 or 2	1 or 2
	Instruction Length, Words		1	1	1
	Addresses per Instruction		1	1	1
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	216	108	36
		c = ab	594	414	126
		c = a/b	675	567	189
	Likely Floating Point Execution Times, μsec	c = a + b	724*	580*	69*
		c = ab	1,068*	874*	87*
		c = a/b	1,322*	1,178*	111*
	Checking of Data Transfers		Parity	Parity	Parity
	Program Interrupt Facility		Yes*, external only	Yes*, external only	Yes*, external only
	Number of Index Registers		3; 96*	3; 96*	3; 96*
	Indirect Addressing		None	None	None
	Special Editing Capabilities		Good	Good	Good
	Boolean Operations		AND, OR	AND, OR	AND, OR
	Table Look-up		None	None	None
	Console Typewriter		Optional	Optional	Yes
	Input-Output Channels		6, permitting a maximum of 5 simultaneous data transfers	11, 8 of which are multiplexed by a Controller Selector	10, 7 of which are multiplexed by a Controller Selector
	Features and Comments			Program-compatible with GE-215 and GE-235	
WORKING STORAGE	Model Number		215	225	MM235
	Type of Storage		Core	Core	Core
	Number of Words	Minimum	4,096	4,096	4,096
		Maximum	8,192	16,384	16,384
	Maximum Total Storage	Decimal Digits	46,694	93,388	93,388
		Characters	24,567	49,152	49,152
	Cycle Time, μsec		36	18	6
	Effective Transfer Rate, char/sec.		12,000; 41,700*	24,000; 83,400*	84,000; 250,000*
	Checking		Parity	Parity	Parity
	Storage Protection		None	None	None
	Features and Comments				

* With optional equipment.
(s) Using subroutine.

GE-415	GE-425	GE-435	System Identity		
332:	333:	334:	Computer System Report No.		
24 + parity	24 + parity	24 + parity	Binary Bits	Word Length	DATA STRUCTURE
4 + sign	4 + sign	4 + sign	Decimal Digits		
4	4	4	Characters		
Binary	Binary	Binary	Radix	Floating Point Representation	
38 bits + sign	38 bits + sign	38 bits + sign	Fraction Size		
8 bits + sign	8 bits + sign	8 bits + sign	Exponent Size		
GE-415	GE-425	GE-435	Model Number		CENTRAL PROCESSOR
Decimal, binary	Decimal, binary	Decimal, binary	Arithmetic Radix		
1 to 4	1 to 4	1 to 4	Operand Length, Words		
1 or 2	1 or 2	1 or 2	Instruction Length, Words		
1 or 2	1 or 2	1 or 2	Addresses per Instruction		
63.8	42.9	16.9	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	
480.1	377.5	310.1	c = ab		
848.8	657.1	522.4	c = a/b		
70.6	47.2	32.8	c = a + b	Likely Floating Point Execution Times, μsec	
74.0	53.4	39.8	c = ab		
83.9	63.3	49.8	c = a/b		
Parity	Parity	Parity	Checking of Data Transfers		
Yes, priority system	Yes, priority system	Yes, priority system	Program Interrupt Facility		
6	6	6	Number of Index Registers		
Yes	Yes	Yes	Indirect Addressing		
Very good	Very good	Very good	Special Editing Capabilities		
AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	Boolean Operations		
None	None	None	Table Look-up		
Yes	Yes	Yes	Console Typewriter		
8 channels standard, 4 additional channels optional	8 channels standard, 4 additional channels optional	8 channels standard, 4 additional channels optional	Input-Output Channels		
Special addressing techniques increase effective no. of index registers	Program compatible with GE-415 and GE-435		Features and Comments		
GE-415	GE-425	GE-435	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		
4,096	8,192	8,192	Minimum	Number of Words	
32,768	32,768	32,768	Maximum		
131,072	131,072	131,072	Decimal Digits	Maximum Total Storage	
131,072	131,072	131,072	Characters		
5.8	3.9	2.7	Cycle Time, μsec		
344,000	512,000	768,000	Effective Transfer Rate, char/sec.		
Parity	Parity	Parity	Checking		
Yes*, using limits registers	Yes*, using limits registers	Yes*, using limits registers	Storage Protection		
			Features and Comments		

* With optional equipment.
(s) Using subroutine.

System Identity			Honeywell Series 200 Model 120	Model 200	Model 1200	Model 2200	Model 4200	Model 8200**
Computer System Report No.			511:	512:	513:	514:	516:	518:
DATA STRUCTURE	Word Length	Binary Bits	6+parity+2 punctuation	6+parity+2 punctuation	6+parity+2 punctuation	6+parity+2 punctuation	6+parity+2 punctuation	48+8 parity+16 punctuation
		Decimal Digits	1	1	1	1	1	12
		Characters	1	1	1	1	1	8
	Floating Point Representation	Radix	---	---	Binary	Binary	Binary	Decimal Binary
		Fraction Size	---	---	36 bits	36 bits	36 bits	10 dig. 40 dig.
		Exponent Size	---	---	12 bits	12 bits	12 bits	7 bits 7 bits
CENTRAL PROCESSOR	Model Number		121	201-2	1201	2201	4201	8201
	Arithmetic Radix		Decimal, binary	Decimal, binary	Decimal, binary	Decimal, binary	Decimal, binary	Decimal, binary
	Operand Length, Words		1 to N char	1 to N char	1 to N char	1 to N char	1 to N char	1
	Instruction Length, Words		1 to 10	1 to 12	1 to 12	1 to 12	1 to 12	1
	Addresses per Instruction		2	2	2	2	2	3
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	123	84	63	51	16	2.5
		c = ab	3,100 (s)	480	360	244	92	5.0
		c = a/b	3,700 (s)	1,148	900	600	233	14.0
	Likely Floating Point Execution Times, μsec	c = a + b	---	---	84*	56*	31*	3.9*
		c = ab	---	---	120*	81*	44*	5.0*
		c = a/b	---	---	149*	99*	46*	13.0*
	Checking of Data Transfers		Parity	Parity	Parity	Parity	Parity	Parity
	Program Interrupt Facility		Yes, I/O only	Yes, I/O only	Yes	Yes	Yes	Yes, multi-level
	Number of Index Registers		6*	6* or 15*	15 or 30*	15 or 30*	15 or 30*	64
	Indirect Addressing		Optional	Optional	Yes	Yes	Yes	Yes
	Special Editing Capabilities		Poor; excellent*	Poor; excellent*	Excellent	Excellent	Excellent	None
	Boolean Operations		AND, EXC OR	AND, EXC OR	AND, EXC OR	AND, EXC OR	AND, EXC OR	AND, INC OR, EXC OR
	Table Look-up		None	None	Optional	Optional	Yes	No
	Console Typewriter		Yes	Yes	Yes	Yes	Yes	Yes
	Input-Output Channels		2 or 3*, with 3 to 15 I/O trunks	3 or 4*, with 8 to 16 I/O trunks	4*, with 16 I/O trunks	4 or 8*, with 16 or 32 I/O trunks	8 or 16*, with 32 or 48 I/O trunks	16 or 32*, with 48 or 96 I/O trunks
	Features and Comments		120 Processor includes built-in I/O control	IBM 1401-compatible through software	IBM 1401/1410/ 7010-compatible through software	IBM 1401/1410/ 7010-compatible through software	IBM 1401/1410/ 7010-compatible through software	Program compatible with H-800, H-1800, and Series 200
WORKING STORAGE	Model Number		121	201-2	1201	2201	4201	8201
	Type of Storage		Core	Core	Core	Core	Core	Core
	Number of Words	Minimum	2,048	4,096	8,192	16,384	65,536	16,384
		Maximum	32,768	65,536	131,072	262,144	524,288	131,072
	Maximum Total Storage	Decimal Digits	32,768	65,536	131,072	262,144	524,288	1,572,864
		Characters	32,768	65,536	131,072	262,144	524,288	1,048,576
	Cycle Time, μsec		3.0 per char	2.0 per char	1.5 per char	1.0 per char	0.75 per 4 chars	0.75 per 4 or 8 chars
	Effective Transfer Rate, char/sec.		167,000	250,000	333,000	500,000	1,333,000	8,000,000
	Checking		Parity	Parity	Parity	Parity	Parity	Parity
	Storage Protection		None	None	Yes*	Yes*	Yes*	Yes, using locks & keys
	Features and Comments		48-character control memory (announced 6/65)	48-character control memory has 0.5-μsec cycle	48 or 96-character control memory has 0.5-μsec cycle	48 or 96-character control memory has 0.5-μsec cycle	96-character control memory has 0.3-μsec cycle	Used by 8200 Word and Character Processors

* With optional equipment.
(s) Using subroutine.

** All entries refer to 8200's Word Processor; Model 8200 also contains a Character Processor similar to the Honeywell 4200 Processor.

Honeywell 400	Honeywell 1400	Honeywell 800 and 1800		System Identity		
501:	505:	502: and 503:		Computer System Report No.		
48 + parity	48 + parity	48		Binary Bits	Word Length	DATA STRUCTURE
12 including optional sign	12 including optional sign	12		Decimal Digits	Word Length	DATA STRUCTURE
8	8	8		Characters	Word Length	DATA STRUCTURE
---	Decimal	Decimal	Binary	Radix	Floating Point Representation	DATA STRUCTURE
---	9 digits	10 digits	40 bits + sign	Fraction Size	Floating Point Representation	DATA STRUCTURE
---	2 digits	6 bits + sign	6 bits + sign	Exponent Size	Floating Point Representation	DATA STRUCTURE
401A	1401	801 (H-800)	1801 (H-1800)	Model Number		CENTRAL PROCESSOR
Decimal, binary	Decimal, binary	Decimal, binary		Arithmetic Radix		CENTRAL PROCESSOR
1	1	1		Operand Length, Words		CENTRAL PROCESSOR
1	1	1		Instruction Length, Words		CENTRAL PROCESSOR
3	3	3		Addresses per Instruction		CENTRAL PROCESSOR
114	78	24	8	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
1, 580*	1, 085*	200	67	c = ab	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
2, 140*	1, 470*	272	30	c = a/b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
---	140*	42*	10*	c = a + b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
---	1, 210*	100*	12*	c = ab	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
---	2, 760*	400*	32*	c = a/b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
Parity	Parity	Parity		Checking of Data Transfers		CENTRAL PROCESSOR
Yes	Yes	Yes, limited I/O sensing		Program Interrupt Facility		CENTRAL PROCESSOR
3	3	64		Number of Index Registers		CENTRAL PROCESSOR
None	None	One level		Indirect Addressing		CENTRAL PROCESSOR
Good	Good	None		Special Editing Capabilities		CENTRAL PROCESSOR
AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR		Boolean Operations		CENTRAL PROCESSOR
None	None	No		Table Look-up		CENTRAL PROCESSOR
Yes	Yes	Yes		Console Typewriter		CENTRAL PROCESSOR
1 integrated non-simultaneous channel	1 integrated non-simultaneous channel; buffered I/O units are available	8 input and 8 output		Input-Output Channels		CENTRAL PROCESSOR
Two magnetic tape operations can be performed simultaneously	Program-compatible with Honeywell 400	H-800 and 1800 are program-compatible; each can run up to 8 programs concurrently		Features and Comments		CENTRAL PROCESSOR
402	1402	802 (H-800)	1802 (H-1800)	Model Number		WORKING STORAGE
Core	Core	Core	Core	Type of Storage		WORKING STORAGE
1, 024	4, 096	4, 096	8, 192	Minimum	Number of Words	WORKING STORAGE
4, 096	32, 768	28, 672	65, 536	Maximum	Number of Words	WORKING STORAGE
49, 152	393, 216	345, 144	786, 432	Decimal Digits	Maximum Total Storage	WORKING STORAGE
32, 768	262, 144	229, 376	524, 288	Characters	Maximum Total Storage	WORKING STORAGE
9.25 per 24 bits	6.5 per 24 bits	6	2	Cycle Time, μsec		WORKING STORAGE
210, 000	310, 000	533, 333	1, 600, 000	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity	Parity	Parity	Parity	Checking		WORKING STORAGE
None	None	None		Storage Protection		WORKING STORAGE
		A 256-word control memory is also utilized		Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			IBM SYSTEM/360 Model 20	Model 30	Model 40	Model 50	Model 65	Model 75
Computer System Report No.			422:	423:	424:	425:	426:	428:
DATA STRUCTURE	Word Length	Binary Bits	8 per byte	8 per byte	8 per byte	8 per byte	8 per byte	8 per byte
		Decimal Digits	2 per byte	2 per byte	2 per byte	2 per byte	2 per byte	2 per byte
		Characters	1 per byte	1 per byte	1 per byte	1 per byte	1 per byte	1 per byte
	Floating Point Representation	Radix	---	Binary	Binary	Binary	Binary	Binary
		Fraction Size	---	24 or 56 bits	24 or 56 bits	24 or 56 bits	24 or 56 bits	24 or 56 bits
		Exponent Size	---	7 bits	7 bits	7 bits	7 bits	7 bits
CENTRAL PROCESSOR	Model Number		2020	2030	2040	2050	2060	2070
	Arithmetic Radix		Decimal	Binary (decimal*)	Binary (decimal*)	Binary or decimal	Binary or decimal	Binary or decimal
	Operand Length, Words		Variable	Variable	Variable	Variable	Variable	Variable
	Instruction Length, Words		2,4, or 6 bytes	2,4, or 6 bytes	2,4, or 6 bytes	2,4, or 6 bytes	2,4, or 6 bytes	2,4, or 6 bytes
	Addresses per Instruction		0, 1, or 2	0, 1, or 2	0, 1, or 2	0, 1, or 2	0, 1, or 2	0, 1, or 2
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	658	78 or 96	36 or 63	12 or 34	3.9 or 9.4	2.5 or 8.2
		c = ab	6,286	296 or 395	113 or 177	40 or 66	7.4 or 33	5.3 or 25
		c = a/b	7,175	481 or 767	216 or 349	44 or 72	11 or 48	? or 32
	Likely Floating Point Execution Times, μsec	c = a + b	---	107 or 161*	43 or 62*	14 or 21	4.9 or 5.2	2.6
		c = ab	---	296 or 874*	105 or 294*	29 or 49	6.4 or 10	3.8 or 5.8
		c = a/b	---	481 or 1,717*	157 or 511	30 or 81	9.6 or 16	5.6 or 8.8
	Checking of Data Transfers		Parity	Parity	Parity	Parity	Parity	Parity
	Program Interrupt Facility		Yes, I/O only	Yes, 5 classes	Yes, 5 classes	Yes, 5 classes	Yes, 5 classes	Yes, 5 classes
	Number of Index Registers		8 max.	16 max.	16 max.	16 max.	16 max.	16 max.
	Indirect Addressing		None	None	None	None	None	None
	Special Editing Capabilities		Good	Good	Good	Good	Good	Good
	Boolean Operations		AND, INC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR
	Table Look-up		None	None	None	None	None	None
	Console Typewriter		None	Optional	Optional	Optional	Optional	Optional
	Input-Output Channels		Integrated channels permit sharing of core storage cycles	0 to 2 selector channels; 1 multiplexor channel	0 to 2 selector channels; 1 multiplexor channel	0 to 3 selector channels; 1 multiplexor channel	0 to 6 selector channels; 0 or 1 multiplexor channel	0 to 6 selector channels; 0 or 1 multiplexor channel
	Features and Comments		Restricted System/360 compatibility	These models have a high degree of program compatibility				
WORKING STORAGE	Model Number		2020	2030	2040	2050	2065	2075
	Type of Storage		Core	Core	Core	Core	Core	Core
	Number of Words	Minimum	4,096 bytes	8,192 bytes	16,384 bytes	65,536 bytes	131,072 bytes	262,144 bytes
		Maximum	16,384 bytes	65,536 bytes	262,144 bytes	262,144 bytes	1,048,576 bytes	1,048,576 bytes
	Maximum Total Storage	Decimal Digits	32,768	131,072	524,288	524,288	2,097,152	2,097,152
		Characters	16,384	65,536	262,144	262,144	1,048,576	1,048,576
	Cycle Time, μsec		3.6 per half-byte	1.5 per 1 byte	2.5 per 2 bytes	2.0 per 4 bytes	0.75 per 8 bytes	0.75 per 8 bytes
	Effective Transfer Rate, char/sec.		62,500 max.	321,000 max.	390,000 max.	851,000 max.	4,760,000 max.	5,857,000 max.
	Checking		Parity	Parity	Parity	Parity	Parity	Parity
	Storage Protection		None	Write only*	Write only*	Write only	Read and write	Read and write
	Features and Comments						Interleaving improves sequential access rate	Interleaving improves sequential access rate

* With optional equipment.
(s) Using subroutine.

IBM System/360 Model 44	IBM System/360 Model 67	IBM 1130	System Identity		
435:	427:	418:	Computer System Report No.		
32 + 4 parity	8 per byte	16 + parity	Binary Bits	Word Length	DATA STRUCTURE
9.2	2 per byte	4.3	Decimal Digits	Word Length	DATA STRUCTURE
4	1 per byte	2	Characters	Word Length	DATA STRUCTURE
Binary	Binary	Binary	Radix	Floating Point Representation	DATA STRUCTURE
24, 32, 40, 48 or 56 bits	24 or 56 bits	23 or 31 (s)	Fraction Size	Floating Point Representation	DATA STRUCTURE
7 bits	7 bits	8 (s)	Exponent Size	Floating Point Representation	DATA STRUCTURE
2044	2067	1131	Model Number		CENTRAL PROCESSOR
Binary	Binary, decimal	Binary	Arithmetic Radix		CENTRAL PROCESSOR
1 or 1/2 word	Variable	1 or 2	Operand Length, Words		CENTRAL PROCESSOR
1 or 1/2 word	2, 4 or 6 bytes	1 or 2	Instruction Length, Words		CENTRAL PROCESSOR
2	0, 1 or 2	1	Addresses per Instruction		CENTRAL PROCESSOR
13.0; 7.0*	4.2 or 9.7	23.2	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
26.3; 20.5*	7.7 or 33	44.5	c = ab	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
41.0; 33.8*	12 or 48	98.4	c = a/b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
18.8 or 11.6*	5.4 or 5.5	460 (s)	c = a + b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
73.6 or 21.8*	6.8 or 10.4	560 (s)	c = ab	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
137.5 or 31.0*	10.0 or 16.9	766 (s)	c = a/b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
Parity	Parity	Parity	Checking of Data Transfers		CENTRAL PROCESSOR
Yes, 5 classes	Yes, 5 classes	Yes, I/O only	Program Interrupt Facility		CENTRAL PROCESSOR
16	25 max.	3	Number of Index Registers		CENTRAL PROCESSOR
None	Yes; 8-register associative memory	One level	Indirect Addressing		CENTRAL PROCESSOR
Restricted	Good	None	Special Editing Capabilities		CENTRAL PROCESSOR
AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	Boolean Operations		CENTRAL PROCESSOR
None	None	None	Table Look-up		CENTRAL PROCESSOR
Standard	Optional	Standard	Console Typewriter		CENTRAL PROCESSOR
1 multiplexor channel with 64 subchannels; 1* or 2* high-speed multiplexor channels	1 to 4 Channel Controllers; up to 7 selector or multiplexor channels per controller	1 or 2 are standard, depending on processor model; a 3rd is optional	Input-Output Channels		CENTRAL PROCESSOR
Limited program compatibility with other System/360 models	Special hardware facilitates time-sharing operations	Most instructions can be in either 1-word or 2-word format	Features and Comments		CENTRAL PROCESSOR
2044	2067	1131	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		WORKING STORAGE
8,192 4-byte words	262,144 bytes	4,096	Minimum	Number of Words	WORKING STORAGE
65,536 4-byte words	2,097,152	8,192	Maximum	Number of Words	WORKING STORAGE
524,288	4,194,304	36,800	Decimal Digits	Maximum Total Storage	WORKING STORAGE
262,144	2,097,152	16,384	Characters	Maximum Total Storage	WORKING STORAGE
1.0 per 4-byte word	0.75 per 8 bytes	3.6	Cycle Time, μsec		WORKING STORAGE
121,200 max.	4,760,000 max.	92,500	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity	Parity	Parity	Checking		WORKING STORAGE
Read* and write*	Read and write	None	Storage Protection		WORKING STORAGE
Standard general registers are in extended core storage; High-Speed Registers are optional	1 to 8 independent 262K modules per system	Some processor models include an integral 512,000-word Disk File	Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			IBM 704		IBM 709		IBM 1401
Computer System Report No.			406:		407:		401:
DATA STRUCTURE	Word Length	Binary Bits	36		36		6 + parity + word mark
		Decimal Digits	10.5		10.5		1
		Characters	6		6		1
	Floating Point Representation	Radix	Binary		Binary		Decimal
		Fraction Size	27 bits + sign		27 bits + sign		8 digits (s)
		Exponent Size	8 bits		8 bits		2 digits (s)
CENTRAL PROCESSOR	Model Number		704		709		1401
	Arithmetic Radix		Binary		Binary		Decimal
	Operand Length, Words		1		1		1 to N char
	Instruction Length, Words		1		1		1 to 8 char
	Addresses per Instruction		1		1		2
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	72		72		437
		c = ab	288		238		21, 216(s); 2,280*
		c = a/b	288		288		27, 730(s); 2,784*
	Likely Floating Point Execution Times, μsec	c = a + b	156 ± 24		125		8,800(s)
		c = ab	252		218		8,600 (s)
		c = a/b	264		264		12,700 (s)
	Checking of Data Transfers		None		None		Parity, char validity
	Program Interrupt Facility		Yes, limited		Yes		None
	Number of Index Registers		3		3		3*
	Indirect Addressing		No		One level		None
	Special Editing Capabilities		None		None		Good; excellent*
	Boolean Operations		AND, OR, NOT		AND, INC OR, EXC OR, NOT		None
	Table Look-up		None		None		None
	Console Typewriter		No		No		Optional
	Input-Output Channels		1 integrated simul-taneous channel		1 to 6, plus 2 integrated channels for drum and CRT devices		1 integrated non-simultan-eous channel; buffered printing*
	Features and Comments		No longer in production		No longer in production		Processing Overlap* Feature permits 1 I/O operation while computing
WORKING STORAGE	Model Number		737-1, 737-2	738	737-1, 737-2	738	1401 & 1406
	Type of Storage		Core	Core	Core	Core	Core
	Number of Words	Minimum	4,096	32,768	4,096	32,768	1,400
		Maximum	4,096	32,768	4,096	32,768	16,000
	Maximum Total Storage	Decimal Digits	43,008	344,064	43,008	344,064	16,000
		Characters	24,576	196,608	24,576	196,608	16,000
	Cycle Time, μsec		12	12	12	12	11.5
	Effective Transfer Rate, char/sec.		125,000 max.	125,000 max.	125,000 max.	125,000 max.	43,500
	Checking		None	None	None	None	Parity
	Storage Protection		None		Limited, using ESNT instruction		None
	Features and Comments						

* With optional equipment.
(s) Using subroutine.

IBM 1401-G	IBM 1410	IBM 1440	System Identity		
401:	402:	414:	Computer System Report No.		
6 + parity + word mark	6 + parity + word mark	6 + parity + word mark	Binary Bits	Word Length	DATA STRUCTURE
1	1	1	Decimal Digits	Word Length	DATA STRUCTURE
1	1	1	Characters	Word Length	DATA STRUCTURE
---	Decimal	Decimal	Radix	Floating Point Representation	DATA STRUCTURE
---	8 digits (s)	8 digits (s)	Fraction Size	Floating Point Representation	DATA STRUCTURE
---	2 digits (s)	2 digits (s)	Exponent Size	Floating Point Representation	DATA STRUCTURE
1401-G	1411	1441A	Model Number		CENTRAL PROCESSOR
Decimal	Decimal	Decimal	Arithmetic Radix		CENTRAL PROCESSOR
1 to N char	1 to N char	1 to N char	Operand Length, Words		CENTRAL PROCESSOR
1 to 8 char	1 to 12 char	1 to 8 char	Instruction Length, Words		CENTRAL PROCESSOR
2	2	2	Addresses per Instruction		CENTRAL PROCESSOR
437	226	422	c = a + b	Likely Fixed Point Execution Times, µsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
21, 216 (s)	1, 206	20, 500 (s); 2, 200*	c = ab	Likely Fixed Point Execution Times, µsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
27, 730 (s)	2, 440	26, 800 (s); 2, 690*	c = a/b	Likely Fixed Point Execution Times, µsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
---	3, 999 (s)	8, 500 (s)	c = a + b	Likely Floating Point Execution Times, µsec	CENTRAL PROCESSOR
---	5, 430 (s)	8, 300 (s)	c = ab	Likely Floating Point Execution Times, µsec	CENTRAL PROCESSOR
---	8, 790 (s)	12, 250 (s)	c = a/b	Likely Floating Point Execution Times, µsec	CENTRAL PROCESSOR
Parity, char validity	Parity, char validity	Parity, char validity	Checking of Data Transfers		CENTRAL PROCESSOR
None	Yes, * with priority scheme	Only for 1448 Transmission Control Unit	Program Interrupt Facility		CENTRAL PROCESSOR
None	15	3*	Number of Index Registers		CENTRAL PROCESSOR
None	None	None	Indirect Addressing		CENTRAL PROCESSOR
Good; excellent*	Excellent	Good; excellent*	Special Editing Capabilities		CENTRAL PROCESSOR
None	None	None	Boolean Operations		CENTRAL PROCESSOR
None	Good	None	Table Look-up		CENTRAL PROCESSOR
None	Yes	Optional	Console Typewriter		CENTRAL PROCESSOR
1 integrated non-simultaneous channel	1 integrated non-simultaneous channel is standard; a second is optional, as is Processing Overlap	1 integrated non-simultaneous channel; buffered printing*	Input-Output Channels		CENTRAL PROCESSOR
Program-compatible with IBM 1401, except input-output	Speeds are about 23% higher with Accelerator feature		Features and Comments		CENTRAL PROCESSOR
1401-G	1411	1441A	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		WORKING STORAGE
1, 400	10, 000	2, 000	Minimum	Number of Words	WORKING STORAGE
4, 000	80, 000	16, 000	Maximum	Number of Words	WORKING STORAGE
4, 000	80, 000	16, 000	Decimal Digits	Maximum Total Storage	WORKING STORAGE
4, 000	80, 000	16, 000	Characters	Maximum Total Storage	WORKING STORAGE
11. 5	4. 5; 4. 0*	11. 1	Cycle Time, µsec		WORKING STORAGE
43, 500	111, 000	45, 000	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity	Parity	Parity	Checking		WORKING STORAGE
None	None	None	Storage Protection		WORKING STORAGE
			Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			IBM 1460	IBM 1620 Model 1	IBM 1620 Model 2
Computer System Report No.			415:	412:	413:
DATA STRUCTURE	Word Length	Binary Bits	6 + parity + word mark	4 + parity + flag	4 + parity + flag
		Decimal Digits	1	1	1
		Characters	1	0.5	0.5
	Floating Point Representation	Radix	Decimal	Decimal	Decimal
		Fraction Size	8 digits (s)	2 to 100 digits	2 to 100 digits
		Exponent Size	2 digits (s)	2 digits	2 digits
CENTRAL PROCESSOR	Model Number		1441B	1620 Model 1	1620 Model 2
	Arithmetic Radix		Decimal	Decimal	Decimal
	Operand Length, Words		1 to N char	2 to N digits	2 to N digits
	Instruction Length, Words		1 to 8 char	12 digits	12 digits
	Addresses per Instruction		2	2	2
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	228	920	280
		c = ab	11,100(s); 1,190*	5,320	1,350
		c = a/b	14,500(s); 1,450*	66,900(s); 17,700*	3,638
	Likely Floating Point Execution Times, μsec	c = a + b	4,600(s)	28,500(s); 1,760*	541*
		c = ab	4,500(s)	36,700(s); 13,100*	3,295*
		c = a/b	6,600(s)	88,700(s); 41,700*	8,960*
	Checking of Data Transfers		Parity, char validity	Parity	Parity
	Program Interrupt Facility		Only for 1448 Transmission Control Unit	None	None
	Number of Index Registers		3*	None	None
	Indirect Addressing		None	Yes*	Yes
	Special Editing Capabilities		Good; excellent*	None	None
	Boolean Operations		None	None	None
	Table Look-up		None	None	None
	Console Typewriter		Optional	Yes	Yes
	Input-Output Channels		1 non-simultaneous channel; Processing Overlap and buffered printing*	1 integrated non-simultaneous channel	1 integrated non-simultaneous channel
	Features and Comments		Program-compatible with IBM 1401		
WORKING STORAGE	Model Number		1441B	1620, 1623	1625
	Type of Storage		Core	Core	Core
	Number of Words	Minimum	8,000	20,000	20,000
		Maximum	16,000	60,000	60,000
	Maximum Total Storage	Decimal Digits	16,000	60,000	60,000
		Characters	16,000	30,000	30,000
	Cycle Time, μsec		6.0	20	10
	Effective Transfer Rate, char/sec.		83,300	12,500	33,300
	Checking		Parity	Parity	Parity
	Storage Protection		None	None	None
	Features and Comments			2 digits represent 1 alphameric character	2 digits represent 1 alphameric character

* With optional equipment.
(s) Using subroutine.

IBM 7010	IBM 7040	IBM 7044	System Identity		
416:	410:	411:	Computer System Report No.		
6 + parity + word mark	36 + parity	36 + parity	Binary Bits	Word Length	DATA STRUCTURE
1	10.5	10.5	Decimal Digits		
1	6	6	Characters		
Decimal	Binary	Binary	Radix	Floating Point Representation	
8 digits (s)	27 or 54 bits	27 or 54 bits	Fraction Size		
2 digits (s)	8 bits	8 bits	Exponent Size		
7114	7106	7107	Model Number		CENTRAL PROCESSOR
Decimal	Binary	Binary	Arithmetic Radix		
1 to N char	1	1	Operand Length, Words		
1 to 12 char	1	1	Instruction Length, Words		
2	1	1	Addresses per Instruction		
56	48	12	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	
431	72	32	c = ab		
925	94	48	c = a/b		
1,590 (s)	56*	19*	c = a + b	Likely Floating Point Execution Times, μsec	
2,175 (s)	67*	28*	c = ab		
3,495 (s)	88*	44*	c = a/b		
Parity, char validity	Parity	Parity	Checking of Data Transfers		
Yes, with priority scheme	Yes, with fixed priorities	Yes, with fixed priorities	Program Interrupt Facility		
15	3*	3*	Number of Index Registers		
None	One level	One level	Indirect Addressing		
Excellent	None	None	Special Editing Capabilities		
None	AND, INC OR, EXC OR, NOT	AND, INC OR, EXC OR, NOT	Boolean Operations		
Good	None	None	Table Look-up		
Yes	Octal pushbuttons	Octal pushbuttons	Console Typewriter		
1 channel is standard; a second is optional	0 to 4; most low-speed I/O devices operate in buffered mode	0 to 4; most low-speed I/O devices operate in buffered mode	Input-Output Channels		
Program-compatible with IBM 1410	Can be directly coupled to an IBM 7090 or 7094	Program-compatible with IBM 7040	Features and Comments		
7114	7106	7107	Model Number		WORKING STORAGE
Core	Core	Core	Type of Storage		
40,000	4,096	8,192	Minimum	Number of Words	
100,000	32,768	32,768	Maximum		
100,000	344,064	344,064	Decimal Digits	Maximum Total Storage	
100,000	196,608	196,608	Characters		
2.4 (per 2 characters)	8.0	2.0	Cycle Time, μsec		
356,000	375,000	1,200,000	Effective Transfer Rate, char/sec.		
Parity	Parity	Parity	Checking		
None	Yes*	Yes*	Storage Protection		
		Cycle time was 2.5 μsec prior to April 1, 1964	Features and Comments		

* With optional equipment.
(s) Using subroutine.

System Identity			IBM 7070	IBM 7072	IBM 7074
Computer System Report No.			403:	404:	405:
DATA STRUCTURE	Word Length	Binary Bits	50 + 3 sign	50 + 3 sign	50 + 3 sign
		Decimal Digits	10 + sign	10 + sign	10 + sign
		Characters	5	5	5
	Floating Point Representation	Radix	Decimal	Decimal	Decimal
		Fraction Size	8 digits	8 digits	8 digits
		Exponent Size	2 digits	2 digits	2 digits
CENTRAL PROCESSOR	Model Number		7601	7105	7104
	Arithmetic Radix		Decimal	Decimal	Decimal
	Operand Length, Words		1 to 10 digits	1 to 10 digits	1 to 10 digits
	Instruction Length, Words		1	1	1
	Addresses per Instruction		1	1	1
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	156	36	24
		c = ab	660	84	72
		c = a/b	1,820	115	103
	Likely Floating Point Execution Times, μsec	c = a + b	324*	44	32*
		c = ab	1,150*	84	72*
		c = a/b	2,540*	110	98*
	Checking of Data Transfers		Fixed count	Fixed count	Fixed count
	Program Interrupt Facility		Yes, with priority scheme	Yes, with priority scheme	Yes, with priority scheme
	Number of Index Registers		99	99	99
	Indirect Addressing		None	None	None
	Special Editing Capabilities		Fair	Fair	Fair
	Boolean Operations		None	None	None
	Table Look-up		Excellent	Excellent	Excellent
	Console Typewriter		Yes	Yes	Yes
	Input-Output Channels		0 to 4; most low-speed devices operate in buffered mode	1 or 2; typewriter and card reader are not buffered	0 to 4; most low-speed devices operate in buffered mode
	Features and Comments		Floating point optional; three accumulators	Floating point standard; program-compatible with IBM 7070	Floating point optional; program-compatible with IBM 7070
WORKING STORAGE	Model Number		7301	7301	7301
	Type of Storage		Core	Core	Core
	Number of Words	Minimum	5,000	5,000	5,000
		Maximum	9,990	30,000	30,000
	Maximum Total Storage	Decimal Digits	99,900	300,000	300,000
		Characters	49,950	150,000	150,000
	Cycle Time, μsec		6.0	6.0	4.0
	Effective Transfer Rate, char/sec.		209,000	416,500	625,000
	Checking		Fixed count	Fixed count	Fixed count
	Storage Protection		None	None	None
	Features and Comments				

* With optional equipment.
(s) Using subroutine.

IBM 7080	IBM 7090	IBM 7094		System Identity		
417:	408:	409:		Computer System Report No.		
6 + parity	36	36		Binary Bits	Word Length	DATA STRUCTURE
1	10.5	10.5		Decimal Digits		
1	6	6		Characters		
Decimal	Binary	Binary		Radix	Floating Point Representation	
8 digits (s)	27 bits + sign	27 or 54 bits + sign		Fraction Size		
2 digits (s)	8 bits	8 bits		Exponent Size		
7102 & 7305	7108 & 7109	Model I	Model II	Model Number		CENTRAL PROCESSOR
Decimal	Binary	Binary		Arithmetic Radix		
1 to 255 char	1	1 or 2		Operand Length, Words		
5 char	1	1		Instruction Length, Words		
1	1	1		Addresses per Instruction		
32	13.08	10	7.0	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	
134	34.01	16	9.8	c = ab		
285	39.24	20	14.0	c = a/b		
--	22.67	12	8.4	c = a + b	Likely Floating Point Execution Times, μsec	
--	32.70	16	11.2	c = ab		
--	37.06	22	14.0	c = a/b		
Parity	None	None		Checking of Data Transfers		
Yes	Yes, with priority levels	Yes, with priority levels		Program Interrupt Facility		
None	3	7		Number of Index Registers		
One level	One level	One level		Indirect Addressing		
Good	None	None		Special Editing Capabilities		
None	AND, INC OR, EXC OR, NOT	AND, INC OR, EXC OR, NOT		Boolean Operations		
None	None	None		Table Look-up		
Yes	No	No		Console Typewriter		
0 to 10, 4 of which can be used only by low-speed devices	1 to 5; also a special data communications channel with 32 subchannels	1 to 5; also a special data communications channel with 32 subchannels		Input-Output Channels		
Can operate in IBM 705-compatible mode				Features and Comments		
7302	7302	Model I	Model II	Model Number		WORKING STORAGE
Core	Core	Core		Type of Storage		
80,000	32,768	32,768		Minimum	Number of Words	
160,000	32,768	32,768		Maximum		
160,000	344,064	344,064		Decimal Digits	Maximum Total Storage	
160,000	196,608	196,608		Characters		
2.0	2.18	2.00	1.40	Cycle Time, μsec		
2,500,000 max.	1,380,000 max.	3,000,000 max.	4,300,000 max.	Effective Transfer Rate, char/sec.		
Parity	None	None	None	Checking		
None	Limited, using ESNT instruction	Limited, using ESNT instruction		Storage Protection		
Can access 1, 5 or 10 characters per cycle		Single bank	Dual banks with over-lapped access	Features and Comments		

* With optional equipment.
(s) Using subroutine.

System Identity			LGP-30 (Control Data Corp.)	Monrobot XI	
Computer System Report No.			352:	531:	
DATA STRUCTURE	Word Length	Binary Bits	31 + spacer	32	
		Decimal Digits	9	9	
		Characters	5 6-bit	5 6-bit	
	Floating Point Representation	Radix	Binary (s)	Binary (s)	
		Fraction Size	25 bits & others (s)	24 bits (s)	
		Exponent Size	6 bits & others (s)	8 bits (s)	
CENTRAL PROCESSOR	Model Number		301	Monrobot XI	
	Arithmetic Radix		Binary	Binary	
	Operand Length, Words		1	1	
	Instruction Length, Words		1	0.5	
	Addresses per Instruction		1	1	
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	52,000 avg.	35,100 avg.	
		c = ab	69,000 avg.	58,500 avg.	
		c = a/b	69,000 avg.	323,000 (s)	
	Likely Floating Point Execution Times, μsec	c = a + b	866,000 (s)	443,000 (s)	
		c = ab	716,000 (s)	523,000 (s)	
		c = a/b	749,000 (s)	623,000 (s)	
	Checking of Data Transfers		None	None	
	Program Interrupt Facility		None	None	
	Number of Index Registers		None	None	
	Indirect Addressing		None	None	
	Special Editing Capabilities		None	None	
	Boolean Operations		AND	AND	
	Table Look-up		None	None	
	Console Typewriter		Yes	Yes	
	Input-Output Channels		1 integrated non-simultaneous channel	4 single-character channels standard; 2 additional channels optional	
	Features and Comments		No longer in production		
WORKING STORAGE	Model Number		Part of 301	General	Fast Access
	Type of Storage		Drum	Drum	Drum
	Number of Words	Minimum	4,096	1,017	7
		Maximum	4,096	2,041	7
	Maximum Total Storage	Decimal Digits	36,864	18,369	63
		Characters	20,480	10,205	35
	Cycle Time, μsec		16,667	11,700	730
	Effective Transfer Rate, char/sec.		60	70	---
	Checking		None	None	None
	Storage Protection		Switches prevent writing*	None	None
	Features and Comments				Regenerated loops

* With optional equipment.
(s) Using subroutine.

NCR 315 and 315-100	NCR 315 RMC	PB 250 (Raytheon)	System Identity		
601: and 602:	603:	631:	Computer System Report No.		
12 + parity	12 + parity	22 + parity + guard	Binary Bits	Word Length	DATA STRUCTURE
3	3	6.3	Decimal Digits		
2	2	3 6-bit	Characters		
Decimal	Decimal	Binary (s)	Radix	Floating Point Representation	
11 digits	11 digits	22 bits & others (s)	Fraction Size		
3 digits	3 digits	22 bits & others (s)	Exponent Size		
315-3 thru 315-5, 315-101	315-501	PB 250	Model Number		CENTRAL PROCESSOR
Decimal	Decimal	Binary	Arithmetic Radix		
1 to 8	1 to 8	1 or 2	Operand Length, Words		
2 or 4	2 or 4	1	Instruction Length, Words		
1	1	1	Addresses per Instruction		
144	16.2	9,252 & 4,744 avg.	c = a + b	Likely Fixed Point Execution Times, µsec (5 Digits Min. Precision)	
690	38.2	12,336 & 4,766 avg.	c = ab		
1,602	128.6	12,336 & 4,766 avg.	c = a/b		
1,232 (s)	33.6	19,488 & 7,188 (s)	c = a + b	Likely Floating Point Execution Times, µsec	
3,132 (s)	217.6	19,176 & 6,876 (s)	c = ab		
3,332 (s)	397.6	19,284 & 6,980 (s)	c = a/b		
Parity	Parity	Parity	Checking of Data Transfers		
Yes, I/O only; processor malfunction*	Yes, I/O only; processor malfunction*	None	Program Interrupt Facility		
30	30	1	Number of Index Registers		
None	None	None	Indirect Addressing		
Good	Good	None	Special Editing Capabilities		
None	None	AND, INC OR	Boolean Operations		
Fair	Fair	None	Table Look-up		
Yes	Yes	Yes	Console Typewriter		
1 integrated non-simultaneous channel; optional tape read/write/compute facility	1 integrated non-simultaneous channel; optional tape read/write/compute facility	1 integrated non-simultaneous channel	Input-Output Channels		
Multiply/divide is standard in 315, optional in 315-100	Program compatible with NCR 315 and 315-100	Times are based on 2 different sequence control methods	Features and Comments		
316	316-502, 316-504	Delay Line Memory	Model Number		WORKING STORAGE
Core	Thin film	Nickel delay lines	Type of Storage		
5,000	20,000	2,320	Minimum	Number of Words	
40,000	80,000	15,888	Maximum		
120,000	240,000	100,100	Decimal Digits	Maximum Total Storage	
80,000	160,000	47,664	Characters		
6	0.8	3,072	Cycle Time, µsec		
83,000	1,244,000	247,956	Effective Transfer Rate, char/sec.		
Parity	Parity	Parity	Checking		
None	None	None	Storage Protection		
	Entire working storage is thin-film "Rod Memory"	Access times based on standard 256-word loops	Features and Comments		

* With optional equipment.
(s) Using subroutine.

System Identity			Philco 2000 - 210	Philco 2000 - 211		Philco 2000 - 212	
Computer System Report No.			651:	652:		653:	
DATA STRUCTURE	Word Length	Binary Bits	48	48		48	
		Decimal Digits	14	14		14	
		Characters	8	8		8	
	Floating Point Representation	Radix	Binary	Binary		Binary	
		Fraction Size	35 bits + sign	35 bits + sign		35 bits + sign	
		Exponent Size	12 bits	12 bits		12 bits	
CENTRAL PROCESSOR	Model Number		210	211 with 10 μsec store	211 with 1.5 μsec store	212	
	Arithmetic Radix		Binary	Binary		Binary	
	Operand Length, Words		1	1		1	
	Instruction Length, Words		1/2; 1 for I/O	1/2; 1 for I/O		1/2; 1 for I/O	
	Addresses per Instruction		1	1		1	
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	45.0	45.0	8.0	4.65	
		c = ab	122.2	83.0	48.9	7.60	
		c = a/b	123.3	84.7	50.0	12.90	
	Likely Floating Point Execution Times, μsec	c = a + b	51.9*	46.1*	12.0*	4.65	
		c = ab	99.9*	72.9*	38.8*	7.60	
		c = a/b	103.8*	74.7*	40.6*	15.40	
	Checking of Data Transfers		None	None		Parity	
	Program Interrupt Facility		None	Yes*, flexible		Yes*, flexible	
	Number of Index Registers		8, 16, or 32	8, 16, or 32		8	
	Indirect Addressing		None	None		Yes; recursive	
	Special Editing Capabilities		None	None		None	
	Boolean Operations		AND, INC OR, EXC OR	AND, INC OR, EXC OR		AND, INC OR, EXC OR	
	Table Look-up		None	None		None	
	Console Typewriter		Yes	Yes		Yes	
	Input-Output Channels		1 Input-Output Processor with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel	1 Input-Output Processor with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel		2 Input-Output Processors, each with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel	
	Features and Comments		Can repeat either 1 or 2 indexed instructions			Look-ahead feature; can repeat up to 4 indexed instructions	
WORKING STORAGE	Model Number		2200 Series	2200 Series	2100 Series	2100 Series	2000 Series
	Type of Storage		Core	Core	Core	Core	Core
	Number of Words	Minimum	8,192	8,192	8,192	8,192	16,384
		Maximum	32,768	32,768	32,768	32,768	65,536
	Maximum Total Storage	Decimal Digits	458,752	458,752	458,752	458,752	917,504
		Characters	262,144	262,144	262,144	262,144	524,288
	Cycle Time, μsec		10.0	10.0	1.5	1.5	1.0
	Effective Transfer Rate, char/sec.		380,000	380,000	888,888	5,333,333 max.	
	Checking		None	None	Parity	Parity	
	Storage Protection		None	None		None	
	Features and Comments		Not overlapped	Not overlapped	Overlapped access to each bank	Overlapped access to each bank	

* With optional equipment.
(s) Using subroutine.

NCR 315 and 315-100	NCR 315 RMC	PB 250 (Raytheon)	System Identity		
601: and 602:	603:	631:	Computer System Report No.		
12 + parity	12 + parity	22 + parity + guard	Binary Bits	Word Length	DATA STRUCTURE
3	3	6.3	Decimal Digits	Word Length	DATA STRUCTURE
2	2	3 6-bit	Characters	Word Length	DATA STRUCTURE
Decimal	Decimal	Binary (s)	Radix	Floating Point Representation	DATA STRUCTURE
11 digits	11 digits	22 bits & others (s)	Fraction Size	Floating Point Representation	DATA STRUCTURE
3 digits	3 digits	22 bits & others (s)	Exponent Size	Floating Point Representation	DATA STRUCTURE
315-3 thru 315-5, 315-101	315-501	PB 250	Model Number		CENTRAL PROCESSOR
Decimal	Decimal	Binary	Arithmetic Radix		CENTRAL PROCESSOR
1 to 8	1 to 8	1 or 2	Operand Length, Words		CENTRAL PROCESSOR
2 or 4	2 or 4	1	Instruction Length, Words		CENTRAL PROCESSOR
1	1	1	Addresses per Instruction		CENTRAL PROCESSOR
144	16.2	9, 252 & 4, 744 avg.	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
690	38.2	12, 336 & 4, 766 avg.	c = ab	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
1, 602	128.6	12, 336 & 4, 766 avg.	c = a/b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
1, 232 (s)	33.6	19, 488 & 7, 188 (s)	c = a + b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
3, 132 (s)	217.6	19, 176 & 6, 876 (s)	c = ab	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
3, 332 (s)	397.6	19, 284 & 6, 980 (s)	c = a/b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
Parity	Parity	Parity	Checking of Data Transfers		CENTRAL PROCESSOR
Yes, I/O only; processor malfunction*	Yes, I/O only; processor malfunction*	None	Program Interrupt Facility		CENTRAL PROCESSOR
30	30	1	Number of Index Registers		CENTRAL PROCESSOR
None	None	None	Indirect Addressing		CENTRAL PROCESSOR
Good	Good	None	Special Editing Capabilities		CENTRAL PROCESSOR
None	None	AND, INC OR	Boolean Operations		CENTRAL PROCESSOR
Fair	Fair	None	Table Look-up		CENTRAL PROCESSOR
Yes	Yes	Yes	Console Typewriter		CENTRAL PROCESSOR
1 integrated non-simultaneous channel; optional tape read/write/compute facility	1 integrated non-simultaneous channel; optional tape read/write/compute facility	1 integrated non-simultaneous channel	Input-Output Channels		CENTRAL PROCESSOR
Multiply/divide is standard in 315, optional in 315-100	Program compatible with NCR 315 and 315-100	Times are based on 2 different sequence control methods	Features and Comments		CENTRAL PROCESSOR
316	316-502, 316-504	Delay Line Memory	Model Number		WORKING STORAGE
Core	Thin film	Nickel delay lines	Type of Storage		WORKING STORAGE
5, 000	20, 000	2, 320	Minimum	Number of Words	WORKING STORAGE
40, 000	80, 000	15, 888	Maximum	Number of Words	WORKING STORAGE
120, 000	240, 000	100, 100	Decimal Digits	Maximum Total Storage	WORKING STORAGE
80, 000	160, 000	47, 664	Characters	Maximum Total Storage	WORKING STORAGE
6	0.8	3, 072	Cycle Time, μsec		WORKING STORAGE
83, 000	1, 244, 000	247, 956	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity	Parity	Parity	Checking		WORKING STORAGE
None	None	None	Storage Protection		WORKING STORAGE
	Entire working storage is thin-film "Rod Memory"	Access times based on standard 256-word loops	Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			Philco 2000 - 210	Philco 2000 - 211		Philco 2000 - 212	
Computer System Report No.			651:	652:		653:	
DATA STRUCTURE	Word Length	Binary Bits	48	48		48	
		Decimal Digits	14	14		14	
		Characters	8	8		8	
	Floating Point Representation	Radix	Binary	Binary		Binary	
		Fraction Size	35 bits + sign	35 bits + sign		35 bits + sign	
		Exponent Size	12 bits	12 bits		12 bits	
CENTRAL PROCESSOR	Model Number		210	211 with 10 μsec store	211 with 1.5 μsec store	212	
	Arithmetic Radix		Binary	Binary		Binary	
	Operand Length, Words		1	1		1	
	Instruction Length, Words		1/2; 1 for I/O	1/2; 1 for I/O		1/2; 1 for I/O	
	Addresses per Instruction		1	1		1	
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	45.0	45.0	8.0	4.65	
		c = ab	122.2	83.0	48.9	7.60	
		c = a/b	123.3	84.7	50.0	12.90	
	Likely Floating Point Execution Times, μsec	c = a + b	51.9*	46.1*	12.0*	4.65	
		c = ab	99.9*	72.9*	38.8*	7.60	
		c = a/b	103.8*	74.7*	40.6*	15.40	
	Checking of Data Transfers		None	None		Parity	
	Program Interrupt Facility		None	Yes*, flexible		Yes*, flexible	
	Number of Index Registers		8, 16, or 32	8, 16, or 32		8	
	Indirect Addressing		None	None		Yes; recursive	
	Special Editing Capabilities		None	None		None	
	Boolean Operations		AND, INC OR, EXC OR	AND, INC OR, EXC OR		AND, INC OR, EXC OR	
	Table Look-up		None	None		None	
	Console Typewriter		Yes	Yes		Yes	
	Input-Output Channels		1 Input-Output Processor with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel	1 Input-Output Processor with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel		2 Input-Output Processors, each with 4 subchannels; 1 to 4 UBC channels; and 1 non-simultaneous channel	
	Features and Comments		Can repeat either 1 or 2 indexed instructions			Look-ahead feature; can repeat up to 4 indexed instructions	
WORKING STORAGE	Model Number		2200 Series	2200 Series	2100 Series	2100 Series	2000 Series
	Type of Storage		Core	Core	Core	Core	Core
	Number of Words	Minimum	8,192	8,192	8,192	8,192	16,384
		Maximum	32,768	32,768	32,768	32,768	65,536
	Maximum Total Storage	Decimal Digits	458,752	458,752	458,752	458,752	917,504
		Characters	262,144	262,144	262,144	262,144	524,288
	Cycle Time, μsec		10.0	10.0	1.5	1.5	1.0
	Effective Transfer Rate, char/sec.		380,000	380,000	888,888	5,333,333 max.	
	Checking		None	None	Parity	Parity	
	Storage Protection		None	None		None	
	Features and Comments		Not overlapped	Not overlapped	Overlapped access to each bank	Overlapped access to each bank	

* With optional equipment.
(s) Using subroutine.

RCA Spectra 70						
Spectra 70/15	Spectra 70/25	Spectra 70/35	Spectra 70/45	Spectra 70/55	System Identity	
712:	713:	714:	715:	716:	Computer System Report No.	
8 per byte	8 per byte	8 per byte	8 per byte	8 per byte	Word Length: Binary Bits	DATA STRUCTURE
2 per byte	2 per byte	2 per byte	2 per byte	2 per byte	Word Length: Decimal Digits	
1 per byte	1 per byte	1 per byte	1 per byte	1 per byte	Word Length: Characters	
---	---	Binary	Binary	Binary	Floating Point Representation: Radix	
---	---	24 or 56 bits	24 or 56 bits	24 or 56 bits	Floating Point Representation: Fraction Size	
---	---	7 bits	7 bits	7 bits	Floating Point Representation: Exponent Size	
70/15	70/25	70/35	70/45	70/55	Model Number	CENTRAL PROCESSOR
Binary, decimal	Binary, decimal	Binary, decimal	Binary, decimal	Binary, decimal	Arithmetic Radix	
Variable	Variable	Variable	Variable	Variable	Operand Length, Words	
4 or 6 bytes	2, 4 or 6 bytes	2, 4, or 6 bytes	2, 4, or 6 bytes	2, 4, or 6 bytes	Instruction Length, Words	
0, 1, or 2	0, 1, or 2	0, 1, or 2	0, 1, or 2	0, 1, or 2	Addresses per Instruction	
62	53	51	25	7.8	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision): c = a + b	
? (s)	454	163	82	17.9	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision): c = ab	
? (s)	660	243	111	25.0	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision): c = a/b	
---	---	81 or 116	37 or 53	13.4 or 19.0	Likely Floating Point Execution Times, μsec: c = a + b	
---	---	203 or 536	68 or 212	24.2 or 53.1	Likely Floating Point Execution Times, μsec: c = ab	
---	---	446 or 1282	101 or 305	28.6 or 83.8	Likely Floating Point Execution Times, μsec: c = a/b	
Parity	Parity	Parity	Parity	Parity	Checking of Data Transfers	
Yes, limited	Yes, 4-level	Yes, multi-level	Yes, multi-level	Yes, multi-level	Program Interrupt Facility	
None	15 max.	16 max.	16 max.	16 max.	Number of Index Registers	
None	None	None	None	None	Indirect Addressing	
Fair	Fair	Good	Good	Good	Special Editing Capabilities	
AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	Boolean Operations	
None	None	None	None	None	Table Look-up	
Optional	Optional	Optional	Optional	Optional	Console Typewriter	
1 with 6 sub-channels, 3 of which can operate simultaneously	4 to 8 selector channels; 0 or 1 multiplexor channel	0 to 2 selector channels; 1 multi-plexor channel	0 to 3 selector channels; 1 multi-plexor channel	0 to 6 selector channels; 1 multi-plexor channel	Input-Output Channels	
No multiply or divide instructions	Multiply-divide in decimal radix only	Program compat-ible with IBM System/360; uses integrated circuits	Program compat-ible with IBM System/360; uses integrated circuits	Program compat-ible with IBM System/360; uses integrated circuits	Features and Comments	
70/15	70/25	70/35	70/45	70/55	Model Number	WORKING STORAGE
Core	Core	Core	Core	Core	Type of Storage	
4,096 bytes	16,384 bytes	16,384 bytes	16,384 bytes	65,536 bytes	Number of Words: Minimum	
8,192 bytes	65,536 bytes	65,536 bytes	262,144 bytes	524,288 bytes	Number of Words: Maximum	
16,384	131,072	131,072	524,288	1,048,576	Maximum Total Storage: Decimal Digits	
8,192	65,536	65,536	262,144	524,288	Maximum Total Storage: Characters	
2.0 per 1 byte	1.5 per 4 bytes	1.44 per 2 bytes	1.44 per 2 bytes	0.84 per 4 bytes	Cycle Time, μsec	
250,000	1,333,333	695,000	695,000	1,136,000	Effective Transfer Rate, char/sec.	
Parity	Parity	Parity	Parity	Parity	Checking	
None	None	Write only*	Write only*	Write only*	Storage Protection	
No general-purpose registers	15 general-purpose registers in core storage	16 general-purpose registers in core storage	16 general-purpose registers in fast scratchpad memory	16 general-purpose registers in fast scratchpad memory	Features and Comments	

* With optional equipment.
(s) Using subroutine.

System Identity			RCA 301		RCA 3301		RECOMP II (Autonetics)	
Computer System Report No.			701:		703:		161:	
DATA STRUCTURE	Word Length	Binary Bits	6 + parity		6 + parity		40	
		Decimal Digits	1		1		12	
		Characters	1		1		5 8-bits	
	Floating Point Representation	Radix	Decimal		Decimal		Binary	
		Fraction Size	8 digits		8 digits		39 bits	
		Exponent Size	2 digits		2 digits		39 bits	
CENTRAL PROCESSOR	Model Number		303, 304, 305	354, 355	3303	3304	D4A-AB	
	Arithmetic Radix		Decimal	Decimal	Decimal		Binary	
	Operand Length, Words		1 to 44 char	8 or 1 to 44 char	1 to 44 char		1 or 2	
	Instruction Length, Words		10 char	10 char	10 char		0.5	
	Addresses per Instruction		2	2	2		1	
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	294	166	45	13	36, 540 & 740 avg.	
		c = ab	8,400(s)	434	562	25	43,070 & 14,110 avg.	
		c = a/b	18,000(s)	441	1,650	41	45, 230 & 16,270 avg.	
	Likely Floating Point Execution Times, μsec	c = a + b	35,000(s)	196	---	13	37,970 & 6,550 avg.	
		c = ab	9,200 (s)	476	---	26	44,690 & 15,730 avg.	
		c = a/b	18,800(s)	483	---	41	46,350 & 17,890 avg.	
	Checking of Data Transfers		Parity		Parity		None	
	Program Interrupt Facility		None		Yes, flexible		None	
	Number of Index Registers		3		3		None	
	Indirect Addressing		Yes		Yes; recursive		None	
	Special Editing Capabilities		Fair		Good		None	
	Boolean Operations		AND, INC OR, EXC OR		AND, INC OR, EXC OR		AND	
	Table Look-up		Single char only		None		None	
	Console Typewriter		No input; output optional		Yes		Yes	
	Input-Output Channels		1 integrated non-simultaneous channel; 2 additional simultaneous operations*		2 standard, a 3rd optional; also, 1 Communications Control for up to 160 devices		1 integrated non-simultaneous channel	
	Features and Comments		Models 354 and 355 contain high speed arithmetic circuits		Model 3304 processes 10-character operands very efficiently		Floating Point standard. Automatic decimal-to-binary conversion	
WORKING STORAGE	Model Number		303, 304, 305		3361		Main Memory	Fast Memory
	Type of Storage		Core		Core		Disc	Disc
	Number of Words	Minimum	10,000		40,000		4,080	16
		Maximum	40,000		160,000		4,080	16
	Maximum Total Storage	Decimal Digits	40,000		160,000		48,960	192
		Characters	40,000		160,000		32,640	128
	Cycle Time, μsec		7.0		1.5 or 1.93		17,000	1,080 read 2,160 write
	Effective Transfer Rate, char/sec.		67,600		1,290,000		1,456	---
	Checking		Parity		Parity		None	None
	Storage Protection		None		None		None	None
	Features and Comments		Optional 4.8 μsec memory reduces execution times by 31%		200-character control memory has 0.214 μsec cycle time			Regenerated loops

* With optional equipment.
(s) Using subroutine.

RECOMP III (Autonetics)	RPC-4000 (Control Data Corp.)	UNIVAC SS 80/90 Model I	UNIVAC SS 80/90 Model II	System Identity	
162:	351:	771:	772:	Computer System Report No.	
40	32	41 + parity	44 + parity	Binary Bits — Word Length	DATA STRUCTURE
12	9	10	11	Decimal Digits — Word Length	DATA STRUCTURE
5 8-bit	5 6-bit	10 char. per 2 words	20 char. per 3 words	Characters — Word Length	DATA STRUCTURE
Binary	Binary (s)	---	---	Radix — Floating Point Representation	DATA STRUCTURE
31 bits	32 bits & others (s)	---	---	Fraction Size — Floating Point Representation	DATA STRUCTURE
8 bits	32 bits & others (s)	---	---	Exponent Size — Floating Point Representation	DATA STRUCTURE
D4-F	4010	Model I	Model II	Model Number	CENTRAL PROCESSOR
Binary	Binary	Decimal	Decimal	Arithmetic Radix	CENTRAL PROCESSOR
1	1	1	1	Operand Length, Words	CENTRAL PROCESSOR
0.5	1	1	1	Instruction Length, Words	CENTRAL PROCESSOR
1	1 + 1	1 + 1	1 + 1	Addresses per Instruction	CENTRAL PROCESSOR
36,540 & 6,580 avg.	16,700 avg.	833	136	c = a + b — Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
43,070 & 17,350 avg.	23,400 avg.	1,800	979	c = ab — Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
45,320 & 17,510 avg.	23,400 avg.	1,800	979	c = a/b — Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
37,160 & 7,360 avg. *	165,000 (s)	---	---	c = a + b — Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
43,880 & 18,160 avg. *	145,000 (s)	---	---	c = ab — Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
46,040 & 20,320 avg. *	152,000 (s)	---	---	c = a/b — Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
None	None	Parity	Parity	Checking of Data Transfers	CENTRAL PROCESSOR
None	None	Yes, I/O only	Yes, I/O only	Program Interrupt Facility	CENTRAL PROCESSOR
1	1	3	9	Number of Index Registers	CENTRAL PROCESSOR
None	None	None	None	Indirect Addressing	CENTRAL PROCESSOR
None	None	Zero suppress	Zero suppress	Special Editing Capabilities	CENTRAL PROCESSOR
AND	AND, Masked Merge	AND, INC OR	AND, INC OR	Boolean Operations	CENTRAL PROCESSOR
None	Fair	None	None	Table Look-up	CENTRAL PROCESSOR
Yes	Yes	Numeric only	Numeric only	Console Typewriter	CENTRAL PROCESSOR
1 integrated non-simultaneous channel	1 channel; limited simultaneous operations	1 for tape and drum	2 for tape and drum	Input-Output Channels	CENTRAL PROCESSOR
Floating Point optional		I/O devices other than tape and drum are buffered		Features and Comments	CENTRAL PROCESSOR

RECOMP III Main Memory	RECOMP III Fast Memory	RPC-4000 Main Memory	RPC-4000 Fast Memory	UNIVAC SS 80/90	UNIVAC SS 80/90	UNIVAC SS 80/90	Item	
Main Memory	Fast Memory	Main Memory	Fast Memory				Model Number	WORKING STORAGE
Disc	Disc	Drum	Drum	Drum	Core	Drum	Type of Storage	WORKING STORAGE
4,080	16	8,000	8	2,400	1,280	2,400	Minimum — Number of Words	WORKING STORAGE
4,080	16	8,000	8	9,200	1,280	8,800	Maximum — Number of Words	WORKING STORAGE
48,960	192	72,000	72	92,000	14,080	96,800	Decimal Digits — Maximum Total Storage	WORKING STORAGE
20,400	80	40,000	40	46,000	9,386	64,566	Characters — Maximum Total Storage	WORKING STORAGE
17,000	2,160	16,667	2,080	3,400	17	3,400	Cycle Time, μsec	WORKING STORAGE
910	---	1,200	---	4,600 or 18,500	53,944	Up to 73,000	Effective Transfer Rate, char/sec.	WORKING STORAGE
None	None	None	None	Parity	Parity	Parity	Checking	WORKING STORAGE
None	None	None	None	None	None	None	Storage Protection	WORKING STORAGE
	Regenerated loops	Dual access heads on 2 bands	Regenerated loop				Features and Comments	WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			UNIVAC III	UNIVAC 418		UNIVAC 1004	
Computer System Report No.			774:	790:		770:	
DATA STRUCTURE	Word Length	Binary Bits	25 + 2 check	18 + parity		6	
		Decimal Digits	6	5.3		1	
		Characters	4	3		1	
	Floating Point Representation	Radix	---	---		---	
		Fraction Size	---	---		---	
		Exponent Size	---	---		---	
CENTRAL PROCESSOR	Model Number		4121	418 Mod I	418 Mod II	1004 I	1004II, 1004 III
	Arithmetic Radix		Decimal	Binary	Binary	Decimal	
	Operand Length, Words		1 to 4	1	1	1 to N char	
	Instruction Length, Words		1	1	1	Plugboard wired	
	Addresses per Instruction		1	1	1	2	
	Likely Fixed Point Execution Times, µsec (5 Digits Min. Precision)	c = a + b	24	24	12	224	182
		c = ab	92 to 140	54	27	3,800(s)	3,100(s)
		c = a/b	88 to 164	72	36	7,100(s)	6,000(s)
	Likely Floating Point Execution Times, µsec	c = a + b	---	561(s)	280(s)	---	
		c = ab	---	775(s)	387(s)	---	
		c = a/b	---	795(s)	397(s)	---	
	Checking of Data Transfers		Modulo 3 check	Parity	Parity	None	
	Program Interrupt Facility		Yes, with priority scheme	Yes, with priority scheme		None	
	Number of Index Registers		15	8	8	None	
	Indirect Addressing		Yes; recursive	None	None	None	
	Special Editing Capabilities		None	None	None	Good	
	Boolean Operations		AND, INC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	INC OR	
	Table Look-up		None	None	None	None	
	Console Typewriter		Yes	Optional	Optional	None	
	Input-Output Channels		13, 5 of which are reserved for magnetic tape operations	8, 12, or 16		1 integrated channel permits some I/O overlapping	
	Features and Comments		Four accumulators	Models I and II are program-compatible; primarily for real-time applications		Programmed by plugboard wiring	
WORKING STORAGE	Model Number		4122	418 Mod I	418 Mod II	1004 I	1004 II, 1004 III
	Type of Storage		Core	Core	Core	Core	
	Number of Words	Minimum	8,192	4,096	4,096	961	
		Maximum	32,768	16,384	65,536	1,922	
	Maximum Total Storage	Decimal Digits	196,608	86,835	347,340	1,922	
		Characters	131,072	49,152	196,608	1,922	
	Cycle Time, µsec		4.0	4.0	2.0	8.0	6.5
	Effective Transfer Rate, char/sec.		400,000	62,500	125,000	62,400	76,700
	Checking		Modulo 3 check	Parity	Parity	None	
	Storage Protection		None	None	None	None	
	Features and Comments					Core storage is used only for data	

* With optional equipment.
(s) Using subroutine.

UNIVAC 1050		UNIVAC 490 Series			System Identity		
		UNIVAC 490	UNIVAC 491/492	UNIVAC 494			
777:		801:	802:	804:	Computer System Report No.		
6 + parity		30	30	30 + parity	Binary Bits	Word Length	DATA STRUCTURE
1		8.7	8.7	8.7	Decimal Digits	Word Length	DATA STRUCTURE
1		5	5	5	Characters	Word Length	DATA STRUCTURE
---		---	---	Binary	Radix	Floating Point Representation	DATA STRUCTURE
---		---	---	48 bits + sign	Fraction Size	Floating Point Representation	DATA STRUCTURE
---		---	---	11 bits	Exponent Size	Floating Point Representation	DATA STRUCTURE
Model III Processor	Model IV Processor	8188 thru 8199	8187-88 thru 8187-99	3012-99	Model Number		CENTRAL PROCESSOR
Decimal		Binary	Binary	Binary	Arithmetic Radix		CENTRAL PROCESSOR
1 to 16 char		1	1	1 or 2	Operand Length, Words		CENTRAL PROCESSOR
5 char		1	1	1	Instruction Length, Words		CENTRAL PROCESSOR
1		1	1	1	Addresses per Instruction		CENTRAL PROCESSOR
337	94	36; 29*	9.6	2.3	c = a + b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
1,566*	563*	85; 68*	29.8 to 68.2	8.7	c = ab	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
2,912*	753*	110; 88*	69.1	8.7	c = a/b	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	CENTRAL PROCESSOR
---		---	---	9.6	c = a + b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
---		---	---	18.1	c = ab	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
---		---	---	18.4	c = a/b	Likely Floating Point Execution Times, μsec	CENTRAL PROCESSOR
Parity		None	None	None	Checking of Data Transfers		CENTRAL PROCESSOR
Yes, 3 priority levels		Yes, multi-level	Yes, multi-level	Yes, multi-level	Program Interrupt Facility		CENTRAL PROCESSOR
7		7	7	7	Number of Index Registers		CENTRAL PROCESSOR
None		None	None	None	Indirect Addressing		CENTRAL PROCESSOR
Excellent		None	None	None	Special Editing Capabilities		CENTRAL PROCESSOR
AND, INC OR		AND, INC OR, EXC OR	AND, INC OR, EXC OR	AND, INC OR, EXC OR	Boolean Operations		CENTRAL PROCESSOR
None		Good, via repeat mode	Good, via repeat mode	Good, via repeat mode	Table Look-up		CENTRAL PROCESSOR
Optional		Yes	Yes	Yes	Console Typewriter		CENTRAL PROCESSOR
3 to 8 fixed-purpose	3 to 8 general-purpose	8 or 14	491 has 8; 492 has 14	12, 16, 20, or 24 general-purpose channels	Input-Output Channels		CENTRAL PROCESSOR
Model III and IV Processors are program-compatible			Difference in number of I/O channels distinguishes 491 from 492		Features and Comments		CENTRAL PROCESSOR
Model III Processor	Model IV Processor	8188 thru 8199	8187-88 thru 8187-99	7005-95 thru 7005-99	Model Number		WORKING STORAGE
Core	Core	Core	Core	Core	Type of Storage		WORKING STORAGE
4,096	8,192	16,384	16,384	16,384	Minimum	Number of Words	WORKING STORAGE
32,768	65,536	32,768	65,536	131,072	Maximum	Number of Words	WORKING STORAGE
32,768	65,536	245,760	491,520	983,040	Decimal Digits	Maximum Total Storage	WORKING STORAGE
32,768	65,536	163,840	327,680	655,360	Characters	Maximum Total Storage	WORKING STORAGE
4.5	2.0 per 2 characters	6.0	4.8	0.750	Cycle Time, μsec		WORKING STORAGE
222,000	1,000,000 max.	415,000	520,000	2,222,000	Effective Transfer Rate, char/sec.		WORKING STORAGE
Parity		None	None	Parity check	Checking		WORKING STORAGE
Only by software		None	Yes, in 1,024-word blocks	Yes, in 64-word blocks	Storage Protection		WORKING STORAGE
		Accelerator feature reduces cycle time to 4.8 μsec			Features and Comments		WORKING STORAGE

* With optional equipment.
(s) Using subroutine.

System Identity			UNIVAC 1107		UNIVAC 1108	UNIVAC 9000 Series: UNIVAC 9200 & 9300	
Computer System Report No.			784:		785:	810:	
DATA STRUCTURE	Word Length	Binary Bits	36		36 bits + 2 parity bits	8 per byte	
		Decimal Digits	10.5		10.5	2 per byte	
		Characters	6		6	1 per byte	
	Floating Point Representation	Radix	Binary		Binary	---	
		Fraction Size	27 bits + sign		27 or 60 bits + sign	---	
		Exponent Size	8 bits		8 or 11 bits	---	
CENTRAL PROCESSOR	Model Number		Type 7200		3011-99	9200	9300
	Arithmetic Radix		Binary		Binary	Decimal	
	Operand Length, Words		1		1 or 2	1 to 31 digits + sign	
	Instruction Length, Words		1		1	4 or 6 bytes	
	Addresses per Instruction		1		1	0,1, or 2	
	Likely Fixed Point Execution Times, μsec (5 Digits Min. Precision)	c = a + b	12.0		2.3	187.2	93.6
		c = ab	20.0		3.9	?	?
		c = a/b	39.3		11.6	?	?
	Likely Floating Point Execution Times, μsec	c = a + b	22.0		3.3	---	---
		c = ab	21.3		4.1	---	---
		c = a/b	34.7		9.8	---	---
	Checking of Data Transfers		None		None	Parity	Parity
	Program Interrupt Facility		Yes, multi-level		Yes, multi-level	Yes, I/O & processor errors	
	Number of Index Registers		15		15	8	8
	Indirect Addressing		Yes; recursive		Yes; recursive	None	None
	Special Editing Capabilities		None		None	Good*	Good
	Boolean Operations		AND, INC OR, EXC OR		AND, INC OR, EXC OR	AND,OR	AND, OR
	Table Look-up		Good		Good	None	None
	Console Typewriter		Yes		Yes	None	None
	Input-Output Channels		16, 1 of which is reserved for the system console device		Up to 5 1108 Processors and I/O Controllers in an 1108-II; up to 16 I/O channels in each Processor and I/O Controller	Integrated controls for simultaneous operation of basic card reader, punch, and printer; 1 8-way multiplexor channel*	
	Features and Comments		16 arithmetic registers; partial word capabilities		A single-processor 1108 can contain 8, 12, or 16 I/O channels	Multiply, divide, and edit instructions are optional features with the 9200 Processor	
WORKING STORAGE	Model Number		7230-7234	7200	7005	9200	9300
	Type of Storage		Core	Thin-film	Core	Plated-wire	Plated-wire
	Number of Words	Minimum	16,384	128	65,536	8,192 bytes	8,192 bytes
		Maximum	65,536	128	262,144	16,384 bytes	32,768 bytes
	Maximum Total Storage	Decimal Digits	688,128	1,344	2,752,512	32,768	65,536
		Characters	393,216	768	1,572,864	16,384	32,768
	Cycle Time, μsec		4.0	0.667	0.75	1.2/byte	0.60/byte
	Effective Transfer Rate, char/sec.		750,000	750,000	4,000,000	60,000	120,000
	Checking		None	None	Parity check on each half-word	Parity	Parity
	Storage Protection		Yes, write only	Yes, write only	Read and write, in 512 word blocks	None	None
	Features and Comments		Overlapped access to each bank	Used for index, arithmetic, and I/O registers	Up to 8 independent memory modules	Data structure and most instructions are IBM System/360-compatible	

* With optional equipment.
(s) Using subroutine.

HARDWARE CHARACTERISTICS COMPARISON CHARTS
AUXILIARY STORAGE AND MAGNETIC TAPE

System Identity			Burroughs B 100/200 Series 10-µsec Processor	Burroughs B 200 Series 6-µsec Processor	Burroughs B 300
Computer System Report No.			201:	201:	201:
AUXILIARY STORAGE	Model Number			B 475	B 475
	Type of Storage			Discs	Discs
	Maximum Number	Units On-Line		10	10
		Read/Write Operations		1	1
		Seek Operations		0	0
	Number of Words per Unit	Minimum		9,600,000	9,600,000
		Maximum		48,000,000	48,000,000
	Maximum Total Storage	Decimal Digits		480,000,000	720,000,000
		Characters		480,000,000	480,000,000
	Waiting Time, msec.	Minimum		0	0
		Average (Random)		20	20
		Maximum		40	40
	Effective Transfer Rate, char/sec.			62,000	62,000
	Transfer Load Size, char.			1 to 19,200 by 96,240, or 480	1 to 19,200 by 96, 240, or 480
	Checking			Multiple character check	Multiple character check
	Features and Comments		No auxiliary storage is available for these processor models.		Optional Data Compress instruction permits packing of decimal digits.

MAGNETIC TAPE	Model Number		B 421	B 423	B 422	B 424	B 425
	Maximum Number of Units	On-Line	6	6	6	6	6
		Reading/Writing	1	1	1	1	1
		Searching	1	1	1	1	1
		Rewinding	6	6	6	6	6
	Demands on Processor, %	Reading/Writing	100	100	100	100	100
		Starting/Stopping	100/0	100/0	100/0	100/0	100/0
	Transfer Rate, Kilo-char/sec.	Peak	50.0	24.0	66.0	66.0	72.0
		1,000-char blocks	29.6	19.0	38.5	39.8	41.9
		100-char blocks	6.3	6.6	8.0	8.7	8.8
	Data Tracks		6	6	6	6	6
	Data Rows per Block		Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch		200, 556	200	200, 556	800	200, 556, 800
	IBM 729 Compatible		Yes	Yes	Yes	Yes	Yes
	Checking	Reading	Track and row parity	Track and row parity	Track and row parity	Track and row parity	Track and row parity
		Writing	Read after write	Read after write	Read after write	Read after write	Read after write
	Features and Comments		A maximum of 4 tape units can be attached to a B 100 Series processor		B 200 Series 6-µsec processor can also use B 421 and B 423 tape units		B 300 Processor can utilize all B 400 Series tape units.

*With optional equipment.

Burroughs B 2500 & B 3500		Burroughs B 5500		System Identity	
210:		203:		Computer System Report No.	
9370	9372	B 430	B 475	Model Number	AUXILIARY STORAGE
Disc	Disc	Drum	Discs	Type of Storage	
2/channel	25/channel	2	100	Units On-Line	Maximum Number
1/channel	1/channel	2	2	Read/Write Operations	
2/channel	5/channel	2	2	Seek Operations	
1,000,000	10,000,000	32,768	1,200,000	Minimum	Number of Words per Unit
2,000,000	10,000,000	32,768	6,000,000	Maximum	
8 x 10^6/ch.	500 x 10^6/ch,	917,504	1,680 x 10^6	Decimal Digits	Maximum Total Storage
4 x 10^6/ch.	250 x 10^6/ch.	524,288	960 x 10^6	Characters	
0	0	0	0	Minimum	Waiting Time, msec.
17	20	8.3	20	Average (Random)	
34	40	16.7	40	Maximum	
286,000	200,000	122,880	80,000	Effective Transfer Rate, char/sec.	
100	100	8 to 8,124	240 to 15,120	Transfer Load Size, char.	
Parity	Parity	Parity	Multiple char.	Checking	
Fixed heads, one per track	Fixed heads, one per track		Fixed heads, one per track	Features and Comments	

9381	9382	9390	9391	9392	9393	B 422	B 423	B 424	B 425	Model Number	MAGNETIC TAPE
4 per channel		10 per channel				16	16	16	16	On-Line	Maximum Number of Units
1 per channel		1 per channel				4	4	4	4	Reading/Writing	
0		0				0	0	0	0	Searching	
4 per channel		10 per channel				16	16	16	16	Rewinding	
Varies		Varies				0 to 3.3	0 to 3.2	0 to 3.3	0 to 3.6	Reading/Writing	Demands on Processor, %
Varies		Varies				0	0	0	0	Starting/Stopping	
36.0	72.0	50.0	72.0	72.0	144.0	66.0	24.0	66.0	72.0	Peak	Transfer Rate, Kilo-char/sec.
24.0	30.2	35.5	44.6	49.0	73.4	64.4	63.5	64.4	68.9	1,000-char blocks	
6.5	7.2	9.5	10.1	12.2	13.0	14.8	32.3	14.8	18.0	100-char blocks	
8; 6*	8; 6*	6	6	8	8	6				Data Tracks	
Variable		Variable				Variable				Data Rows per Block	
200, 800	200 or 800, 1600	200, 556	200, 556, 800	200, 800	200, 800, 1600	220, 556	200	800	200, 556, 800	Data Rows per Inch	
Yes*	Yes*	Yes	Yes	No	No	Yes				IBM 729 Compatible	
Track and row parity		Track and row parity				Track and row parity				Reading	Checking
Read after write		Read after write				Read after write				Writing	
Can read backward; optional 7-channel recording		Can read backward				Can read backward				Features and Comments	

*With optional equipment.

System Identity			CDC 160 & 160-A		CDC 1604			CDC 1604-A
Computer System Report No.			242: & 244:		241:			243:
AUXILIARY STORAGE	Model Number		8951		818			818
	Type of Storage		Drum		Discs			Discs
	Maximum Number	Units On-Line	1		28			28
		Read/Write Operations	1		1			6
		Seek Operations	1		6			6
	Number of Words per Unit	Minimum	32,864		4,194,304			4,194,304
		Maximum	32,864		4,194,304			4,194,304
	Maximum Total Storage	Decimal Digits	108,400		938 x 10^6			938 x 10^6
		Characters	65,728		938 x 10^6			938 x 10^6
	Waiting Time, msec.	Minimum			0			0
		Average (Random)			146			146
		Maximum			226			226
	Effective Transfer Rate, char/sec.		64,000 max		98,000 max			98,000 max
	Transfer Load Size, char.				8 to 32,768			8 to 32,768
	Checking				Check characters			Check characters
	Features and Comments				Individually positionable access arm serves each disc			Individually positionable access arm serves each disc
MAGNETIC TAPE	Model Number		603	606	CDC 1607	IBM 729 II	IBM 729 IV	CDC 606
	Maximum Number of Units	On-Line	8	8	24	24	24	48
		Reading/Writing	1 (2* in 160-A)	1 (2* in 160-A)	6	2	2	6
		Searching	0	0	0	0	0	0
		Rewinding	8	8	24	24	24	48
	Demands on Processor, %	Reading/Writing	100 (80* in 160-A)	100 (83* in 160-A)	5.4	7.8 max	11.3 max	3.3 max
		Starting/Stopping			0	0	0	0
	Transfer Rate, Kilo-char/sec.	Peak	41.7	83.4	30.0	41.7	62.5	83.4
		1,000-char blocks	24.7	49.0	27.4	27.3	40.3	49.0
		100-char blocks	5.4	10.4	10.2	6.7	9.6	10.4
	Data Tracks		6	6	6	6	6	6
	Data Rows per Block		Variable	Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch		200, 556	200, 556	200	200, 556	200, 556	200, 556
	IBM 729 Compatible		Yes	Yes	Yes	Yes	Yes	Yes
	Checking	Reading	Track & row parity		Row parity	Row parity		Row parity
		Writing	Read after write		Row parity	Read after write		Read after write
	Features and Comments							

*With optional equipment.

CDC 3100/3200/3300	CDC 3400	CDC 3600	System Identity		
245:	246:	247:	Computer System Report No.		
828	828		Model Number		AUXILIARY STORAGE
Discs	Discs		Type of Storage		
4	16		Units On-Line	Maximum Number	
2	4		Read/Write Operations		
2	8		Seek Operations		
8.5×10^6	4.25×10^6		Minimum	Number of Words per Unit	
8.5×10^6	4.25×10^6		Maximum		
132×10^6	528×10^6		Decimal Digits	Maximum Total Storage	
132×10^6	528×10^6		Characters		
0	0		Minimum	Waiting Time, msec.	
236	236		Average (Random)		
369	369		Maximum		
98, 000 max	98, 000 max		Effective Transfer Rate, char/sec.		
256 to 131, 072	256 to 262, 144		Transfer Load Size, char.		
Parity	Parity		Checking		
Dual-channel controllers are standard	Dual-channel controllers are standard		Features and Comments		

CDC 3100/3200/3300		CDC 3400		CDC 3600			
604	607	604	607	CDC 606	Model Number		MAGNETIC TAPE
128	128	512	512	256	On-Line	Maximum Number of Units	
8	8	4	4	16	Reading/Writing		
0	0	0	0	0	Searching		
128	128	512	512	256	Rewinding		
7.6 max	15 max	4.5	8.9	1.5	Reading/Writing	Demands on Processor, %	
0	0	0	0	0	Starting/Stopping		
60.0	120.0	60.0	120.0	83.4	Peak	Transfer Rate, Kilo-char/sec.	
36.0	64.0	36.0	64.0	49.0	1,000-char blocks		
6.8	12.4	6.8	12.4	10.4	100-char blocks		
6		6		6	Data Tracks		
Variable		Variable		Variable	Data Rows per Block		
200, 556, 800		200, 556, 800		200, 556	Data Rows per Inch		
Yes		Yes		Yes	IBM 729 Compatible		
Track & row parity		Track & row parity		Track & row parity	Reading	Checking	
Read after write		Read after write		Read after write	Writing		
2, 3, and 4-channel controllers available		1, 2, 3, and 4-channel controllers available			Features and Comments		

*With optional equipment.

System Identity		Control Data 6000 Series						
Computer System Report No.		260:						
AUXILIARY STORAGE	Model Number	6400/6600 Extended Core Storage	6800 Extended Core Storage	6603	6607/6608	852	853	854
	Type of Storage	Core	Core	Disc	Disc	Disc	Disc	Disc
Maximum Number	Units On-Line	1, 2, 8, or 16 modules	4 or 8 modules	8	8	8	8	8
	Read/Write Operations	1	1	1/ch	1/ch	1/ch	1/ch	1/ch
	Seek Operations	-	-	1/ch	1/ch	1/ch	1/ch	1/ch
Number of Words per Unit	Minimum	131, 072	524, 288	8×10^6	42, 000	1.49×10^6	2.048×10^6	4.086×10^6
	Maximum	2, 097, 152	1, 048, 576	8×10^6	84, 000	1.49×10^6	2.048×10^6	4.086×10^6
Maximum Total Storage	Decimal Digits	37, 028, 736	37, 028, 736	144×10^6	294, 000	5.21×10^6	7.168×10^6	14.3×10^6
	Characters	20, 571, 520	10, 485, 760	80×10^6	168, 000	23.860×10^6	32.768×10^6	65.536×10^6
Waiting Time, msec.	Minimum	.0032	.0016	0	0	0	0	0
	Average (Random)	.0032	.0016	153	23.3	77.5	70	70
	Maximum	.0032	.0016	186	152.5	185	170	170
	Effective Transfer Rate, char/sec.	80×10^6 to 100×10^6	320×10^6 to 400×10^6	2 to 1, 195, 297	1, 666, 666	69, 840	193, 750	193, 750
	Transfer Load Size, char.	10 to 1, 200, 000	10 to 1, 310, 00	2 to 88, 376	5, 120 to 81, 912	2 to 20, 000	2 to 40, 960	2 to 40, 960
	Checking	None	None	Parity	Parity	Parity	Parity	Parity
	Features and Comments					Compatible with IBM 1311		

MAGNETIC TAPE		600 Series 7-Track					600 Series 9-Track			626 14-Track
	Model Number	601	603	604	606	607	692	694	696	
Maximum Number of Units	On-Line	6/ch	6/ch	6/ch	6/ch	6/ch	8/ch	8/ch	8/ch	8/ch
	Reading/Writing	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch
	Searching	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch	1/ch
	Rewinding	All	All	All	All	All	All	All	All	All
Demands on Processor, %	Reading/Writing	0	0	0	0	0	0	0	0	0
	Starting/Stopping	0	0	0	0	0	0	0	0	0
Transfer Rate, Kilo-char/sec.	Peak	20.85	47.7	60.0	83.4	120.0	30.0	60.0	90.0	240.0
	1,000-char blocks	14.8	29.6	37.2	59.2	74.4	20.4	40.8	61.2	10.8
	100-char blocks	3.9	7.9	8.4	15.8	16.8	5.1	10.2	15.3	18.24
	Data Tracks	7	7	7	7	7	9	9	9	14
	Data Rows per Block	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch	200, 556	200, 556	200, 556, 800	200, 556	200, 556, 800	800			800
	IBM 729 Compatible	Yes					Yes			No
Checking	Reading	Track and row parity					Track, row, & cyclic parity			Parity
	Writing	Read after write					Read after write			Read after write
	Features and Comments									

*With optional equipment.

GE-215	GE-225	GE-235	System Identity		
320:	321:	323:	Computer System Report No.		
M640A	M640A	M640A	Model Number		AUXILIARY STORAGE
Discs	Discs	Discs	Type of Storage		
4	32	28	Units On-Line	Maximum Number	
1	1	1	Read/Write Operations		
4	32	28	Seek Operations		
6,290,000	6,290,000	6,290,000	Minimum	Number of Words per Unit	
6,290,000	6,290,000	6,290,000	Maximum		
138.4×10^6	$1,107 \times 10^6$	968×10^6	Decimal Digits	Maximum Total Storage	
75.5×10^6	604×10^6	528×10^6	Characters		
0	0	0	Minimum	Waiting Time, msec.	
225	225	225	Average (Random)		
357	357	357	Maximum		
60,000	60,000	60,000	Effective Transfer Rate, char/sec.		
192 to 3,072 by 192	192 to 3,072 by 192	192 to 3,072 by 192	Transfer Load Size, char.		
Parity	Parity	Parity	Checking		
Programmed error correction is possible	Programmed error correction is possible	Programmed error correction is possible	Features and Comments		

GE-215	GE-225		GE-235				
MTH680	MTH680	MTH690	MTH680	MTH690	Model Number		MAGNETIC TAPE
8	64	64	56	56	On-Line	Maximum Number of Units	
1	8	2	7	4	Reading/Writing		
0	0	0	0	0	Searching		
8	64	64	56	56	Rewinding		
18	9	25	3	8.3	Reading/Writing	Demands on Processor, %	
0	0	0	0	0	Starting/Stopping		
15.0	15.0	41.6	15.0	41.6	Peak	Transfer Rate, Kilo-char/sec.	
12.7	12.7	29.0	12.7	29.0	1,000-char blocks		
5.3	5.3	6.9	5.3	6.9	100-char blocks		
6	6	6	6	6	Data Tracks		
Variable	Variable	Variable	Variable	Variable	Data Rows per Block		
200	200	200, 556	200	200, 556	Data Rows per Inch		
Yes	Yes		Yes		IBM 729 Compatible		
Track & row parity	Track & row parity		Track & row parity		Reading	Checking	
Read after write	Read after write		Read after write		Writing		
Can read backward	Can read backward		Can read backward		Features and Comments		

*With optional equipment.

System Identity			GE 400†Series				GE 600 Series	
Computer System Report No.			330:				340:	
AUXILIARY STORAGE	Model Number		DS-15	DS-20	DS-25	MS-40	DS-20	MDS-200
	Type of Storage		Discs	Discs	Discs	Mag. strips	Discs	Drum
	Maximum Number	Units On-Line	8/channel	4/channel	4/channel	8/channel	4/channel	1/channel
		Read/Write Operations	1/channel	1/channel	1/channel	1/channel	1/channel	1/channel
		Seek Operations	8/channel	4/channel	64/channel	8/channel	1/unit	1/unit
	Number of Words per Unit	Minimum	2.0×10^6	1.5×10^6	25.2×10^6	13.3×10^6	983,000	768,432
		Maximum	2.0×10^6	5.9×10^6	50.3×10^6	133×10^6	3,925,000	768,432
	Maximum Total Storage	Decimal Digits	62.9×10^6/ch	94×10^6/ch	805×10^6/ch	$4{,}262 \times 10^6$/ch	94×10^6/ch.	7.90×10^6/ch.
		Characters	62.9×10^6/ch	94×10^6/ch	805×10^6/ch	$4{,}262 \times 10^6$/ch	94×10^6/ch.	4.55×10^6/ch.
	Waiting Time, msec.	Minimum	0	0	0	0	0	0
		Average (Random)	95	225	116	550	225	17.0
		Maximum	150	357	172	600	357	33.4
	Effective Transfer Rate, char/sec.		190,600	50,000	195,500	43,700	69,500	300,000
	Transfer Load Size, char.		1 to 98,304	240 to 7,680	1 to 98,304	1 to 53,280	240 to 7,680	1 to 262,144
	Checking		Check char	Parity, check char	check char	Cyclic check code	Parity, check character	Parity
	Features and Comments		Uses changeable disc cartridges	Optical Fast Access feature uses fixed access arms	16 independent access arms in each unit	IBM 2321 Data Cell Drive uses changeable "data cells"	Optional fast access feature uses fixed access arms	An adaptation of the UNIVAC FH-880 Drum
MAGNETIC TAPE	Model Number		MT Series (7-track)		MT Series (9-track)		MT Series (7-track)	MT Series (9-track)
	Maximum Number of Units	On-Line	8/channel		8/channel		16/channel	16/channel
		Reading/Writing	1/channel		1/channel		1/channel	1/channel
		Searching	0		0		0	0
		Rewinding	all		all		all	all
	Demands on Processor, %	Reading/Writing	3.5 to 23.2		4.8 to 31.0		0.35 to 4.0	0.47 to 5.4
		Starting/Stopping	0		0		0	0
	Transfer Rate, Kilo-char/sec.	Peak	20.9 to 120		28 to 160		26.9 to 120	28 to 160
		1,000-char blocks	14.6 to 73.5		17.7 to 86.6		14.5 to 70	17.7 to 86.5
		100-char blocks	3.9 to 16.3		4.1 to 16.8		3.9 to 14.7	4.1 to 16.8
	Data Tracks		6		8		6	8
	Data Rows per Block		Variable		Variable		Variable	Variable
	Data Rows per Inch		200, 556 or 200, 556, 800		200, 556 or 200, 556, 800		200, 556 or 200, 556, 800	200, 556 or 200, 556, 800
	IBM 729 Compatible		Yes		No		Yes	No
	Checking	Reading	Track and row parity		3-way parity		Track & row parity	Track & row parity
		Writing	Read after write		Read after write		Read after write	Read after write
	Features and Comments		6 models, varying in tape speeds and densities		6 models, varying in tape speeds and densities; compatible with IBM 2400 Series Tape units		6 models, varying in tape speed and densities	6 models, varying in tape speed and densities

*With optional equipment.

GE-115	Honeywell Series 200		Honeywell 400 & 1400			System Identity		
310:	510:		501: & 505:			Computer System Report No.		
DS-12	251, 252, 253	270	460			Model Number		AUXILIARY STORAGE
Disc	Mag. strips	Drum	Discs			Type of Storage		AUXILIARY STORAGE
6/controller	8 per pair of trunks	8 per pair of trunks	1			Units On-Line	Maximum Number	AUXILIARY STORAGE
1	1/channel	1/channel	1			Read/Write Operations	Maximum Number	AUXILIARY STORAGE
	1/transport	0	1			Seek Operations	Maximum Number	AUXILIARY STORAGE
590, 000/surface	15.8 x 10^6 char	2.6 x 10^6 char	1, 572, 864			Minimum	Number of Words per Unit	AUXILIARY STORAGE
590, 000/surface	317 x 10^6 char	2.6 x 10^6 char	12, 582, 912			Maximum	Number of Words per Unit	AUXILIARY STORAGE
3.5 x 10^6	2, 536 x 10^6/ pr. trunks	20.8 x 10^6/ pr. trunks	150 x 10^6			Decimal Digits	Maximum Total Storage	AUXILIARY STORAGE
3.5 x 10^6	2, 536 x 10^6/ pr. trunks	20.8 x 10^6/ pr. trunks	10 x 10^6			Characters	Maximum Total Storage	AUXILIARY STORAGE
	0	0	0			Minimum	Waiting Time, msec.	AUXILIARY STORAGE
445	95, 150, or 225	25	129			Average (Random)	Waiting Time, msec.	AUXILIARY STORAGE
	135, 190, or 265	50	197			Maximum	Waiting Time, msec.	AUXILIARY STORAGE
(peak rate: 95, 000)	42, 300 49, 500 47, 600	94, 800	27, 800 to 75, 000			Effective Transfer Rate, char/sec.		AUXILIARY STORAGE
1 to 1, 024	1 to 968 char	Variable	512			Transfer Load Size, char.		AUXILIARY STORAGE
	Parity	Parity	Parity			Checking		AUXILIARY STORAGE
Uses changeable single-disc cartridges; only 1 surface is accessible at a time	Uses changeable cartridges					Features and Comments		AUXILIARY STORAGE
	204A Series	204B Series	404-3	404-1	404-2	Model Number		MAGNETIC TAPE
	8/pair trunks	8/pair trunks	8 (16 on H-1400)	8 (16 on H-1400)	8 (16 on H-1400)	On-Line	Maximum Number of Units	MAGNETIC TAPE
	1/channel	1/channel	2	2	2	Reading/Writing	Maximum Number of Units	MAGNETIC TAPE
	0	0	0	0	0	Searching	Maximum Number of Units	MAGNETIC TAPE
	All	All	8 (16 on H-1400)	8 (16 on H-1400)	8 (16 on H-1400)	Rewinding	Maximum Number of Units	MAGNETIC TAPE
	Varies widely	Varies widely	100	100	100	Reading/Writing	Demands on Processor, %	MAGNETIC TAPE
	0	0	100/0	100/0	100/0	Starting/Stopping	Demands on Processor, %	MAGNETIC TAPE
	32.0 to 88.8	13.3 to 96.	32.0	64.0	89.0	Peak	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
	23.7 to 59.7	10.7 to 60.	23.5	47.0	59.0	1,000-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
	7.1 to 15.1	3.8 to 13.7	6.8	13.6	14.5	100-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
	8	6	8	8	8	Data Tracks		MAGNETIC TAPE
	Variable	Variable	18 to N	18 to N	18 to N	Data Rows per Block		MAGNETIC TAPE
	533, 740	200, 556, 800	400	400	555	Data Rows per Inch		MAGNETIC TAPE
	No	Yes*	No			IBM 729 Compatible		MAGNETIC TAPE
	Track and row parity	Track and row parity	Track & row parity, plus Orthotronic system			Reading	Checking	MAGNETIC TAPE
	None	Read after write	None			Writing	Checking	MAGNETIC TAPE
No magnetic tape equipment announced to date.	Compatible with H-400/ 1400/800/1800 tapes	Only four 13KC units can be attached to a pair of trunks				Features and Comments		MAGNETIC TAPE

*With optional equipment.

System Identity			Honeywell 800 & 1800				IBM 1130	IBM System/360 Model 44
Computer System Report No.			502: & 503:				418:	435:
AUXILIARY STORAGE	Model Number		860				1131 2A and 2B Processors	2315
	Type of Storage		Discs				Disc	Disc
	Maximum Number	Units On-Line	8				1	2/channel
		Read/Write Operations	1 per unit				1	1/channel
		Seek Operations	1 per unit				1	2/channel
	Number of Words per Unit	Minimum	6,291,456				512,000	1.1 x 10^6 bytes
		Maximum	100,663,296				512,000	1.1 x 10^6 bytes
	Maximum Total Storage	Decimal Digits	1,208 x 10^6				2	4.4 x 10^6
		Characters	805 x 10^6				1.024 x 10^6	2.2 x 10^6
	Waiting Time, msec.	Minimum	0				0	0
		Average (Random)	40				790	70.0
		Maximum	197				1,560	140
	Effective Transfer Rate, char/sec.		85,000				70,000	90,000
	Transfer Load Size, char.		512				2 to 640	1 to 2,720 bytes
	Checking		Parity				Cyclic check code	Cyclic check code
	Features and Comments						1130 Disk File is an integral part of the 1131 2A and 2B Processing Units	Model 2311 Disk Storage Drive can also be used; see Comparison Charts, page 11:220.111
MAGNETIC TAPE	Model Number		804-3	804-1	804-2	804-4		See comment below
	Maximum Number of Units	On-Line	64	64	64	64		
		Reading/Writing	8 + 8	8 + 8	8 + 8	8 + 8		
		Searching	0	0	0	0		
		Rewinding	64	64	64	64		
	Demands on Processor, %	Reading/Writing	0.8 to 7.5	1.6 to 15.0	2.2 to 20.0	3.3 to 30.0		
		Starting/Stopping	0	0	0	0		
	Transfer Rate, Kilo-char/sec.	Peak	32.0	64.0	89.0	124.0		
		1,000-char blocks	23.5	47.0	59.0	83.0		
		100-char blocks	6.8	13.6	14.5	20.6		
	Data Tracks		8					
	Data Rows per Block		Variable					
	Data Rows per Inch		400	400	555	777		
	IBM 729 Compatible		No					
	Checking	Reading	Track & row parity, plus Orthotronic system					
		Writing	None					
	Features and Comments						No magnetic tape equipment announced	The IBM 2400 Series magnetic tape units, Models 1 through 6, can be connected; see Comparison Charts, page 11:220.111

*With optional equipment.

IBM System/360						System Identity		
420:						Computer System Report No.		
2361	2302	2311	2321	2314	2301	Model Number.		AUXILIARY STORAGE
Core	Discs	Discs	Mag. strips	Discs	Drum	Type of Storage		
4	32/channel	64/channel	64/channel	8/channel	8/channel	Units On-Line	Maximum Number	
1	1/channel	1/channel	1/channel	1/channel	1/channel	Read/Write Operations		
—	64/channel	64/channel	64/channel	64/channel	1/channel	Seek Operations		
1.05×10^6 bytes	112×10^6 bytes	7.25×10^6 bytes	40×10^6 bytes	25.9×10^6 bytes	4.10×10^6 bytes	Minimum	Number of Words per Unit	
2.10×10^6 bytes	224×10^6 bytes	7.25×10^6 bytes	400×10^6 bytes	207×10^6 bytes	4.10×10^6 bytes	Maximum		
16.78×10^6	$14{,}352 \times 10^6$/ch.	928×10^6/ch.	$51{,}200 \times 10^6$/ch.	$3{,}312 \times 10^6$/ch.	66×10^6/ch.	Decimal Digits	Maximum Total Storage	
8.39×10^6	$7{,}176 \times 10^6$/ch.	464×10^6/ch.	$25{,}600 \times 10^6$/ch.	$1{,}656 \times 10^6$/ch.	33×10^6/ch.	Characters		
0.008	0	0	0	0	0	Minimum	Waiting Time, msec.	
0.008	182	97.5	550	87.5	8.6	Average (Random)		
0.008	214	170	600	165	17.2	Maximum		
500,000	132,000	104,000	25,800	222,000	1,170,000	Effective Transfer Rate, char/sec.		
1 to 255	1 to 224,280	1 to 36,250	1 to 40,000	1 to 129,384	1 to 20,486	Transfer Load Size, char.		
Parity	Cyclic check code	Cyclic check code	Cyclic check code	Cyclic check code	Cyclic check code	Checking		
Directly addressable; for Models 50-75 only	2 or 4 access arms per unit	Changeable "Disk Pack" storage medium	10 changeable "Data Cells" per drive	8 on-line disc drives per 2314	For Models 50-75 only	Features and Comments		

2400 Series						2415 Series	7340 Mod. 3	Model Number		MAGNETIC TAPE
Mod. 1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6					
64 per channel			64 per channel			48/channel	64/channel	On-Line	Maximum Number of Units	
1 per channel			1 per channel			1/channel	1/channel	Reading/Writing		
0			0			0	0	Searching		
64 per channel			64 per channel			48/channel	64/channel	Rewinding		
Varies			Varies			Varies	Varies	Reading/Writing	Demands on Processor, %	
Varies			Varies			Varies	Varies	Starting/Stopping		
30.0	60.0	90.0	60.0	120.0	180.0	15.0 or 30.0	340.0	Peak	Transfer Rate, Kilo-char/sec.	
20.3	40.5	60.8	30.6	61.2	91.8	10.1 or 15.3		1,000-char blocks		
5.2	10.3	15.5	5.6	11.3	16.9	2.6 or 2.8		100-char blocks		
8 (6 with Compatibility option)			8 (6 with Compatibility option)			8 (or 6*)	8	Data Tracks		
Variable			Variable			Variable	Variable	Data Rows per Block		
800 (200 or 556 with Compatibility option)			1600 (800/556/200 with Compatibility option)			800 (or 200-556*)	1,511 or 3,022	Data Rows per Inch		
Yes*			Yes*			Yes*	No	IBM 729 Compatible		
Track, row, and diagonal parity			Vertical parity check bit			Same as 2400's	Dual-row parity	Reading	Checking	
Read after write			Read after write			Read after write	Read after write	Writing		
Dual-channel controllers and tape switching units are available; backward reading and error correction facilities are standard						Models 1, 2, and 3 lack the error correction feature.	Cartridge-loaded; can read backward.	Features and Comments		

*With optional equipment.

System Identity	IBM 704 & 709	IBM 1401 & 1460	IBM 1410
Computer System Report No.	406: & 407:	401: & 415:	402:

			IBM 704 & 709	IBM 1401 & 1460		IBM 1410	
AUXILIARY STORAGE	Model Number		733	1311	1405	1301 Mod. 1, 2	1311
	Type of Storage		Drum	Discs	Discs	Discs	Discs
	Maximum Number	Units On-Line	4	5	1	5	10
		Read/Write Operations	1	1	1	2	2
		Seek Operations	0	1 or 5*	1 or 3*	10	2 or 10*
	Number of Words per Unit	Minimum	4,096	2,000,000	10,000,000	28,000,000	2,000,000
		Maximum	4,096	2,980,000*	20,000,000	56,000,000	2,980,000*
	Maximum Total Storage	Decimal Digits	172,032	14.9×10^6	20×10^6	280×10^6	29.8×10^6
		Characters	98,304	14.9×10^6	20×10^6	280×10^6	29.8×10^6
	Waiting Time, msec.	Minimum	0	0	0	0	0
		Average (Random)	12.5	270 or 170*	600	177	170
		Maximum	47.7	432 or 288*	800	214	288
	Effective Transfer Rate, char/sec.		60,436	33,800 or 38,200*	8,420	42,000 or 82,000*	38,200
	Transfer Load Size, char.		6	100 to 20,000 by 100	200 or 1,000	1 to 112,000	100 to 20,000 by 100
	Checking		Timing	Parity, write check	Parity, write check	Parity, write check	Parity, write check
	Features and Comments			Changeable storage medium	Not available with 1460 systems	1302 can also be used	Changeable storage medium

			IBM 704 & 709		IBM 1401 & 1460			IBM 1410		
MAGNETIC TAPE	Model Number		727	729 I	7330	729 Series	7340 Mod. 2	7330	729 Series	7340 Mod. 2
	Maximum Number of Units	On-Line	10	48	6	6	4	20	20	8
		Reading/Writing	1	6	1	1	1	2	2	2
		Searching	0	0	0	0	0	0	0	0
		Rewinding	10	48	6	6	4	20	20	8
	Demands on Processor, %	Reading/Writing	36/21	4 max.	100 or 23*	100	100	100 or 11*	100 to 22*	?
		Starting/Stopping	0		38 or 0*	83 to 0*	?	54 or 0*	83 to 0*	?
	Transfer Rate, Kilo-char/sec.	Peak	15		20.0	41.6 to 62.5	34.0	20.0	41.6 to 90.0	34.0
		1,000-char blocks	12.9		14.2	27.3 to 40.0	20.2	14.2	6.7 to 50.2	20.2
		100-char blocks	5.5		4.0	6.7 to 9.6	4.4	4.0	6.7 to 10.1	4.4
	Data Tracks		6		6	6	6 or 8	6	6	6 or 8
	Data Rows per Block		Variable		1 to N	1 to N	1 to N	1 to N	1 to N	1 to N
	Data Rows per Inch		200		200, 556	200, 556, 800	1511	200, 556	200, 556 800	1511
	IBM 729 Compatible		Yes		Yes		No	Yes		No
	Checking	Reading	Track & row parity		Track & row parity		Dual-row parity	Track & row parity		Dual-row parity
		Writing	None	Read after write	Read after write			Read after write		
	Features and Comments				7340 (Hypertape) is cartridge-loaded			7340 (Hypertape) is cartridge-loaded		

*With optional equipment.

IBM 1440		IBM 1620	IBM 7010		System Identity		
414:		412: & 413:	416:		Computer System Report No.		
1301 Mod. 11, 12, 21, 22	1311	1311	1301 Mod. 1, 2	1311	Model Number		AUXILIARY STORAGE
Discs	Discs	Magnetic discs	Discs	Discs	Type of Storage		AUXILIARY STORAGE
5	5	4	5	10	Units On-Line	Maximum Number	AUXILIARY STORAGE
1	1	1	2	2	Read/Write Operations	Maximum Number	AUXILIARY STORAGE
5	1 or 5*	1	10	2 or 10*	Seek Operations	Maximum Number	AUXILIARY STORAGE
20,000,000	2,000,000	2,000,000 char	28,000,000	2,000,000	Minimum	Number of Words per Unit	AUXILIARY STORAGE
40,000,000	2,980,000*	2,000,000 char	56,000,000	2,980,000*	Maximum	Number of Words per Unit	AUXILIARY STORAGE
100 x 10^6	14.9 x 10^6*	8.0 x 10^6	280 x 10^6	29.8 x 10^6	Decimal Digits	Maximum Total Storage	AUXILIARY STORAGE
100 x 10^6	14.9 x 10^6*	8.0 x 10^6	280 x 10^6	29.8 x 10^6	Characters	Maximum Total Storage	AUXILIARY STORAGE
0	0	0	0	0	Minimum	Waiting Time, msec.	AUXILIARY STORAGE
177	270 or 174*	250	177	170	Average (Random)	Waiting Time, msec.	AUXILIARY STORAGE
214	432 or 288*	400	214	288	Maximum	Waiting Time, msec.	AUXILIARY STORAGE
41,500	38,200*	77,000 max	82,000	38,200	Effective Transfer Rate, char/sec.		AUXILIARY STORAGE
100 to 100N by 100	100 to 20,000 by 100	100 to 2,000 by 100	1 to 112,000	100 to 20,000 by 100	Transfer Load Size, char.		AUXILIARY STORAGE
Parity, write check	Parity, write check	Parity	Parity, write check	Parity, write check	Checking		AUXILIARY STORAGE
Also usable in IBM 1401 and 1460 systems	Changeable storage medium	Changeable storage medium	1302 can also be used	Changeable storage medium	Features and Comments		AUXILIARY STORAGE
7335			7330	729 Series	Model Number		MAGNETIC TAPE
2			20	20	On-Line	Maximum Number of Units	MAGNETIC TAPE
1			2	2	Reading/Writing	Maximum Number of Units	MAGNETIC TAPE
0			0	0	Searching	Maximum Number of Units	MAGNETIC TAPE
2			20	20	Rewinding	Maximum Number of Units	MAGNETIC TAPE
100			2.4	10.8 max	Reading/Writing	Demands on Processor, %	MAGNETIC TAPE
100/0			0	0	Starting/Stopping	Demands on Processor, %	MAGNETIC TAPE
20.0			20.0	41.6 to 90.0	Peak	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
14.2			14.2	27.3 to 50.2	1,000-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
4.0			4.0	6.7 to 10.0	100-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
6			6	6	Data Tracks		MAGNETIC TAPE
Variable			Variable	Variable	Data Rows per Block		MAGNETIC TAPE
556			200, 556	200, 556, 800	Data Rows per Inch		MAGNETIC TAPE
Yes			Yes	Yes	IBM 729 Compatible		MAGNETIC TAPE
Track & row parity			Track & row parity		Reading	Checking	MAGNETIC TAPE
Read after write			Read after write		Writing	Checking	MAGNETIC TAPE
		7330 and 729 II Magnetic Tape Units available on a special-order basis			Features and Comments		MAGNETIC TAPE

*With optional equipment.

System Identity			IBM 7040 & 7044		IBM 7070/7072/7074		IBM 7080	
Computer System Report No.			410: & 411:		403: etc.		417:	
AUXILIARY STORAGE	Model Number		1301 Mod. 1, 2	1302	7300	1301	1301	1302
	Type of Storage		Discs	Discs	Discs	Discs	Discs	Discs
	Maximum Number	Units On-Line	5	5	4	5	5	5
		Read/Write Operations	2	2	2	2	2	2
		Seek Operations	10	20	12	10	10	20
	Number of Words per Unit	Minimum	4,650,000	19,400,000	600,000	2,780,000	28×10^6	117×10^6
		Maximum	9,300,000	38,800,000	1,200,000	5,560,000	56×10^6	234×10^6
	Maximum Total Storage	Decimal Digits	279×10^6	$1,168 \times 10^6$	48×10^6	278×10^6	433×10^6	$1,813 \times 10^6$
		Characters	279×10^6	$1,168 \times 10^6$	24×10^6	278×10^6	280×10^6	$1,170 \times 10^6$
	Waiting Time, msec.	Minimum	0	0	38	0	0	0
		Average (Random)	177	177	760	177	177	177
		Maximum	214	214	940	214	214	214
	Effective Transfer Rate, char/sec.		83,700	158,000	2,580	83,000*	82,300*	158,000*
	Transfer Load Size, char.		1 to 111,600	1 to 234,000	300	1 to 111,200	1 to 112,000	1 to 234,000
	Checking		Parity, write check	Parity, write check	Fixed count, write compare	Check characters	Check characters	
	Features and Comments				No longer in production; not usable with 7072	Not usable with 7072; 7074 can also use the 1302		

System Identity			IBM 7040 & 7044		IBM 7070/7072/7074			IBM 7080	
MAGNETIC TAPE	Model Number		7330	729 Series	7330	729 Series	7340 Mod. 1	729 Series	7340 Mod. 1
	Maximum Number of Units	On-Line	50	50	20	40	20	40	20
		Reading/Writing	5	5	2	4	2	4	2
		Searching	0	0	0	0	0	0	0
		Rewinding	50	50	20	40	20	40	20
	Demands on Processor, %	Reading/Writing	5.3 max	24.0 max	2.4	11 max	14 max	2.4 to 14.5	27.0
		Starting/Stopping	0	0	0	0	0	0	0
	Transfer Rate, Kilo-char/sec.	Peak	20.0	41.6 to 90.0	20.0	41.6 to 90.0	170.0	41.6 to 90.0	170.0
		1,000-char blocks	14.2	27.3 to 50.2	14.2	27.3 to 50.2	100.0	27.3 to 50.2	100.0
		100-char blocks	4.0	6.7 to 10.1	4.0	6.7 to 10.1	22.0	6.7 to 10.1	22.0
	Data Tracks		6	6	6	6	6 or 8	6	6 or 8
	Data Rows per Block		Variable	Variable	Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch		200, 556	200, 556, 800	200, 556	200, 556, 800	1511	200, 556, 800	1511
	IBM 729 Compatible		Yes	Yes	Yes	Yes	No	Yes	No
	Checking	Reading	Track & row parity		Track & row parity		Dual-row parity	Track & row parity	Dual-row parity
		Writing	Read after write		Read after write			Read after write	Read after write
	Features and Comments				Usable with 7072 only	Usable with 7070 or 7074	Usable with 7074 only		Cartridge loaded; can read backward

*With optional equipment.

IBM 7090 & 7094		LGP-30 (Control Data)	Monrobot XI	System Identity		
408: & 409:		352:	531:	Computer System Report No.		
1301	7320		Monroe-Card Processor	Model Number		AUXILIARY STORAGE
Discs	Drum		Magnetic cards	Type of Storage		AUXILIARY STORAGE
5	10		1	Units On-Line	Maximum Number	AUXILIARY STORAGE
2	2		1	Read/Write Operations	Maximum Number	AUXILIARY STORAGE
10	0		1	Seek Operations	Maximum Number	AUXILIARY STORAGE
4,650,000	212,000		96	Minimum	Number of Words per Unit	AUXILIARY STORAGE
9,300,000	212,000		174	Maximum	Number of Words per Unit	AUXILIARY STORAGE
279×10^6	12.7×10^6		1,566 per card	Decimal Digits	Maximum Total Storage	AUXILIARY STORAGE
279×10^6	12.7×10^6		870 per card	Characters	Maximum Total Storage	AUXILIARY STORAGE
0	0		56	Minimum	Waiting Time, msec.	AUXILIARY STORAGE
177	8.6		196	Average (Random)	Waiting Time, msec.	AUXILIARY STORAGE
214	17.5		336	Maximum	Waiting Time, msec.	AUXILIARY STORAGE
83,700	203,000 max		15	Effective Transfer Rate, char/sec.		AUXILIARY STORAGE
1 to 111,600	Variable		5 (1 word)	Transfer Load Size, char.		AUXILIARY STORAGE
Parity, write check	Parity, write check		Parity	Checking		AUXILIARY STORAGE
1302 can also be used; see IBM 7040 & 7044		No auxiliary storage equipment announced	Card feeding, ejection, and stacker selection are program controlled	Features and Comments		AUXILIARY STORAGE
729 Series	7340 Mod. 1			Model Number		MAGNETIC TAPE
80	20			On-Line	Maximum Number of Units	MAGNETIC TAPE
8	2			Reading/Writing	Maximum Number of Units	MAGNETIC TAPE
0	0			Searching	Maximum Number of Units	MAGNETIC TAPE
80	20			Rewinding	Maximum Number of Units	MAGNETIC TAPE
3.3 max	6.2 max			Reading/Writing	Demands on Processor, %	MAGNETIC TAPE
0	0			Starting/Stopping	Demands on Processor, %	MAGNETIC TAPE
41.6 to 90.0	170.0			Peak	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
27.3 to 50.2	100.0			1,000-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
6.7 to 10.1	22.0			100-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
6	6 or 8			Data Tracks		MAGNETIC TAPE
Variable	Variable			Data Rows per Block		MAGNETIC TAPE
200, 556, 800	1511			Data Rows per Inch		MAGNETIC TAPE
Yes	No			IBM 729 Compatible		MAGNETIC TAPE
Track & row parity	Dual-row parity			Reading	Checking	MAGNETIC TAPE
Read after write	Read after write			Writing	Checking	MAGNETIC TAPE
	Cartridge-loaded; can read backward	No magnetic tape equipment announced	No magnetic tape equipment announced	Features and Comments		MAGNETIC TAPE

*With optional equipment.

System Identity			NCR 315, 315-100, 315 RMC			PB 250 (Raytheon)		Philco 2000 Series	
Computer System Report No.			601:, 602:, 603:			631:		651: etc.	
AUXILIARY STORAGE	Model Number		353-1	353-2	353-3			272	315
	Type of Storage		Magnetic cards	Magnetic cards	Magnetic cards			Drum	Discs
	Maximum Number	Units On-Line	16	16	16			4	4
		Read/Write Operations	1	1	1			1	1
		Seek Operations	16	16	16			0	4
	Number of Words per Unit	Minimum	2.8×10^6	4.0×10^6	8.0×10^6			32,768	5,242,880
		Maximum	2.8×10^6	4.0×10^6	8.0×10^6			32,768	5,242,880
	Maximum Total Storage	Decimal Digits	133×10^6	192×10^6	384×10^6			1.84×10^6	168×10^6
		Characters	89×10^6	128×10^6	256×10^6			1.05×10^6	168×10^6
	Waiting Time, msec.	Minimum	3	3	3			0	0
		Average (Random)	235	235	235			16.4	173
		Maximum	235	235	235			32.8	?
	Effective Transfer Rate, char/sec.		42,300	21,700	21,700			558,000	960,000
	Transfer Load Size, char.		2 to 3,100	2 to 1,120	2 to 1,120			1 to 32,768	1 to 262,144
	Checking		Parity, read after write					Amplification tolerance	Parity
	Features and Comments		Changeable CRAM cartridges of 128 (Model 353-2) or 256 cards each			No auxiliary storage equipment announced		High transfer rate inhibits all other operations	Usable with 212 Processor only
MAGNETIC TAPE	Model Number		332-204	333 Series	334 Series	MTU 1	MTU 2	234	334
	Maximum Number of Units	On-Line	16	16	16	6		16	64
		Reading/Writing	2	2	2	1		4	8
		Searching	0	0	0	0		4	8
		Rewinding	16	16	16	6		16	64
	Demands on Processor, %	Reading/Writing	100 or 26.7*	100 or 48.0*	100 or 13.3*	100		1.1 to 11.2	2.3
		Starting/Stopping	100 or 0*	100 or 0*	100 or 0*	100		0	0
	Transfer Rate, Kilo-char/sec.	Peak	66.7	120.0	33.4	2.0	15.0	90	240
		1,000-char blocks	40.8	75.0	23.6	Depends upon routine		54.6 (for 1024-char blocks)	120
		100-char blocks	9.2	17.2	6.4	Depends upon routine		Fixed block size	23
	Data Tracks		6	6	6	7		12	12
	Data Rows per Block		Variable	Variable	Variable	1 to N		512	Variable
	Data Rows per Inch		200, 556	200, 556 or 800	200 or 200, 556	200		375	1000 (?)
	IBM 729 Compatible		Yes	Yes	Yes	Binary only		No	No
	Checking	Reading	Track and row parity			As programmed		Track & row parity	Track & row parity
		Writing	Read after write			None		Read after write	Read after write
	Features and Comments		Model 332-204 is no longer being produced			Tape timing requires constant program control		Tape has prerecorded block and sprocket marks	Usable with 212 Processor only

*With optional equipment.

RCA Spectra 70			RCA 301		System Identity		
710:			701:		Computer System Report No.		
70/564	70/565	70/568-11	366	3488	Model Number		AUXILIARY STORAGE
Discs	Drum	Magnetic cards	Discs	Mag. cards	Type of Storage		
8/trunk	8/trunk	8/trunk	2	8	Units On-Line	Maximum Number	
1/channel	1/channel	1/channel	2	2	Read/Write Operations		
1/unit	1/channel	1/unit	2	8	Seek Operations		
7.25×10^6 bytes	1.0×10^6 bytes	249×10^6 bytes	22,118,400	42×10^6	Minimum	Number of Words per Unit	
7.25×10^6 bytes	1.0×10^6 bytes	249×10^6 bytes	88,473,600	681×10^6	Maximum		
116×10^6/trunk	16.4×10^6/trunk	$3,984 \times 10^6$/trunk	177×10^6	$5,452 \times 10^6$	Decimal Digits	Maximum Total Storage	
58×10^6/trunk	8.2×10^6/trunk	$1,992 \times 10^6$/trunk	177×10^6	$5,452 \times 10^6$	Characters		
0	0	0	0	0	Minimum	Waiting Time, msec.	
97.5	8.6	385	105	300	Average (Random)		
170	17.2	573	150	1,000	Maximum		
156,000	117,000	62,000	25,400	42,000 (80,000 max)	Effective Transfer Rate, char/sec.		
1 to 36,250	1 to 1,953	1,000 to 121,600	1 to 1,600	1 to 40,000	Transfer Load Size, char.		
Cyclic check code	Parity	Parity	Parity	Parity	Checking		
Changeable "Disk Packs" (IBM 2311 Disk Storage Drive)		Changeable cartridges hold 256 cards each		Changeable storage medium	Features and Comments		

70/432	70/442	70/445	381, 382	581	582	Model Number		MAGNETIC TAPE
16/trunk	16/trunk	16/trunk	12	14	14	On-Line	Maximum Number of Units	
1/channel	1/channel	1/channel	2	2	2	Reading/Writing		
0	0	0	0	0	0	Searching		
All	All	All	12	14	14	Rewinding		
Varies	Varies	Varies	100 (7 or 21*)	100 (23*)	100 (46*)	Reading/Writing	Demands on Processor, %	
Varies	Varies	Varies	100 (0*)	100 (0*)	100 (0*)	Starting/Stopping		
30.0	60.0	120.0	10.0 or 30.0	33.3	66.7	Peak	Transfer Rate, Kilo-char/sec.	
20.4	40.0	81.3	9.0 or 25.0	30.0	47.0	1,000-char blocks		
5.2	10.3	20.8	5.0 or 15.0	15.0	15.0	100-char blocks		
8 (6 with optional 7-Channel Tape Feature)			6	6 (2 bands)	6 (2 bands)	Data Tracks		
Variable			Variable	Variable	Variable	Data Rows per Block		
800 (200, 556, or 800 with 7-Channel Feature)			333	333	667	Data Rows per Inch		
Only when 7-Channel Tape Feature is installed			No	No	No	IBM 729 Compatible		
Track & row parity, cyclical redundancy			Row parity	Row parity	Row parity	Reading	Checking	
Read after write			Echo parity	Echo parity	Read after write	Writing		
Dual-channel controllers are available; backward reading is standard; compatible with IBM 2400 Series Tape Units			All three units can read backward			Features and Comments		

*With optional equipment.

System Identity			RCA 3301			RECOMP II & III (Autonetics)		RPC-4000 (Control Data)
Computer System Report No.			703:			161: & 162:		351:
AUXILIARY STORAGE	Model Number		3465	3488				
	Type of Storage		Drum	Mag. Cards				
	Maximum Number	Units On-Line	1	8				
		Read/Write Operations	1	2				
		Seek Operations	1	8				
	Number of Words per Unit	Minimum	32,768	42×10^6				
		Maximum	262,144	681×10^6				
	Maximum Total Storage	Decimal Digits	2.62×10^6	$5,452 \times 10^6$				
		Characters	2.62×10^6	$5,452 \times 10^6$				
	Waiting Time, msec.	Minimum	0	0				
		Average (Random)	8.6	300				
		Maximum	17.2	1,000				
	Effective Transfer Rate, char/sec.		149,000	42,000 (80,000 max)				
	Transfer Load Size, char.		1 to 160,000	1 to 160,000				
	Checking		Parity	Parity				
	Features and Comments			Changeable storage medium		No auxiliary storage equipment announced		No auxiliary storage equipment announced
MAGNETIC TAPE	Model Number		681	3485	3487	M 906 II		
	Maximum Number of Units	On-Line	24	24	24	4		
		Reading/Writing	2 (3*)	2 (3*)	2 (3*)	1		
		Searching	0	0	0	0		
		Rewinding	24	24	24	4		
	Demands on Processor, %	Reading/Writing	11.5	11.5	6.0	100		
		Starting/Stopping	0	0	0	100		
	Transfer Rate, Kilo-char/sec.	Peak	120.0	120.0	60.0	1.85	1.85	
		1,000-char blocks	64.0	75.0	37.5	1.78	Not possible	
		100-char blocks	12.0	17.0	8.5	Not possible	Not possible	
	Data Tracks		6	6	6	5	6	
	Data Rows per Block		Variable	Variable	Variable	512 to 4096 by 512	384	
	Data Rows per Inch		800	200, 556 800	200, 556, 800	200	200	
	IBM 729 Compatible		No	Yes	Yes	No	Binary only	
	Checking	Reading	Row parity	Track & row parity		Row parity		
		Writing	Read after write			Read after write		
	Features and Comments		581 and 582 can also be used (see RCA 301); dual-channel tape controllers are standard			Usable with RECOMP II only; can be updated randomly		No magnetic tape equipment announced

*With optional equipment.

UNIVAC SS 80/90		UNIVAC III			System Identity		
Model 1	Model 2						
771:	772:	774:			Computer System Report No.		
Randex	Randex	Fastrand			Model Number		AUXILIARY STORAGE
Drum	Drum	Drum			Type of Storage		
10	10	16			Units On-Line	Maximum Number	
1	1	2			Read/Write Operations		
1	1	16			Seek Operations		
1,152,000	1,152,000	16,515,072			Minimum	Number of Words per Unit	
2,304,000	2,304,000	16,515,072			Maximum		
230 x 10^6	230 x 10^6	1,584 x 10^6			Decimal Digits	Maximum Total Storage	
144 x 10^6	154 x 10^6	1,056 x 10^6			Characters		
0	0	5			Minimum	Waiting Time, msec.	
375	375	92			Average (Random)		
624	624	156			Maximum		
4,350	4,640	156,000 max			Effective Transfer Rate, char/sec.		
300	320	4 to 131,072			Transfer Load Size, char.		
Parity	Parity	Check character			Checking		
		Can store either 24 bits or all 27 bits of each word			Features and Comments		
Uniservo II	Uniservo II	Uniservo IIA	Uniservo IIIA	Uniservo IIIC	Model Number		MAGNETIC TAPE
10	20	6	32	8	On-Line	Maximum Number of Units	
1	2	1	4	1	Reading/Writing		
0	0	0	0	0	Searching		
10	20	6	32	8	Rewinding		
5.7	5.7	1.9 max	13.3	6.3 max	Reading/Writing	Demands on Processor, %	
0	0	0	0	0	Starting/Stopping		
25.0	25.0	25.0	133.0	62.5	Peak	Transfer Rate, Kilo-char/sec.	
16.4	16.4	18.3	74.0	36.4	1,000-char blocks		
Not possible	Not possible	Not possible	17.0	7.7	100-char blocks		
6	6	6	9	6	Data Tracks		
720 or 1100	720 or 1100	720	Variable	Variable	Data Rows per Block		
125, 250	125, 250	125, 250	1000	200, 256	Data Rows per Inch		
No	No	No	No	Yes	IBM 729 Compatible		
Row parity	Row parity	Row parity	Row parity	2-way parity	Reading	Checking	
None	None	None	Read after write		Writing		
Can read backward	Can read backward				Features and Comments		

*With optional equipment.

System Identity			UNIVAC 418				UNIVAC 9000 Series: 9200 & 9300	
Computer System Report No.			790:				810:	
AUXILIARY STORAGE	Model Number		FH-220	FH-330	FH-880	Fastrand II		
	Type of Storage		Drum	Drum	Drum	Drum		
	Maximum Number	Units On-Line	16	80	64	64		
		Read/Write Operations	418-I: 8 418-II:. 16	418-I: 2 418-II: 4	418-I: 1 418-II: 3	418-I: 1 418-II: 3		
		Seek Operations	16	80	64	64		
	Number of Words per Unit	Minimum	65,536	262,144	1,572,864	44,040,192		
		Maximum	65,536	262,144	1,572,864	44,040,192		
	Maximum Total Storage	Decimal Digits	5.56 x 10^6	111 x 10^6	534 x 10^6	14,938 x 10^6		
		Characters	3.15 x 10^6	63 x 10^6	302 x 10^6	8,456 x 10^6		
	Waiting Time, msec.	Minimum	0	0	0	0		
		Average (Random)	8.5	8.5	17.0	92		
		Maximum	17.0	17.0	33.4	155		
	Effective Transfer Rate, char/sec.		23,000	90,000 max	180,000 max	158,000 max		
	Transfer Load Size, char.		3 to 196,608	3 to 196,608	3 to 196,608	3 to 196,608		
	Checking		Parity	Parity	Parity	Parity		
	Features and Comments					Fastrand I is the same except for halved data capacity	No auxiliary storage equipment announced to date	
MAGNETIC TAPE	Model Number		Uniservo II A	Uniservo III A	Uniservo IV C	Uniservo VI C	Uniservo VI C	
							0858-99	0858-98
	Maximum Number of Units	On-Line	96	128	192	256	16	16
		Reading/Writing	8	418-I: 2 418-II: 5	418-I: 2 418-II: 4	418-I: 5 418-II: 11	2	2
		Searching	8	8	0	0	0	0
		Rewinding	All	All	All	All	16	16
	Demands on Processor, %	Reading/Writing	418-I: 8.0 418-II: 4.0	418-I: 40.0 418-II: 20.0	418-I: 48.4 418-II: 24.2	418-I: 18.4 418-II: 9.2	33	33
		Starting/Stopping	0	0	0	0	?	?
	Transfer Rate, Kilo-char/sec.	Peak	25.0	120.0	90.0	34.1	34.1	34.1
		1,000-char blocks	19.8	54.9	39.5	21.3	21.5	21.5
		100-char blocks	6.9	10.9	6.5	4.9	5.1	5.1
	Data Tracks		6	8	6	6	8	6
	Data Rows per Block		Variable	Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch		125,250	1,000	200,556,800	200,556,800	800	200,556,800
	IBM 729 Compatible		No	No	Yes	Yes	No	Yes
	Checking	Reading	Row parity	Row parity	Track & row parity	Track & row parity	Track and row parity	
		Writing	None	Read after write	Read after write	Read after write	Read after write	
	Features and Comments		Can read backward	Can read backward			Available only with UNIVAC 9300; 0858-99 is IBM 2400 Series compatible.	

*With optional equipment.

UNIVAC 490 Series				System Identity		
800:				Computer System Report No.		
Fastrand II	FH-432	FH-880	FH-1782	Model Number		AUXILIARY STORAGE
Drum	Drum	Drum	Drum	Type of Storage		AUXILIARY STORAGE
8/channel	9/channel	8/channel	8/channel	Units On-Line	Maximum Number	AUXILIARY STORAGE
1/channel	1/channel	1/channel	1/channel	Read/Write Operations	Maximum Number	AUXILIARY STORAGE
8/channel	1/channel	1/channel	1/channel	Seek Operations	Maximum Number	AUXILIARY STORAGE
25,952,256	262,144	786,432	2,097,152	Minimum	Number of Words per Unit	AUXILIARY STORAGE
25,952,256	262,144	786,432	2,097,152	Maximum	Number of Words per Unit	AUXILIARY STORAGE
1,557 x 10^6/ch	17,594 x 10^6/ch	47.2 x 10^6/ch	125.8 x 10^6/ch	Decimal Digits	Maximum Total Storage	AUXILIARY STORAGE
1,038 x 10^6/ch	11,796 x 10^6/ch	31.5 x 10^6/ch	83.9 x 10^6/ch	Characters	Maximum Total Storage	AUXILIARY STORAGE
5	0	0	0	Minimum	Waiting Time, msec.	AUXILIARY STORAGE
92	4.25	17	17	Average (Random)	Waiting Time, msec.	AUXILIARY STORAGE
155	8.5	33.4	34	Maximum	Waiting Time, msec.	AUXILIARY STORAGE
125,000	1,200,000	300,000 max	1,200,000	Effective Transfer Rate, char/sec.		AUXILIARY STORAGE
5 to 163,835 or 20,480 (494)	5 to 20,480	5 to 163,835 or 20,480 (494)	5 to 20,480	Transfer Load Size, char.		AUXILIARY STORAGE
Parity, phase	Word parity	Word parity	Word parity	Checking		AUXILIARY STORAGE
Dual-channel controller available	With 494 only		With 494 only; can be intermixed with FH-432 on same controller	Features and Comments		AUXILIARY STORAGE
Uniservo IIA	Uniservo IIIA	Uniservo VIC	Uniservo VIIIC	Model Number		MAGNETIC TAPE
12/ch	16/ch	16/ch	16/ch	On-Line	Maximum Number of Units	MAGNETIC TAPE
1/ch	1/ch	1/ch	1/ch	Reading/Writing	Maximum Number of Units	MAGNETIC TAPE
1/ch	1/ch	1/ch	1/ch	Searching	Maximum Number of Units	MAGNETIC TAPE
All	All	All	All	Rewinding	Maximum Number of Units	MAGNETIC TAPE
0.63 to 5.0	3.3 to 25.0	0.21 to 6.8	0.6 to 19.2	Reading/Writing	Demands on Processor, %	MAGNETIC TAPE
0	0	0	0	Starting/Stopping	Demands on Processor, %	MAGNETIC TAPE
25.0	125.0	8.5 to 34.0	24.0 to 96.0	Peak	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
19.8	65.9	7.4 to 21.1	19.9 to 59.5	1,000-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
6.9	12.5	3.4 to 4.7	9.6 to 13.4	100-char blocks	Transfer Rate, Kilo-char/sec.	MAGNETIC TAPE
6	8	6		Data Tracks		MAGNETIC TAPE
5 to 163,835 or 20,480 (494)	5 to 135,068 or 16,384 (494)	5 to 163,835 or 20,480 (494)		Data Rows per Block		MAGNETIC TAPE
125,250	1000	200,556,800		Data Rows per Inch		MAGNETIC TAPE
No	No	Yes		IBM 729 Compatible		MAGNETIC TAPE
Row parity	Row parity	Track and row parity		Reading	Checking	MAGNETIC TAPE
None	Read after write	Read after write		Writing	Checking	MAGNETIC TAPE
		9-track, IBM 2400 Series compatible versions available; dual-channel controllers available		Features and Comments		MAGNETIC TAPE

*With optional equipment.

System Identity			UNIVAC 1004	UNIVAC 1050		UNIVAC 1107	
Computer System Report No.			770:	777:		784:	
AUXILIARY STORAGE	Model Number			Fastrand I	Fastrand II	FH-880	Fastrand
	Type of Storage			Drum (movable heads)		Drum	Drum
	Maximum Number	Units On-Line		8 per I/O channel		120	120
		Read/Write Operations		1		2	5
		Seek Operations		1		0	15
	Number of Words per Unit	Minimum		66×10^6	132×10^6	786,432	12,976,128
		Maximum		66×10^6	132×10^6	786,432	12,976,128
	Maximum Total Storage	Decimal Digits		528×10^6	$1,056 \times 10^6$	991×10^6	$16,340 \times 10^6$
		Characters		528×10^6	$1,056 \times 10^6$	566×10^6	$9,340 \times 10^6$
	Waiting Time, msec.	Minimum		5		0	5
		Average (Random)		93		17.0	92
		Maximum		155		33.4	155
	Effective Transfer Rate, char/sec.			154,000		360,000	150,000
	Transfer Load Size, char.			1 to 65,536		6 to 393,210	6 to 393,210
	Checking			Parity, phase		Parity	Check character
	Features and Comments			Search capability; can recover up to 11 bits of missed data			

System Identity			UNIVAC 1004	UNIVAC 1050			UNIVAC 1107		
Computer System Report No.			770:	777:			784:		
MAGNETIC TAPE	Model Number		Model 0857 Uniservo	Uniservo IIIA	Uniservo IV C	Uniservo VI C	Uniservo II A	Uniservo III A	Uniservo III C
	Maximum Number of Units	On-Line	2	12	12	32	180	240	180
		Reading/Writing	1	1	1	4	15	6	12
		Searching	0	0	0	0	15	15	15
		Rewinding	2	12	12	32	180	240	180
	Demands on Processor, %	Reading/Writing	100	60 max	44 max	16 max	1.7 max	8.0	4.2 max
		Starting/Stopping	100/0	0	0	0	0	0	0
	Transfer Rate, Kilo-char/sec.	Peak	33.7	133.0	90.0	34.1	25.0	120.0	62.5
		1,000-char blocks	20.7	43.2	39.4	21.3	19.8	63.2	42.2
		100-char blocks	4.7	7.2	7.0	4.9	6.9	12.0	10.8
	Data Tracks		6	9	6	6	6	8	6
	Data Rows per Block		Variable	Variable	Variable	Variable	Variable	Variable	Variable
	Data Rows per Inch		200, 556, 800	1,000	200, 556, 800		125, 250	1000	200, 556
	IBM 729 Compatible		Yes	No	Yes	Yes	No	No	Yes
	Checking	Reading	Track & row parity	Row parity	Track & row parity		Row parity	Row parity	2-way parity
		Writing	Read after write	Read after write			None	Read after write	
	Features and Comments		Can be connected to 1004 III systems only	1050 IV Processor can control twice as many tape units as indicated			Can read backward	Can read backward	

*With optional equipment.

UNIVAC 1108			System Identity		
785:			Computer System Report No.		
Fastrand II	FH-432	FH-1782	Model Number		AUXILIARY STORAGE
Drum	Drum	Drum	Type of Storage		
8/channel	9/channel	8/channel	Units On-Line	Maximum Number	
1/channel	1/channel	1/channel	Read/Write Operations		
8/channel	1/channel	1/channel	Seek Operations		
22, 020, 096	262, 144	2, 097, 152	Minimum	Number of Words per Unit	
176, 160, 768	2, 097, 152	16, 778, 216	Maximum		
1, 850 x 10^6/ch	22.1 x 10^6/ch	174.3 x 10^6/ch	Decimal Digits	Maximum Total Storage	
1, 057 x 10^6/ch	12.6 x 10^6/ch	99.7 x 10^6/ch	Characters		
5.0	0	0	Minimum	Waiting Time, msec.	
93.0	4.25	17.0	Average (Random)		
155.0	8.5	34.0	Maximum		
148, 200	1, 422, 000	1, 362, 000	Effective Transfer Rate, char/sec.		
6 to 393, 204	6 to 393, 204	6 to 393, 204	Transfer Load Size, char.		
Parity, phase	Word parity	Word parity	Checking		
Dual-channel controller available	Dual-channel controller available	Can be intermixed with FH-432 on same controller	Features and Comments		
Uniservo VIC	Uniservo VIIIC		Model Number		MAGNETIC TAPE
16/channel	16/channel		On-Line	Maximum Number of Units	
1/channel	1/channel		Reading/Writing		
1/channel	1/channel		Searching		
All	All		Rewinding		
0.43 max	1.2 max		Reading/Writing	Demands on Processor, %	
0	0		Starting/Stopping		
8.5 to 34.0	24.0 to 96.0		Peak	Transfer Rate, Kilo-char/sec.	
21.1 to 29.6	59.5 to 79.7		1,000-char blocks		
4.76 to 13.6	13.4 to 38.4		100-char blocks		
6			Data Tracks		
6 to 393, 204			Data Rows per Block		
200, 556, 800			Data Rows per Inch		
Yes			IBM 729 Compatible		
Track and row parity			Reading	Checking	
Read after write			Writing		
Dual-channel controllers available; 9-track, IBM 2400 Series compatible versions available			Features and Comments		

*With optional equipment.

HARDWARE CHARACTERISTICS COMPARISON CHARTS
PUNCHED CARD AND PUNCHED TAPE INPUT-OUTPUT

	System Identity	Burroughs B 100/200/300 Series		Burroughs B 5500		Burroughs 500 Systems B 2500 & B 3500	
	Computer System Report No.	201:		203:		210:	
PUNCHED CARD INPUT	Model Number	B 122	B 123; 124; or 129	B 122	B 123; B 124; B 129	9110	9111;9112
	Maximum Number On-Line	2	2	2	2	1/ch.	1/ch.
	Peak Speed, cards/min.	200	475; 800; 1400	200	475; 800; 1400	200	800; 1400
	Demands on Processor, %	0.7	2.5; 4.3; 7.5	0.04	0.16	?	?
	Code Translation	Automatic	Automatic	Automatic	Automatic	Automatic	Automatic
	Checking	Validity, photocells	Validity, photocells	Validity	Validity	Validity	Validity
	Features and Comments	Maximum of 1 reader with B 100 Series; B 200/300 6-μsec processor is necessary for use of B 129		Reads Hollerith or column binary code		Reads Hollerith or column binary code	
PUNCHED CARD OUTPUT	Model Number	B 303	B 304	B 303	B 304	9210	9211
	Maximum Number On-Line	1	1	1	1	1/ch.	1/ch.
	Peak Speed, cards/min.	100	300	100	300	100	300
	Demands on Processor, %	2.5	7.4	0.01	0.03	?	?
	Code Translation	Automatic	Automatic	Automatic		Automatic	
	Checking	Read compare	Read compare	Read compare		Read compare	
	Features and Comments	Binary card punching is possible with B 300 Series processor only		Punches Hollerith or binary code		Punches Hollerith or binary code	
PUNCHED TAPE INPUT	Model Number	B 141		B 141		9120	
	Maximum Number On-Line	2		2		1/channel	
	Peak Speed, char/sec.	500 or 1,000		500 or 1,000		500 or 1,000	
	Demands on Processor, %	1.5 or 3.1		?		?	
	Code Translation	Automatic		Programmed; automatic*		Automatic	
	Checking	Parity		Parity		Parity	
	Features and Comments	Available for use only with B 200/300 6-μsec processor				Optional Input Code Translator provides full code translation capability	
PUNCHED TAPE OUTPUT	Model Number	B 341		B 341		9220	
	Maximum Number On-Line	1		2		1/channel	
	Peak Speed, char/sec.	100		100		100	
	Demands on Processor, %	0.3		?		?	
	Code Translation	Automatic		Programmed; automatic*		Automatic	
	Checking	None		None		None	
	Features and Comments	Available for use only with B 200/300 6-μsec processor				Optional Output Code Translator provides full code translation capability	

*With optional equipment.

CDC 160 & 160-A	CDC 1604 & 1604-A		CDC 3000 Series			System Identity	
242: & 244:	241: & 243:		245: etc.			Computer System Report No.	
167	1610 (IBM 088)	1617	405			Model Number	PUNCHED CARD INPUT
1	3	3	Many			Maximum Number On-Line	
250	1,300	250	1,200			Peak Speed, cards/min.	
100 (1.1 in 160-A*)		0.4 max.	<0.2			Demands on Processor, %	
Programmed (Automatic*)	None	Automatic or matched	Automatic			Code Translation	
None	At half speed	None	Dual read*			Checking	
	A number of other IBM units can be used		Full card buffer and dual read controls optional			Features and Comments	
170	1609 (IBM 521)		CDC 415	IBM 523	IBM 544	Model Number	PUNCHED CARD OUTPUT
1	3		Many			Minimum Number On-Line	
100	100		250	100	250	Peak Speed, cards/min.	
100 (1.0 in 160-A*)	0.06 max.		<0.1			Demands on Processor, %	
Programmed	Matched or instruction		Automatic			Code Translation	
None	None		Optional; depends on controller			Checking	
	A number of other IBM units can be used		Full card buffer and dual write controls optional			Features and Comments	
350	CDC 350		350			Model Number	PUNCHED TAPE INPUT
1	1		Many			Maximum Number On-Line	
350	350		350			Peak Speed, char/sec.	
100	0.06 max.		<0.1			Demands on Processor, %	
Programmed	Matched		Programmed			Code Translation	
None	None		Parity			Checking	
						Features and Comments	
BRPE-11	BRPE		BRPE-11			Model Number	PUNCHED TAPE OUTPUT
1	1		Many			Maximum Number On-Line	
110	110		110			Peak Speed, char/sec.	
100	0.16 max.		<0.1			Demands on Processor, %	
Programmed	Matched		Programmed			Code Translation	
None	None		Parity			Checking	
						Features and Comments	

*With optional equipment.

Punched Card Input

System Identity	Control Data 6000 Series	GE-115			GE 200 Series	
Computer System Report No.	260:	310:			320: etc.	
Model Number	405	CR-10	CR-11	CR-12	D225B	D225C
Maximum Number On-Line	Many	65	65	65	1	1
Peak Speed, cards/min.	1, 200	300	300	600	400	1, 000
Demands on Processor, %	0	80 max.	54 max.	54 max.	0. 3 to 2. 0	1. 3 to 7. 5
Code Translation	Automatic	Automatic			Automatic	Automatic
Checking	Dual read*	?			None	Read check
Features and Comments	Full-card buffer and dual read controls are optional	CR-11 and CR-12 have 3 program-selectable stackers			Decimal or 10- or 12-row binary formats	

Punched Card Output

	Control Data 6000 Series	GE-115		GE 200 Series	
Model Number	415	CP-11	CP-21	E225K	E225M
Maximum Number On-Line	Many	64	64	1	1
Peak Speed, cards/min.	250	60 to 200	300	100	300
Demands on Processor, %	0	?	?	1. 0 to 5. 8	2. 9 to 17. 3
Code Translation	Automatic	Automatic	Automatic	Automatic	
Checking	Optional; depends on controller	?	Hole count	Double punch, blank col.	Hole count
Features and Comments	Full-card buffer and dual write controls are optional	Speed depends upon no. of columns punched per card		Decimal or 10- or 12-row binary formats	

Punched Tape Input

	Control Data 6000 Series		GE-115	GE 200 Series
Model Number	3691	3694	TR-10	Paper Tape System
Maximum Number On-Line	Many	Many	64	1
Peak Speed, char/sec.	350	1, 000	400	250 or 1, 000
Demands on Processor, %	0	0	?	0. 9 to 11. 0
Code Translation	Programmed	Programmed	Programmed	Programmed
Checking	None	Character parity	Parity or read compare	Parity
Features and Comments			Reads square-hole or round-hole tape	

Punched Tape Output

	Control Data 6000 Series		GE-115	GE 200 Series
Model Number	3691	3694	TP-11	Paper Tape System
Maximum Number On-Line	Many	Many	64	1
Peak Speed, char/sec.	110	110	100	110
Demands on Processor, %	0	0	?	0. 4 to 2. 4
Code Translation	Programmed	Programmed	Programmed	Programmed
Checking	None	Character parity	None	None
Features and Comments			Square-hole and round-hole versions are available	

*With optional equipment.

GE 400 Series		GE 600 Series		Honeywell Series 200		System Identity	
330:		340:		510:		Computer System Report No.	
CR-21		CR-20		214-2	223	Model Number	PUNCHED CARD INPUT
7		10 per I/O Controller		1/trunk	1/trunk	Maximum Number On-Line	
900		900		400	800	Peak Speed, cards/min.	
0.8 to 1.4		0.72 max.		Varies	Varies	Demands on Processor, %	
Automatic		Automatic		Automatic	Automatic	Code Translation	
Validity, photocells		Validity, photocells		Validity	Validity	Checking	
Can read intermixed Hollerith and binary cards		Can read intermixed Hollerith and binary cards				Features and Comments	
CP-10	CP-20	CP-10	CP-20	214-1, 2	224	Model Number	PUNCHED CARD OUTPUT
7	7	10 per I/O Controller		1/trunk	1/trunk	Minimum Number On-Line	
100	300	100	300	100 to 400	50 to 270 or 80 to 360	Peak Speed, cards/min.	
1.1 to 1.8	0.29 to 0.42	0.96 max.	0.24 max.	Varies	Varies	Demands on Processor, %	
Automatic	Automatic	Automatic	Automatic	Automatic	Automatic	Code Translation	
Hole count	Hole count	Row parity	Row parity	Check on punching dies activated	Hole count	Checking	
Row buffer only	Full card-image buffer		Full card-image buffer	Speed depends upon position of last column punched	Speed depends upon no. of columns punched	Features and Comments	
TS-20		TS-20		209		Model Number	PUNCHED TAPE INPUT
7		10 per I/O Controller		1/trunk		Maximum Number On-Line	
500		500		600		Peak Speed, char/sec.	
0.34 to 0.56		0.30 max.		Varies		Demands on Processor, %	
Programmed		Programmed		Programmed		Code Translation	
Parity		Parity		Parity (by program)		Checking	
Combination reader/punch unit; can be used off-line		Combination reader/punch unit; can be used off-line				Features and Comments	
TS-20		TS-20		210		Model Number	PUNCHED TAPE OUTPUT
7		10 per I/O Controller		1/trunk		Maximum Number On-Line	
110		110		110		Peak Speed, char/sec.	
0.07 to 0.12		0.07 max.		Varies		Demands on Processor, %	
Programmed		Programmed		Programmed		Code Translation	
None		None		None		Checking	
						Features and Comments	

*With optional equipment.

System Identity		Honeywell 400 & 1400			Honeywell 800 & 1800	IBM 1130	
Computer System Report No.		501: and 505:			502: and 503:	418:	
PUNCHED CARD INPUT	Model Number	427	423-2		827	1442 Model 6	1442 Model 7
	Maximum Number On-Line	1	1		64	1	1
	Peak Speed, cards/min.	800	650		800	300	400
	Demands on Processor, %	60 or 2*	57		0.1 max.	Varies	
	Code Translation	Automatic	Instruction		Automatic	By subroutine	
	Checking	Hole count, validity	Hole count		Hole count, validity	Dual read	
	Features and Comments	IBM 1402 Card Read Punch	IBM 088 collator			Reader-punch has single feed	
PUNCHED CARD OUTPUT	Model Number	427	424-1	424-2	827	1442 Model 6	1442 Model 7
	Maximum Number On-Line	1	1	1	64	1	1
	Peak Speed, cards/min.	250	100	250	250	49 to 202	91 to 355
	Demands on Processor, %	70 or 2*	83	74	0.03 max.	Varies	
	Code Translation	Automatic	Instruction		Automatic	By subroutine	
	Checking	Hole count	Echo		Hole count	Echo	
	Features and Comments	IBM 1402 Card Read Punch	Usable for off-line gang punching			Serial-by-column punching	
PUNCHED TAPE INPUT	Model Number	409			809	1134	
	Maximum Number On-Line	3			8	1	
	Peak Speed, char/sec.	1,000			1,000	60	
	Demands on Processor, %	100			2.0 max.	Varies	
	Code Translation	Programmed			Programmed	By subroutine	
	Checking	Parity			Parity	None	
	Features and Comments					Model 1 reads strips only; Model 2 reads strips or spooled tape	
PUNCHED TAPE OUTPUT	Model Number	410			810	1055 Model 1	
	Maximum Number On-Line	2			8	1	
	Peak Speed, char/sec.	110			110	14.8	
	Demands on Processor, %	100			0.66 max.	Varies	
	Code Translation	Programmed			Programmed	By subroutine	
	Checking	None			None	None	
	Features and Comments					Punches one-inch 8-track paper tape	

*With optional equipment.

IBM SYSTEM/360									System Identity	
Model 20				Models 30 thru 75						
422:				423: thru 428:					Computer System Report No.	
2501 Model A1	2501 Model A2	2520 Model A1	2560 MFCM	1442 Mdl N1, N2	2501 Mdl B1	2501 Mdl B2	2520 Mdl B1	2540 Mdl 1	Model Number	PUNCHED CARD INPUT
1	1	1	1	8/channel	8/channel	8/channel	8/channel	8/channel	Maximum Number On-Line	
600	1, 000	500	500	400	600	1, 000	500	1, 000	Peak Speed, cards/min.	
12.0	20.0	10.0	4.1	Varies	Varies		Varies	Varies	Demands on Processor, %	
Automatic				Automatic	Automatic		Automatic	Automatic	Code Translation	
Validity, circuit checks				Dual read	Dual read		Validity	Dual read	Checking	
All use solar cells and read serially by column; 2520 A1 is a combination reader/punch unit; 2560 is a combination reader/punch/interpreter/collator unit.				Reader-punch has single feed	Single-access clutch		Reader-punch has single feed	Reader and punch are inde-pendent	Features and Comments	
1442 Model 5	2520 Mdl A1, A2	2520 Model A3	2560 MFCM	1442 Mdl N1, N2	2520 Mdl B1, B2	2520 Mdl B3	2540 Model 1		Model Number	PUNCHED CARD OUTPUT
1	1	1	1	8/channel	8/channel	8/channel	8/channel		Minimum Number On-Line	
91 to 360	500	300	91 to 360	91 to 360	500	300	300		Peak Speed, cards/min.	
Varies	7.5	9.5	3.1	Varies	Varies		Varies		Demands on Processor, %	
Automatic				Automatic	Automatic		Automatic		Code Translation	
Echo				Echo	Echo		Hole count		Checking	
1442 punches serially by column, others by row; 2520 A1 is a combination reader/punch unit; 2560 is a combination reader/punch/interpreter/collator unit.				Serial by column punching	Row-by-row parallel punching		Column Binary and Punch Feed Read options available		Features and Comments	
				2671					Model Number	PUNCHED TAPE INPUT
				8/channel					Maximum Number On-Line	
				1, 000					Peak Speed, char/sec.	
				Varies					Demands on Processor, %	
				Programmed					Code Translation	
				Parity					Checking	
				Spooling facilities are optional					Features and Comments	
									Model Number	PUNCHED TAPE OUTPUT
									Maximum Number On-Line	
									Peak Speed, char/sec.	
									Demands on Processor, %	
									Code Translation	
									Checking	
									Features and Comments	

*With optional equipment.

System Identity		IBM System/360 Model 44				IBM 704 & 709
Computer System Report No.		435:				406: & 407:
PUNCHED CARD INPUT	Model Number	1442 Model N1	2501 Models B1, B2	2520 Model B1	2540 Model 1	711
	Maximum Number On-Line	8/channel	8/channel	8/channel	8/channel	1
	Peak Speed, cards/min.	400	600/1,000	500	1,000	250
	Demands on Processor, %	Varies	Varies	Varies	Varies	27 with 704; < 1 with 709
	Code Translation	Automatic	Automatic	Automatic	Automatic	None
	Checking	Dual read	Dual read	Validity	Dual read	Possible
	Features and Comments	Reader-punch has single feed	Single-access clutch	Reader-punch has single feed	Reader and punch are independent	Reads binary image of 72 out of 80 columns
PUNCHED CARD OUTPUT	Model Number	1442 Models N1, N2	2520 Models B1, B2	2520 Model B3	2540 Model 1	721
	Maximum Number On-Line	8/channel	8/channel	8/channel	8/channel	1
	Peak Speed, cards/min.	91 to 360	500	300	300	100
	Demands on Processor, %	Varies	Varies		Varies	40 with 704; < 1 with 709
	Code Translation	Automatic	Automatic		Automatic	None
	Checking	Echo	Echo		Hole count	None
	Features and Comments	Serial-by-column punching	Row-by-row parallel punching		Column Binary and Punch Feed Read options available	Can be used to gang punch
PUNCHED TAPE INPUT	Model Number	2671				
	Maximum Number On-Line	8/channel				
	Peak Speed, char/sec.	1,000				
	Demands on Processor, %	Varies				
	Code Translation	Programmed				
	Checking	Parity				
	Features and Comments	Spooling facilities are optional				
PUNCHED TAPE OUTPUT	Model Number					
	Maximum Number On-Line					
	Peak Speed, char/sec.					
	Demands on Processor, %					
	Code Translation					
	Checking					
	Features and Comments					

*With optional equipment.

IBM 1401 & 1460	IBM 1401-G	IBM 1410	System Identity	
401: & 415:	401: 012	402:	Computer System Report No.	
1402 Mod. 1	1402 Mod. 4 or 5	1402 Mod. 2	Model Number	PUNCHED CARD INPUT
1	1	2	Maximum Number On-Line	
800	450	800	Peak Speed, cards/min.	
87 to 16*	84 or 58*	1	Demands on Processor, %	
Automatic	Automatic	Automatic	Code Translation	
Hole count, validity	Hole count, validity	Hole count, validity	Checking	
Column binary format is optional; three stackers	Three stackers	Three stackers	Features and Comments	
1402 Mod. 1	1402 Mod. 4 or 5	1402 Mod. 2	Model Number	PUNCHED CARD OUTPUT
1	1	2	Minimum Number On-Line	
250	250	250	Peak Speed, cards/min.	
91 to 7*	91 or 75*	0.4	Demands on Processor, %	
Automatic	Automatic	Automatic	Code Translation	
Hole count	Hole count	Hole count	Checking	
Column binary format is optional; three stackers	Three stackers; optional read station	Three stackers	Features and Comments	
1011	1011	1011	Model Number	PUNCHED TAPE INPUT
1	1	2	Maximum Number On-Line	
500	500	500	Peak Speed, char/sec.	
100 or 0.6*	100	0.5	Demands on Processor, %	
Plugboard wiring	Plugboard wiring	Plugboard wiring	Code Translation	
Parity	Parity	Parity	Checking	
			Features and Comments	
1012			Model Number	PUNCHED TAPE OUTPUT
1			Maximum Number On-Line	
150			Peak Speed, char/sec.	
100			Demands on Processor, %	
Programmed			Code Translation	
Read compare			Checking	
			Features and Comments	

*With optional equipment.

	System Identity	IBM 1440			IBM 7010	IBM 7040 & 7044	
	Computer System Report No.	414:			416:	410: & 411:	
PUNCHED CARD INPUT	Model Number	1442 Mod. 1	1442 Mod. 2, 4		1402 Mod. 2	1402 Mod. 2	1622
	Maximum Number On-Line	2	2		2	1	1
	Peak Speed, cards/min.	300	400		800	800	250
	Demands on Processor, %	21 to 73	21 to 73		0.32	0.4 max.	0.2 max.
	Code Translation	Automatic			Automatic	Automatic	Automatic
	Checking	Dual read			Hole count, validity	Hole count	Dual read
	Features and Comments	Models 1 and 2 are combination read/punch units			Three stackers	Reads binary images or BCD	
PUNCHED CARD OUTPUT	Model Number	1442 Mod. 1	1442 Mod. 2	1444	1402 Mod. 2	1402 Mod. 2	1622
	Maximum Number On-Line	2	2	1	2	1	1
	Peak Speed, cards/min.	50 to 270	88 to 360	250	250	250	125
	Demands on Processor, %	83	76	91	0.1	0.3 max.	0.1 max.
	Code Translation	Automatic			Automatic	Automatic	Automatic
	Checking	Echo		Hole count	Hole count	Hole count	Read compare
	Features and Comments	1442 speed depends on number of columns punched			Three stackers	Punches BCD or binary image	
PUNCHED TAPE INPUT	Model Number	1011			1011	1011	
	Maximum Number On-Line	1			2	5	
	Peak Speed, char/sec.	500			500	500	
	Demands on Processor, %	100			0.144 min.	0.1 max.	
	Code Translation	Plugboard wiring			Plugboard wiring	Plugboard wiring	
	Checking	Parity			Parity	Parity	
	Features and Comments						
PUNCHED TAPE OUTPUT	Model Number	1012					
	Maximum Number On-Line	1					
	Peak Speed, char/sec.	150					
	Demands on Processor, %	100					
	Code Translation	Programmed					
	Checking	Read compare					
	Features and Comments						

*With optional equipment.

IBM 7070/7072/7074		IBM 7080		IBM 7090 & 7094	System Identity	
403: etc.		417:		408: & 409:	Computer System Report No.	
7501	7500	714	7502	711	Model Number	PUNCHED CARD INPUT
1	3	10	1	1	Maximum Number On-Line	
60	500	250	60	250	Peak Speed, cards/min.	
100	5 max.	100	100	<1	Demands on Processor, %	
Automatic	Automatic	Automatic	Automatic	None	Code Translation	
Double punch, blank column	Read compare, char. validity	Hole count	Validity	Possible	Checking	
Reads numeric codes only	No longer in production; not usable on 7072			Reads binary image of 72 out of 80 columns	Features and Comments	
7550		722		721	Model Number	PUNCHED CARD OUTPUT
3		10		1	Minimum Number On-Line	
250		100		100	Peak Speed, cards/min.	
2.5 max.		100		<1	Demands on Processor, %	
Automatic		Automatic		None	Code Translation	
Double punch, blank column		Hole count, validity		None	Checking	
No longer in production; not usable on 7072		No longer in production		Can be used to gang punch	Features and Comments	
					Model Number	PUNCHED TAPE INPUT
					Maximum Number On-Line	
					Peak Speed, char/sec.	
					Demands on Processor, %	
					Code Translation	
					Checking	
					Features and Comments	
					Model Number	PUNCHED TAPE OUTPUT
					Maximum Number On-Line	
					Peak Speed, char/sec.	
					Demands on Processor, %	
					Code Translation	
					Checking	
					Features and Comments	

*With optional equipment.

	System Identity	IBM 1620	LGP-30 (Control Data)		Monrobot XI	
	Computer System Report No.	412: & 413:	352:		531:	
PUNCHED CARD INPUT	Model Number	1622	IBM 024 or 026		IBM 024 or 026	
	Maximum Number On-Line	1	1		1	
	Peak Speed, cards/min.	250	(20 col/sec.)		(16 col/sec.)	
	Demands on Processor, %	1.4	100		4.6	
	Code Translation	Automatic	Programmed		Matched or programmed	
	Checking	Dual read, parity	None		Parity	
	Features and Comments		Model 321 Control Unit required		Model 24 Coupler required	
PUNCHED CARD OUTPUT	Model Number	1622			IBM 024 or 026	
	Maximum Number On-Line	1			1	
	Peak Speed, cards/min.	125			(16 col/sec.)	
	Demands on Processor, %	0.7			4.6	
	Code Translation	Automatic			Matched or programmed	
	Checking	Read compare			None	
	Features and Comments				Model 26 Coupler required	
PUNCHED TAPE INPUT	Model Number	1621	360	341, 342	Paper Tape Reader	Photoelectric Reader
	Maximum Number On-Line	1	1	1	3	3
	Peak Speed, char/sec.	150	10	200	20	300
	Demands on Processor, %	100	100	100	5.8	?
	Code Translation	Automatic	Matched or programmed		Matched or programmed	
	Checking	Parity	None		Parity	
	Features and Comments		The 360, a modified Flexowriter, is basic LGP-30 I/O device			
PUNCHED TAPE OUTPUT	Model Number	1624	360	342	Paper Tape Punch	
	Maximum Number On-Line	1	1	1	3	
	Peak Speed, char/sec.	15	10	20	20	
	Demands on Processor, %	100	2.4 to 100	5 to 100	5.8	
	Code Translation	Automatic	Matched	Matched	Matched or programmed	
	Checking	None	None	None	None	
	Features and Comments					

*With optional equipment.

NCR 315, 315-100, 315 RMC				PB 250 (Raytheon)		System Identity	
601:, 602:, 603:				631:		Computer System Report No.	
376-7	376-8	380-3	472-2, -3	CR 2		Model Number	PUNCHED CARD INPUT
2	2	1	1			Maximum Number On-Line	
300	400	2, 000	400			Peak Speed, cards/min.	
73 max.	73 max.	80 max.	84 max.			Demands on Processor, %	
Automatic		Automatic	Programmed			Code Translation	
Dual read		Validity	None			Checking	
IBM 1442 Card Read Punch units; not available with 315 RMC systems			Not available with 315 RMC systems	No firm specifications available		Features and Comments	
376-7	376-8	376-2	376-101	Card Punch Coupler		Model Number	PUNCHED CARD OUTPUT
2	2	4	4			Minimum Number On-Line	
50 to 270	88 to 360	100	250			Peak Speed, cards/min.	
83 max.	77 max.	<1	<1			Demands on Processor, %	
Automatic		Automatic	Automatic			Code Translation	
Echo		Echo	?			Checking	
IBM 1442 Card Read Punch units; not available with 315 RMC systems				No firm specifications available		Features and Comments	
472-1, 472-3		361-201		Flexowriter Reader	HSR-1	Model Number	PUNCHED TAPE INPUT
1		1		1	2	Maximum Number On-Line	
1, 000		600		10	300	Peak Speed, char/sec.	
100		100		6 to 100	100	Demands on Processor, %	
Programmed		Programmed		Matched or programmed		Code Translation	
Parity		Parity		None		Checking	
Code translation can be performed during time between characters		Code translation can be performed during time between characters				Features and Comments	
472-1, 472-3		371-201		Flexowriter Punch	HSP-1	Model Number	PUNCHED TAPE OUTPUT
1		1		1	?	Maximum Number On-Line	
110		120		15	110	Peak Speed, char/sec.	
100		100		22 to 37	0. 05 to 100	Demands on Processor, %	
Programmed		Programmed		Matched or programmed		Code Translation	
None		None		None		Checking	
Code translation can be performed during time between characters		Code translation can be performed during time between characters				Features and Comments	

*With optional equipment.

System Identity		Philco 2000 Series		RCA 301		RCA 3301	
Computer System Report No.		651; etc.		701:		703:	
PUNCHED CARD INPUT	Model Number	258		323		324	329
	Maximum Number On-Line	28		2		2	2
	Peak Speed, cards/min.	2,000		600		900	1,470
	Demands on Processor, %	0.33 max.		80 to 13*		0.1	0.2
	Code Translation	Automatic		Automatic		Automatic	
	Checking	Dual read		Hole count, validity		Char. validity	
	Features and Comments	May be any of 7 units on a UBC		Reject stacker		Photocells are tested during each card cycle	
PUNCHED CARD OUTPUT	Model Number	265		334		3436	
	Maximum Number On-Line	28		1		2	
	Peak Speed, cards/min.	100		100		300	
	Demands on Processor, %	0.02 max.		100 to 1*		<0.1	
	Code Translation	Automatic		Automatic		Automatic	
	Checking	Read after punch		Hole count, validity		Hole count	
	Features and Comments	May be any of 7 units on a UBC				Punches Hollerith or column binary code	
PUNCHED TAPE INPUT	Model Number	Part of 240	Part of 241	321	322	321	322
	Maximum Number On-Line	1	28	1	1	2	2
	Peak Speed, char/sec.	1,000 & 500		100	500 or 1,000	100	1,000
	Demands on Processor, %	0.1 max.		100 to 0.1*	100 to 0.4*	<0.1	0.2
	Code Translation	Matched		Matched		Programmed	
	Checking	Parity		Parity		Parity	
	Features and Comments	Separate direct connection	May be any of 7 units on a UBC				
PUNCHED TAPE OUTPUT	Model Number	Part of 240	Part of 241	321, 331		321, 331	332
	Maximum Number On-Line	1	28	1		2	2
	Peak Speed, char/sec.	60		100		100	300
	Demands on Processor, %	0.1 max.		100 to 0.1*		<0.1	<0.1
	Code Translation	Matched		Matched		Programmed	
	Checking	None		None		Echo	
	Features and Comments	Separate direct connection	May be any of 7 units on a UBC				

*With optional equipment.

UNIVAC 418	UNIVAC 1004		UNIVAC 1050		System Identity	
790:	770:		777:		Computer System Report No.	
UNIVAC 1004 Card Reader	1004 I	1004 II, 1004 III	0706-00	0706-01	Model Number	PUNCHED CARD INPUT
16	1	1	4 or 8	4 or 8	Maximum Number On-Line	
400 or 615	400	615	800/900	600	Peak Speed, cards/min.	
0.1 to 0.4	100	94	0.6 max.	0.3 max.	Demands on Processor, %	
Automatic	Automatic		Automatic on 80-column models		Code Translation	
Circuit checks	Proper photocell functioning only		Hole count		Checking	
1004 is used on-line with 418 to handle card I/O	Auxiliary 400 cpm reader can be added to any 1004 system		900 cpm rate is attained when only 72 columns per card are read		Features and Comments	
UNIVAC 1004 Card Punch	2009, 2011		0600-00	0600-12	Model Number	PUNCHED CARD OUTPUT
16	1		4 or 8	4 or 8	Minimum Number On-Line	
200	200		300	200	Peak Speed, cards/min.	
<0.1	<1		5.1 max.	3.4 max.	Demands on Processor, %	
Automatic	Automatic		Automatic on 80-column models		Code Translation	
Hole count	Hole count		Hole count		Checking	
1004 is used on-line with 418 to handle card I/O	Available for 80 or 90-column cards; read station is optional		Can punch binary images		Features and Comments	
Paper Tape Subsystem	0902		0903-00	?	Model Number	PUNCHED TAPE INPUT
1	1		3 or 8	3 or 8	Maximum Number On-Line	
200	400		1,000	500	Peak Speed, char/sec.	
<0.1	100		0.5 max.	0.3 max.	Demands on Processor, %	
Programmed	Programmed		Programmed		Code Translation	
Parity	Parity		Parity		Checking	
Combination reader/punch unit					Features and Comments	
Paper Tape Subsystem	F0606		0606-01		Model Number	PUNCHED TAPE OUTPUT
1	1		3 or 8		Maximum Number On-Line	
110	110		110		Peak Speed, char/sec.	
<0.1	<1		0.05 max.		Demands on Processor, %	
Programmed	Programmed		Programmed		Code Translation	
None	None		None		Checking	
					Features and Comments	

*With optional equipment.

System Identity		UNIVAC 490 Series	UNIVAC 1107		UNIVAC 1108
Computer System Report No.		800:	784:		785:
PUNCHED CARD INPUT	Model Number	490 Punched Card Subsystem	Type 7223		1108 Punched Card Subsystem
	Maximum Number On-Line	1 per channel	15		1 per channel
	Peak Speed, cards/min.	800/900	600		900
	Demands on Processor, %	0.032 to 0.25	0.15 max.		0.016 max.
	Code Translation	Automatic on 80-column models	Automatic (or matched)		Automatic
	Checking	Hole count	Dual read		Hole count
	Features and Comments	Higher rate when reading only 72 columns; row and column binary optional			Row binary and column binary reading optional
PUNCHED CARD OUTPUT	Model Number	490 Punched Card Subsystem	Type 7224	Type 7266	1108 Punched Card Subsystem
	Maximum Number On-Line	1 per channel	15	15	1 per channel
	Peak Speed, cards/min.	300	150	300	300
	Demands on Processor, %	0.011 to 0.084	0.04 max.	0.08 max.	0.005 max.
	Code Translation	Automatic on 80-column models	Automatic (or matched)		Automatic
	Checking	Hole count	Read compare		Full card image check
	Features and Comments	Binary card images can be punched (240 holes max.)	Only Type 7266 is suitable for binary punching		Binary card images can be punched (240 holes max.)
PUNCHED TAPE INPUT	Model Number	490 Paper Tape Subsystem	Type 7423		1108 Paper Tape Subsystem
	Maximum Number On-Line	1 per channel	15		1 per channel
	Peak Speed, char/sec.	400	400		400
	Demands on Processor, %	0.06 to 0.48	0.16		0.03 max.
	Code Translation	Programmed	Programmed		Programmed
	Checking	None	None		None
	Features and Comments	Parity check can be programmed	Parity check can be programmed		Parity check can be programmed
PUNCHED TAPE OUTPUT	Model Number	490 Paper Tape Subsystem	Type 7423		1108 Paper Tape Subsystem
	Maximum Number On-Line	1 per channel	15		1 per channel
	Peak Speed, char/sec.	110	110		110
	Demands on Processor, %	0.016 to 0.13	0.04		0.008 max.
	Code Translation	Programmed	Programmed		Programmed
	Checking	Verify punch activation	Verify punch activation		Verify punch activation
	Features and Comments				

*With optional equipment.

UNIVAC 418	UNIVAC 1004		UNIVAC 1050		System Identity	
790:	770:		777:		Computer System Report No.	
UNIVAC 1004 Card Reader	1004 I	1004 II, 1004 III	0706-00	0706-01	Model Number	PUNCHED CARD INPUT
16	1	1	4 or 8	4 or 8	Maximum Number On-Line	
400 or 615	400	615	800/900	600	Peak Speed, cards/min.	
0.1 to 0.4	100	94	0.6 max.	0.3 max.	Demands on Processor, %	
Automatic	Automatic		Automatic on 80-column models		Code Translation	
Circuit checks	Proper photocell functioning only		Hole count		Checking	
1004 is used on-line with 418 to handle card I/O	Auxiliary 400 cpm reader can be added to any 1004 system		900 cpm rate is attained when only 72 columns per card are read		Features and Comments	
UNIVAC 1004 Card Punch	2009, 2011		0600-00	0600-12	Model Number	PUNCHED CARD OUTPUT
16	1		4 or 8	4 or 8	Minimum Number On-Line	
200	200		300	200	Peak Speed, cards/min.	
<0.1	<1		5.1 max.	3.4 max.	Demands on Processor, %	
Automatic	Automatic		Automatic on 80-column models		Code Translation	
Hole count	Hole count		Hole count		Checking	
1004 is used on-line with 418 to handle card I/O	Available for 80 or 90-column cards; read station is optional		Can punch binary images		Features and Comments	
Paper Tape Subsystem	0902		0903-00	?	Model Number	PUNCHED TAPE INPUT
1	1		3 or 8	3 or 8	Maximum Number On-Line	
200	400		1,000	500	Peak Speed, char/sec.	
<0.1	100		0.5 max.	0.3 max.	Demands on Processor, %	
Programmed	Programmed		Programmed		Code Translation	
Parity	Parity		Parity		Checking	
Combination reader/punch unit					Features and Comments	
Paper Tape Subsystem	F0606		0606-01		Model Number	PUNCHED TAPE OUTPUT
1	1		3 or 8		Maximum Number On-Line	
110	110		110		Peak Speed, char/sec.	
<0.1	<1		0.05 max.		Demands on Processor, %	
Programmed	Programmed		Programmed		Code Translation	
None	None		None		Checking	
					Features and Comments	

*With optional equipment.

System Identity		UNIVAC 490 Series	UNIVAC 1107	UNIVAC 1108
Computer System Report No.		800:	784:	785:
PUNCHED CARD INPUT	Model Number	490 Punched Card Subsystem	Type 7223	1108 Punched Card Subsystem
	Maximum Number On-Line	1 per channel	15	1 per channel
	Peak Speed, cards/min.	800/900	600	900
	Demands on Processor, %	0.032 to 0.25	0.15 max.	0.016 max.
	Code Translation	Automatic on 80-column models	Automatic (or matched)	Automatic
	Checking	Hole count	Dual read	Hole count
	Features and Comments	Higher rate when reading only 72 columns; row and column binary optional		Row binary and column binary reading optional

PUNCHED CARD OUTPUT		UNIVAC 490 Series	UNIVAC 1107		UNIVAC 1108
	Model Number	490 Punched Card Subsystem	Type 7224	Type 7266	1108 Punched Card Subsystem
	Maximum Number On-Line	1 per channel	15	15	1 per channel
	Peak Speed, cards/min.	300	150	300	300
	Demands on Processor, %	0.011 to 0.084	0.04 max.	0.08 max.	0.005 max.
	Code Translation	Automatic on 80-column models	Automatic (or matched)		Automatic
	Checking	Hole count	Read compare		Full card image check
	Features and Comments	Binary card images can be punched (240 holes max.)	Only Type 7266 is suitable for binary punching		Binary card images can be punched (240 holes max.)

PUNCHED TAPE INPUT		UNIVAC 490 Series	UNIVAC 1107	UNIVAC 1108
	Model Number	490 Paper Tape Subsystem	Type 7423	1108 Paper Tape Subsystem
	Maximum Number On-Line	1 per channel	15	1 per channel
	Peak Speed, char/sec.	400	400	400
	Demands on Processor, %	0.06 to 0.48	0.16	0.03 max.
	Code Translation	Programmed	Programmed	Programmed
	Checking	None	None	None
	Features and Comments	Parity check can be programmed	Parity check can be programmed	Parity check can be programmed

PUNCHED TAPE OUTPUT		UNIVAC 490 Series	UNIVAC 1107	UNIVAC 1108
	Model Number	490 Paper Tape Subsystem	Type 7423	1108 Paper Tape Subsystem
	Maximum Number On-Line	1 per channel	15	1 per channel
	Peak Speed, char/sec.	110	110	110
	Demands on Processor, %	0.016 to 0.13	0.04	0.008 max.
	Code Translation	Programmed	Programmed	Programmed
	Checking	Verify punch activation	Verify punch activation	Verify punch activation
	Features and Comments			

*With optional equipment.

UNIVAC 9000 Series: Models 9200 and 9300			System Identity	
810:			Computer System Report No.	
0711-00	0711-02	1001 Card Controller	Model Number	PUNCHED CARD INPUT
1	1	1	Maximum Number On-Line	
400	600	2,000	Peak Speed, cards/min.	
<1	1	1.6	Demands on Processor, %	
Automatic	Automatic	Automatic	Code Translation	
Proper photocell functioning	Proper photocell functioning	Proper photocell functioning	Checking	
Used with UNIVAC 9200 only	Used with UNIVAC 9300 only	Two card feeds and seven stackers permit collating; can be used off-line	Features and Comments	
0603-04	0604-00		Model Number	PUNCHED CARD OUTPUT
1	1		Minimum Number On-Line	
75 to 200	200		Peak Speed, cards/min.	
<1	<1		Demands on Processor, %	
Automatic	Automatic		Code Translation	
Echo	Hole count		Checking	
Punches serially by column; has 2 850-card stackers	Punches serially by row; has 2 1,000-card stackers		Features and Comments	
			Model Number	PUNCHED TAPE INPUT
			Maximum Number On-Line	
			Peak Speed, char/sec.	
			Demands on Processor, %	
			Code Translation	
			Checking	
			Features and Comments	
			Model Number	PUNCHED TAPE OUTPUT
			Maximum Number On-Line	
			Peak Speed, char/sec.	
			Demands on Processor, %	
			Code Translation	
			Checking	
			Features and Comments	

*With optional equipment.

HARDWARE CHARACTERISTICS COMPARISON CHARTS
OTHER INPUT-OUTPUT EQUIPMENT

System Identity			Burroughs B 100/200/300 Series		Burroughs B 5500		Burroughs 500 Systems: B 2500 & B 3500			
Computer System Report No.			201:		203:		210:			
PRINTED OUTPUT	Model Number		B 320;321;328	B 325;329	B 320;B 321; B 328	B 325; B 329	9240	9241	9242	9243
	Maximum Number On-Line		2	2	2	2	1 per channel			
	Speed, lines/min.	Single Spacing	475;700;1040	700;1040	475;700;1040	700;1040	700	1,040	815	1,040
		1-inch Spacing	370;500;595	500;595	370;540;648	540;648	540	648	620	648
	Demands on Processor, %		1.0;1.5;2.2	1.5;2.2	0.1	0.1	?			
	Number of Print Positions		120	132*	120	132	120; 132*			
	Checking		Parity, timing	Parity, timing	Parity, timing		Parity, timing			
	Features and Comments		B 100 Series can use only 1 printer	132 print positions are standard on B 300 Series			9240 and 9241 are buffered; 9242 and 9243 are unbuffered			
MICR READER	Model Number		B 106, 107	B 102, 103, 104, 116			9130; 9131; 9132			
	Maximum Number On-Line		1	1			1 per channel			
	Peak Speed, documents/min.		1,200	1,560			1565			
	Demands on Processor, %		4.0	5.2			?			
	Code Translation		Automatic				Automatic			
	Checking		Validity, signal level				Validity, signal level			
	Features and Comments		All models usable for off-line sorting; B 116 has 16 stackers; all others have 13				9130 is an off-line unit; 9130 and 9131 have 13 stackers; 9132 has 16 stackers			
OTHER INPUT-OUTPUT DEVICES	Model Number		B 401		B 5480		3351			
	Name		Record Processor		Data Communication Control Unit		Single-Line Communications Control			
	Peak Speed		44 Active ledgers/min		30,000 char/sec		?			
	Model Number		B 322, 323, 326, 332, 333		B 487		3353			
	Name		Multiple Tape Listers		Data Transmission Terminal Unit		Multi-Line Communications Control			
	Peak Speed		1,600 lines/min		38,400 bits/sec		Can control up to 36 line adapters			
	Model Number		B 248				9244-1, 9244-2			
	Name		Data Communications Control				Multiple Tape Listers			
	Peak Speed		30,000 char/sec between Control and Processor				1565 lines/min			

*With optional equipment.

CDC 160 & 160-A		CDC 1604 & 1604-A	CDC 3000 Series			System Identity	
242: & 244:		241: & 243:	245: etc			Computer System Report No.	
1612	166	1612	3253	3655	501	Model Number	PRINTED OUTPUT
1	1	24	many	many	many	Maximum Number On-Line	
500	150	667	300	1,000	1,000	Single Spacing — Speed, lines/min.	
500	130	500	241	500	?	1-inch Spacing — Speed, lines/min.	
1	0.2	2.8 max	<0.1	<0.3	<0.3	Demands on Processor, %	
120	120	120	120	120	136	Number of Print Positions	
None	None	None	Timing	None	?	Checking	
Higher speeds possible when restricted character sets are used		Increased speed is possible with restricted character set	Dual-channel controller provided with 501			Features and Comments	
						Model Number	MICR READER
						Maximum Number on-Line	
						Peak Speed, documents/min.	
						Demands on Processor, %	
						Code Translation	
						Checking	
						Features and Comments	
		1605	3681			Model Number	OTHER INPUT-OUTPUT DEVICES
		Control unit for various IBM units working in BCD	Data Channel Converter			Name	
		Depends upon units connected	Connects a CDC 160-A to a 3000 Series system			Peak Speed	
		1610	3682			Model Number	
		Control Unit for various IBM units working in column binary	Satellite Coupler			Name	
		Depends upon units connected	Links two Control Data computers			Peak Speed	
						Model Number	
						Name	
						Peak Speed	

*With optional equipment.

System Identity			Control Data 6000 Series				GE-115	
Computer System Report No.			260:				310:	
PRINTED OUTPUT	Model Number		1403	3152	501	505	PR-10	PR-11
	Maximum Number On-Line		8/ch	1/ch	8/ch	8/ch	65	65
	Speed, lines/min.	Single Spacing	1100	150	1000	500	300	600
		1-inch Spacing	750	150	571	375	220	220
	Demands on Processor, %		0	0	0	0	80 max	80 max
	Number of Print Positions		132	120	136	136	104, 120, or 136	
	Checking		Echo, validity	Echo	Echo	Echo	Parity	
	Features and Comments							
MICR READER	Model Number							
	Maximum Number On-Line							
	Peak Speed, documents/min.							
	Demands on Processor, %							
	Code Translation							
	Checking							
	Features and Comments							
OTHER INPUT-OUTPUT DEVICES	Model Number		3276				DATANET-10	
	Name		Communication Terminal Controller				Communications Control	
	Peak Speed		Up to 2400 bits/sec, depending upon terminal unit used				2,000 bits/sec (1 line)	
	Model Number		6600 Series				DATANET-11	
	Name		Data Set Controllers				Communications control	
	Peak Speed		40,800 bits/sec				2,400 bits/sec (1 line)	
	Model Number		6411					
	Name		Input-Output Buffer and Control					
	Peak Speed		Doubles input-output capability of a 6000 Series system					

*With optional equipment.

GE-200 Series		GE-400 Series	GE-600 Series	System Identity	
320: etc.		330:	340:	Computer System Report No.	
P215E (GE-215)	P225A (GE-225 & 235)	PR-21	PR-20	Model Number	PRINTED OUTPUT
3	8	7	10 per I/O Controller	Maximum Number On-Line	
450	900	1,200	949/1,200	Speed, lines/min.: Single Spacing	
360	601	665	640	Speed, lines/min.: 1-inch Spacing	
2	2 max	1.9 to 3.1	1.3 max	Demands on Processor, %	
120	120	136	136	Number of Print Positions	
Receipt of data, timing	Receipt of data, timing	Validity	Receipt of data	Checking	
	On/off-line models available	64 printable characters; listed speed is based on a restricted, 48-character set	1,200-lpm speed is based on use of 46 of the 64 printable characters	Features and Comments	
S12A (GE-215)	S12B, S12C (GE-225 & 235)	MR-20		Model Number	MICR READER
1	3	7		Maximum Number on-Line	
750 (550 on demand)	1,200 (600 on demand)	1,155		Peak Speed, documents/min.	
?	1	Variable		Demands on Processor, %	
Automatic	Automatic	Automatic		Code Translation	
Validity	Validity	Validity		Checking	
12 stackers; usable for off-line sorting	12 stackers; usable for off-line sorting	12 stackers; usable for off-line sorting		Features and Comments	
Datanet-15		ML-20	Datanet-30	Model Number	OTHER INPUT-OUTPUT DEVICES
Data Transmission Controller		Multiple Tape Lister	Data Communications Processor	Name	
2,400 bits/sec		2,000 lines/min	2,400 bits/sec; up to 128 lines	Peak Speed	
		DATANET-20, -21, -25, -30, -70		Model Number	
		Data communications equipment		Name	
		Varies with model		Peak Speed	
				Model Number	
				Name	
				Peak Speed	

*With optional equipment.

			Honeywell Series 200	Honeywell 400 & 1400	Honeywell 800 & 1800
System Identity			Honeywell Series 200	Honeywell 400 & 1400	Honeywell 800 & 1800
Computer System Report No.			510:	501: & 505:	502: & 503:
PRINTED OUTPUT	Model Number		222	422-3, 422-4	822
	Maximum Number On-Line		1/trunk	1	8
	Speed, lines/min.	Single Spacing	450, 650, or 950	900	900
		1-inch Spacing	381, 465, or 640	560	560
	Demands on Processor, %		Varies	79 or 2*	0.3 max
	Number of Print Positions		96, 108, 120, or 132*	120	120
	Checking		Timing	Echo	Echo
	Features and Comments			422-4 can print in any 120 of 160 print positions	Prints 120 of 160 positions, as selected by plugboard
MICR READER	Model Number				
	Maximum Number On-Line				
	Peak Speed, documents/min.				
	Demands on Processor, %				
	Code Translation				
	Checking				
	Features and Comments		An adapter permits on-line use of Burroughs or IBM MICR Sorter/Readers		
OTHER INPUT-OUTPUT DEVICES	Model Number		281	480	840
	Name		Single-Channel Communications Control	Communications Control Unit	Optical Scanner
	Peak Speed		up to 5,100 char/sec	150 char/sec	312 documents/min
	Model Number		286	436	
	Name		Multi-Channel Communications Control	Tape Control Unit	
	Peak Speed		up to 300 char/sec; up to 63 lines	(controls IBM 729II)	
	Model Number		288		
	Name		Data Station; controls remote I/O devices		
	Peak Speed		up to 120 char/sec		

*With optional equipment.

IBM SYSTEM/360									System Identity	
Model 20			Models 30-75							
422:			423: thru 428:						Computer System Report No.	
1403 Model 2, 7	1403 Model N1	2203 Model A1	1403 Model 2, 7	1403 Model 3	1403 Model N1	1404 Model 2	1443 Model N1	1445 Model N1	Model Number	PRINTED OUTPUT
1	1	1	8/channel	8/channel	8/channel	8/channel	8/channel	8/channel	Maximum Number On-Line	
600	1,100	350 (750 numeric)	600	1,100	1,100	600	240 (600 numeric)	190 (525 numeric)	Speed, lines/min.: Single Spacing	
480	755	265	480	755	755	480	190	150	Speed, lines/min.: 1-inch Spacing	
2.0	3.6	21.5 max	Varies	Varies	Varies	Varies	Varies	Varies	Demands on Processor, %	
132-Mdl 2 120-Mdl 7	120	120 (or 144*)	132-Mdl 2 120-Mdl 7	132	120	132	120 (or 144*)	113	Number of Print Positions	
Echo	Echo	Print synch.	Echo	Echo	Echo	Echo	Print synch.	Print synch.	Checking	
Horiz. chain printer	Uses train of type slugs	Horiz. typebar; 13, 39, 52, or 63 chars.	Horiz. chain printer	Horiz. train of type slugs	Has acous-tical cover	Can print on punched cards	Horiz. typebar; 13, 39, 52, or 63 chars.	Can print MICR chars.	Features and Comments	

1419 Model 1	1412 Model 1	1419 Model 1	Model Number	MICR READER
1	1	2	Maximum Number on-Line	
1,515	950	1,515	Peak Speed, documents/min.	
	Varies	Varies	Demands on Processor, %	
Automatic	Automatic	Automatic	Code Translation	
Validity, timing	Validity, timing	Validity, timing	Checking	
Can be used for off-line sorting	For Model 30 only	For Models 30 & 40 only	Features and Comments	

#2073	1418	2701	2250	Model Number	OTHER INPUT-OUTPUT DEVICES
Communications Adapter	Optical Character Reader	Data Adapter Unit	Display Unit	Name	
75 to 600 char/sec over a single line	413 doc/min	40,800 bits/sec over 4 lines max.	approx. 60,000 points or char/sec.	Peak Speed	
2560	1428	2702	2260	Model Number	
Multi-Function Card Machine	Alphameric Optical Reader	Transmission Control Unit	Display Station	Name	
Reads 500 cpm; punches 160 col/sec; prints 140 col/sec*	400 doc/min.	200 bits/sec over 31 lines* max.	2,560 char/sec.	Peak Speed	
	1285	2703	7770 and 7772	Model Number	
	Optical Journal Tape Reader	Transmission Control Unit	Audio Response Units	Name	
	2,500 lines/min.	180 bits/sec. over 176 lines max.	- -	Peak Speed	

*With optional equipment.

System Identity			IBM System/360 Model 44				IBM 1130
Computer System Report No.			435:				418:
PRINTED OUTPUT	Model Number		1403 Model 2, 7	1403 Model 3	1403 Model N1	1443 Model N1	1132
	Maximum Number On-Line		8/channel	8/channel	8/channel	8/channel	1
	Speed, lines/min.	Single Spacing	600	1,100	1,100	240 (600 numeric)	110
		1-inch Spacing	480	755	755	190	62
	Demands on Processor, %		Varies	Varies	Varies	Varies	Varies
	Number of Print Positions		132-Mdl 2; 120-Mdl 7	132	120	120 (or 144*)	120
	Checking		Echo	Echo	Echo	Print synch.	Synchronization
	Features and Comments		Horizontal chain printer	Horizontal train of type slugs	Has acoustical cover	Horizontal typebar; 13, 39, 52, or 63 characters	Peak speed is 82 LPM when printing alphanumeric data; uses a print drum
MICR READER	Model Number						
	Maximum Number On-Line						
	Peak Speed, documents/min.						
	Demands on Processor, %						
	Code Translation						
	Checking						
	Features and Comments		No MICR equipment available				
OTHER INPUT-OUTPUT DEVICES	Model Number		2701		2702		1627 Model 1
	Name		Data Adapter Unit		Transmission Control Unit		Plotter
	Peak Speed		40,800 bits/sec over 4 lines max.		200 bits/sec over 31 lines* max.		18,000 X-Y steps/min.
	Model Number		2250		2260		1627 Model 2
	Name		Display Unit		Display Station		Plotter
	Peak Speed		approx. 60,000 points or char/sec		2,560 char/sec		12,000 X-Y steps/min.
	Model Number		1801 and 1802		2280, 2281, and 2282		1130
	Name		Processor-Controller		Film Devices		Console Printer/Keyboard
	Peak Speed		--		102 to 408 μsec per line recorded		15.5 char/sec

*With optional equipment.

IBM 704 & 709	IBM 1401		IBM 1401-G		System Identity	
406: & 407:	401		401:012		Computer System Report No.	
716	1403 Mod. 1, 2		1403 Mod. 4 or 5	1403 Mod. 6	Model Number	PRINTED OUTPUT
1	1		1	1	Maximum Number On-Line	PRINTED OUTPUT
75 to 150	600 (1,285 numeric*)		465	340	Speed, lines/min.: Single Spacing	PRINTED OUTPUT
75 to 150	480 (838 numeric*)		390	300	Speed, lines/min.: 1-inch Spacing	PRINTED OUTPUT
20 in 704; < 1 in 709	84 to 2*		87	?	Demands on Processor, %	PRINTED OUTPUT
120	100 or 132		100 or 132	120	Number of Print Positions	PRINTED OUTPUT
Programmed echo	Echo, validity		Echo, validity		Checking	PRINTED OUTPUT
Maximum of 72 characters per print cycle	Horizontal-chain print mechanism		Horizontal-chain print mechanism		Features and Comments	PRINTED OUTPUT
	1412	1419	1412		Model Number	MICR READER
	1	1	1		Maximum Number on-Line	MICR READER
	950	1,600	950		Peak Speed, documents/min.	MICR READER
	76.4	74.7 or 14.1*	76.4		Demands on Processor, %	MICR READER
	Automatic		Automatic		Code Translation	MICR READER
	Validity, timing		Validity, timing		Checking	MICR READER
	13 stackers; usable for off-line sorting		13 stackers; usable for off-line sorting		Features and Comments	MICR READER
740	1404		1418		Model Number	OTHER INPUT-OUTPUT DEVICES
CRT Recorder	Printer (cards or forms)		Optical Character Reader		Name	OTHER INPUT-OUTPUT DEVICES
7,000 points/sec	400 cards or 600 lines/min.		415 documents/min.		Peak Speed	OTHER INPUT-OUTPUT DEVICES
780	1418		1285		Model Number	OTHER INPUT-OUTPUT DEVICES
CRT Display	Optical Character Reader		Optical Journal Tape Reader		Name	OTHER INPUT-OUTPUT DEVICES
7,000 points/sec	415 documents/min.		2,500 lines/min.		Peak Speed	OTHER INPUT-OUTPUT DEVICES
	1428		1009		Model Number	OTHER INPUT-OUTPUT DEVICES
	Alphameric Optical Reader		Data Transmission Unit		Name	OTHER INPUT-OUTPUT DEVICES
	400 documents/min.		up to 300 char/sec.		Peak Speed	OTHER INPUT-OUTPUT DEVICES

*With optional equipment.

	System Identity		IBM 1410		IBM 1440		IBM 1460	
	Computer System Report No.		402:		414:		415:	
PRINTED OUTPUT	Model Number		1403 Mod. 1, 2	1403 Mod. 3	1443 Mod. 1	1443 Mod. 2	1403 Mod. 2	1403 Mod. 3
	Maximum Number On-Line		2	2	1	1	3	3
	Speed, lines/min.	Single Spacing	600 (1,285 numeric*)	1,100	150 (430 numeric)	240 (600 numeric)	600 (1,285 numeric*)	1,100
		1-inch Spacing	480 (838 numeric*)	750	132	196	480 (838 numeric*)	750
	Demands on Processor, %		1 to 3	2.6	94 or 0.6*	90 or 1.0*	84 to 1*	1.8
	Number of Print Positions		100 or 132	132	120 or 144*		132	
	Checking		Echo, validity		Print synch.		Echo, validity	
	Features and Comments				Interchangeable horizontal typebar: 13, 39, 52, or 63 characters*			
MICR READER	Model Number		1412	1419	1412		1412	1419
	Maximum Number On-Line		2	2	1		1	1
	Peak Speed, documents/min.		950	1,600	950		950	1,600
	Demands on Processor, %		76.4 (or 8.4*)	74.7 (or 14.1*)	?		?	?
	Code Translation		Automatic		Automatic		Automatic	
	Checking		Validity, timing		Validity, timing		Validity, timing	
	Features and Comments		13 stackers; usable for off-line sorting		13 stackers; usable for off-line sorting		13 stackers; usable for off-line sorting	
OTHER INPUT-OUTPUT DEVICES	Model Number		1009		1448		1009	
	Name		Data Transmission Unit		Transmission Control Unit		Data Transmission Unit	
	Peak Speed		300 char/sec		up to 60 char/sec		300 char/sec	
	Model Number		1014		7740		1418	
	Name		Remote Inquiry Unit		Communication Control System		Optical Character Reader	
	Peak Speed		15.5 char/sec		2,400 bits/sec; up to 84 lines		420 documents/min	
	Model Number		7750		1231		1428	
	Name		Programmed Transmission Control		Optical Mark Page Reader		Alphameric Optical Reader	
	Peak Speed		1,200 bits/sec		2,000 documents/hr		400 documents/min	

*With optional equipment.

IBM 1620		IBM 7010		IBM 7040 & 7044		System Identity		
412: & 413:		416:		410: & 411:		Computer System Report No.		
Model 1	Model 2	1403 Mod. 1, 2	1403 Mod. 3	1403 Mod. 1, 2	1403 Mod. 3	Model Number		PRINTED OUTPUT
I/O Typewriter								
1	1	2	2	2	2	Maximum Number On-Line		
(10 char/sec)	(15.5 char/ sec)	600 (1,285 numeric*)	1,100	600 (1,285 numeric*)	1,100	Single Spacing	Speed, lines/min.	
- -	- -	480 (838 numeric*)	750	480 (838 numeric*)	750	1-inch Spacing		
100		0.3 to 0.84	0.73	0.7 max	1.3 max	Demands on Processor, %		
85		100 or 132	132	100 or 132	132	Number of Print Positions		
None		Echo, validity		Echo, validity		Checking		
Also usable for keyboard input. See also 1443 Printer, below.						Features and Comments		
						Model Number		MICR READER
						Maximum Number on-Line		
						Peak Speed, documents/min.		
						Demands on Processor, %		
						Code Translation		
						Checking		
						Features and Comments		
560-R		1009		1009		Model Number		OTHER INPUT-OUTPUT DEVICES
Calcomp Digital Recorder		Data Transmission Unit		Data Transmission Unit		Name		
200 increments/sec		300 char/sec		300 char/sec		Peak Speed		
1443 Model 1 or 2		1014		1014		Model Number		
Printer		Remote Inquiry Unit		Remote Inquiry Unit		Name		
150 or 240 alphameric lines/min		15.5 char/sec		15.5 char/sec		Peak Speed		
		7750		7740		Model Number		
		Programmed Transmission Control		Communication Control System		Name		
		1,200 bits/second		Controls up to 84 low and 4 high-speed lines		Peak Speed		

*With optional equipment.

System Identity			IBM 7070/7072/7074	IBM 7080		IBM 7090 & 7094
Computer System Report No.			403: etc.	417:		408: & 409:
PRINTED OUTPUT	Model Number		7400	717	720	716
	Maximum Number On-Line		3	10	10	1
	Speed, lines/min.	Single Spacing	150	150	500	75 to 150
		1-inch Spacing	150	150	400	75 to 150
	Demands on Processor, %		1.5 max	100	100	< 1
	Number of Print Positions		120	120	120	120
	Checking		Validity, timing	Echo	Synch.	Programmed echo
	Features and Comments		No longer in production; not usable with 7072	No longer in production		Maximum of 72 characters per print cycle
MICR READER	Model Number					
	Maximum Number On-Line					
	Peak Speed, documents/min.					
	Demands on Processor, %					
	Code Translation					
	Checking					
	Features and Comments					
OTHER INPUT-OUTPUT DEVICES	Model Number		7900	1014		1414 Model 6
	Name		Inquiry Station	Remote Inquiry Unit		Input-Output Synchronizer
	Peak Speed		10 char/sec	15.5 char/sec		Communication equipment
	Model Number		1414 Model 6	7740		7740
	Name		Input-Output Synchronizer	Communication Control System		Communication Control System
	Peak Speed		10 to 500 char/sec	2,400 bits/sec; up to 84 lines		2,400 bits/sec; up to 84 lines
	Model Number			7750		
	Name			Programmed Transmission Control		
	Peak Speed			1,200 bits/sec; up to 112 lines		

*With optional equipment.

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LGP-30 (Control Data)	Monrobot XI		PB 250 (Raytheon)	System Identity	
352:	531:		631:	Computer System Report No.	
360 (Flexowriter)	Typewriter	Teletype Printer	Flexowriter	Model Number	PRINTED OUTPUT
1	3	3	1	Maximum Number On-Line	
(10 char/sec)	(10 char/sec)	(10 char/sec)	(10 char/sec)	Speed, lines/min.: Single Spacing	
- -	- -	- -	- -	Speed, lines/min.: 1-inch Spacing	
2.4 to 100	2.9	2.9	30 to 100	Demands on Processor, %	
180 max *	180 max *	85 max	110 max	Number of Print Positions	
None	None	None	None	Checking	
Includes tape reader, punch, and keyboard	Also usable for keyboard input		Includes tape reader, punch, and keyboard	Features and Comments	
				Model Number	MICR READER
				Maximum Number on-Line	
				Peak Speed, documents/min.	
				Demands on Processor, %	
				Code Translation	
				Checking	
				Features and Comments	
	- -		- -	Model Number	OTHER INPUT-OUTPUT DEVICES
	16-Key Keyboard		Digital Graph Recorder	Name	
	Manual		200 increments/sec	Peak Speed	
	- -			Model Number	
	Edge-Punched Card Reader			Name	
	20 char/sec			Peak Speed	
	- -			Model Number	
	Edge-Punched Card Punch			Name	
	20 char/sec			Peak Speed	

*With optional equipment.

System Identity			NCR 315, 315-100, 315 RMC				Philco 2000 Series
Computer System Report No.			610: 602:, 603:				651: etc.
PRINTED OUTPUT	Model Number		340-3	340-502, 340-512	340-503	340-601	2256
	Maximum Number On-Line		4	4	4	4	28
	Speed, lines/min.	Single Spacing	690 (940 numeric)	650 (805 numeric)	805	1,000	900
		1-inch Spacing	407	400	400	520	600
	Demands on Processor, %		1.4 max	81 max	81 max	2.0 max	0.22 max
	Number of Print Positions		120	120	120	120	120
	Checking		Validity	Validity	Validity	Validity	None
	Features and Comments		340-512 can operate as a 24-position numeric lister at 1,850 lpm		Listed speeds are based on use of a restricted, 42-character set		May be any of 7 units on a UBC
MICR READER	Model Number		402-3		407-1		
	Maximum Number On-Line		4		4		
	Peak Speed, documents/min.		750		1,200		
	Demands on Processor, %		0.9		1.6		
	Code Translation		Automatic		Automatic		
	Checking		Validity, timing		Validity, timing		
	Features and Comments		12 stackers: usable for off-line sorting		18 stackers; usable for off-line sorting		
OTHER INPUT-OUTPUT DEVICES	Model Number		420-1				2280 series
	Name		Optical Reader (for numeric journal tapes)				Digital Incremental Recorder
	Peak Speed		832 char/sec				300 point plots/sec
	Model Number		356-1				209
	Name		Central Inquiry Buffer				Console Typewriter Buffer
	Peak Speed		10 char/sec; controls up to 128 lines				- -
	Model Number		321-1				293
	Name		Central Communications Controller				Accounting Clock System
	Peak Speed		varies; controls up to 100 lines				- -

*With optional equipment.

RCA Spectra 70			RCA 301		System Identity		
710:			701:		Computer System Report No.		
70/242	70/243	70/248	333	335	Model Number		PRINTED OUTPUT
1/trunk	1/trunk	1/trunk	2	2	Maximum Number On-Line		
600	1,000/1,250	600	800 to 1,000	835 to 1,075	Single Spacing	Speed, lines/min.	
450	667	480	500	572	1-inch Spacing		
Varies	Varies	Varies	85 to 22*	84 to 32*	Demands on Processor, %		
132 or 160*	132	132	120	160	Number of Print Positions		
None	None	None	None		Checking		
	Higher speed based on use of 48 of the 64 characters	Can print on punched cards	Higher speeds with restricted sets of 47 chars.		Features and Comments		

RCA Spectra 70	RCA 301		
	Burroughs Corp. B 102	Model Number	MICR READER
	1	Maximum Number on-Line	
	1,560	Peak Speed, documents/min.	
	?	Demands on Processor, %	
	Automatic	Code Translation	
	Validity	Checking	
Model 70/272 Sorter-Reader Controller permits use of Burroughs, IBM, and NCR Sorter-Readers	13 stackers; usable for off-line sorting.	Features and Comments	

RCA Spectra 70		RCA 301		
70/251	70/510	328	Model Number	OTHER INPUT-OUTPUT DEVICES
Videoscan Document Reader	Audio Response Unit	Interrogating Typewriter	Name	
1,300 documents/min.	up to 189 word vocabulary	10 char/sec	Peak Speed	
70/653	6050	338	Model Number	
Communication Control (Single Channel)	Video Data Terminal	Monitor Printer	Name	
5,100 char/sec	180 char/sec max.	10 char/sec	Peak Speed	
70/668	70/820	5820	Model Number	
Communication Controller-Multichannel	Videocomp	Videoscan Document Reader	Name	
6,000 bytes/sec over 48 lines max.	600 chars. of text/ second	1,500 documents/min	Peak Speed	

*With optional equipment.

System Identity			RCA 3301		RECOMP II & III (Autonetics)		RPC-4000 (Control Data)
Computer System Report No.			703:		161: & 162:		351:
PRINTED OUTPUT	Model Number		333	335	Typewriter (RECOMP II)	Flexowriter (RECOMP III)	4480 (Typewriter)
	Maximum Number On-Line		2	2	1	1	22
	Speed, lines/min.	Single Spacing	800	800	(10 char/sec)	(10 char/sec)	(10 char/sec)
		1-inch Spacing	540	540	--	--	--
	Demands on Processor, %		<0.1	<0.1	100	100	1 to 100
	Number of Print Positions		120	160	110 max	110 max	180 max*
	Checking		None		Echo	None	Platen strike
	Features and Comments		1,000 lpm with restricted set of 47 characters		Also usable for keyboard input	Includes tape reader, punch, and keyboard	4500 Tape Typewriter System includes 4430 Reader/Punch
MICR READER	Model Number						
	Maximum Number On-Line						
	Peak Speed, documents/min.						
	Demands on Processor, %						
	Code Translation						
	Checking						
	Features and Comments						
OTHER INPUT-OUTPUT DEVICES	Model Number		3378		--		4700
	Name		Communications Mode Control		RECOMP X-Y Plotter		Off-Line Tape Typewriter
	Peak Speed		Controls up to 160 buffered lines		200 increments/sec		10 char/sec
	Model Number		3376				
	Name		Communications Control				
	Peak Speed		Controls one line at up to 5,000 char/sec				
	Model Number		3377				
	Name		Data Exchange Control				
	Peak Speed		Links two computers at up to 276,000 char/sec				

*With optional equipment.

UNIVAC SS 80/90	UNIVAC III	UNIVAC 418		System Identity	
771: & 772:	774:	790:		Computer System Report No.	
7912	4152	UNIVAC 1004 Printer	High Speed Printer	Model Number	PRINTED OUTPUT
1	8	16	8	Maximum Number On-Line	
600	700 (922 numeric)	400 to 600	700 (922 numeric)	Speed, lines/min.: Single Spacing	
430	480 (670 numeric)	340 or 380	472 (563 numeric)	Speed, lines/min.: 1-inch Spacing	
14	0.165 to 0.22	0.2 to 0.7	0.2 to 0.7	Demands on Processor, %	
100 to 130	128	132	132	Number of Print Positions	
Echo	None	None	None	Checking	
No form control loop	No form control loop	1004 can be used on-line with 418		Features and Comments	
				Model Number	MICR READER
				Maximum Number on-Line	
				Peak Speed, documents/min.	
				Demands on Processor, %	
				Code Translation	
				Checking	
				Features and Comments	
		CLT Series		Model Number	OTHER INPUT-OUTPUT DEVICES
		Communication Line Terminals		Name	
		Up to 4,800 bits/sec		Peak Speed	
				Model Number	
				Name	
				Peak Speed	
				Model Number	
				Name	
				Peak Speed	

*With optional equipment.

System Identity			UNIVAC 1004		UNIVAC 1050		UNIVAC 490 Series
Computer System Report No.			770:		777:		800:
PRINTED OUTPUT	Model Number		1004 I	1004 II, 1004 III	0755-01	0755-02	0751, 0755, 8121
	Maximum Number On-Line		1	1	4 or 8	4 or 8	1/channel
	Speed, lines/min.	Single Spacing	400	600	600/750	700/922	700/922
		1-inch Spacing	340	380	422	468	472/484
	Demands on Processor, %		100	100	0.6 max*	0.7 max	0.051 to 0.41
	Number of Print Positions		132		128		132
	Checking		None		Validity		None
	Features and Comments		Indicated speeds are based on use of 47 of the 63 printable characters		The higher rates are attained with restricted character sets		Different models used with various members of the 490 Series; higher speeds with restricted character set
MICR READER	Model Number						
	Maximum Number On-Line						
	Peak Speed, documents/min.						
	Demands on Processor, %						
	Code Translation						
	Checking						
	Features and Comments						
OTHER INPUT-OUTPUT DEVICES	Model Number		DLT-1 and DLT-2		CLT Series		CTM Series
	Name		Data Line Terminals		Communication Line Terminals		Communication Terminal Modules
	Peak Speed		250 to 300 char/sec		Up to 4,800 bits/sec		4,800 bits/sec per line
	Model Number						WTS
	Name						Word Terminal Synchronous
	Peak Speed						40,800 bits/sec
	Model Number						CTS
	Name						Communication Terminal Synchronous
	Peak Speed						40,800 bits/sec

*With optional equipment.

UNIVAC 1107		UNIVAC 1108	UNIVAC 9000 Series		System Identity	
			UNIVAC 9200	UNIVAC 9300		
784:		785:	810:	810:	Computer System Report No.	
7418	7400	7299-03	3030-00	3030-02	Model Number	PRINTED OUTPUT
15	15	4/channel	1	1	Maximum Number On-Line	
600	700 to 922	700/922	250; 500*	600; 1,200*	Speed, lines/min. — Single Spacing	
424	475	472/484	220	451	Speed, lines/min. — 1-inch Spacing	
0.09	0.12 max	0.025 max	13	31	Demands on Processor, %	
128	100 to 130	132	96; 132*	120; 132*	Number of Print Positions	
None	None	None	Timing	Timing	Checking	
No form control loop		No vertical form control loop; higher printing speeds achieved with restricted character set	Printers are integrated into Processor cabinet; they use horizontal oscillating typebars		Features and Comments	
					Model Number	MICR READER
					Maximum Number on-Line	
					Peak Speed, documents/min.	
					Demands on Processor, %	
					Code Translation	
					Checking	
					Features and Comments	
		CTM Series			Model Number	OTHER INPUT-OUTPUT DEVICES
		Communication Terminal Modules			Name	
		4,800 bits/sec per line			Peak Speed	
		WTS			Model Number	
		Word Terminal Synchronous			Name	
		40,800 bits/sec			Peak Speed	
		CTS			Model Number	
		Communication Terminal Synchronous			Name	
		40,800 bits/sec			Peak Speed	

*With optional equipment.

SYSTEM PERFORMANCE COMPARISONS AND MONTHLY RENTALS

SYSTEM PERFORMANCE COMPARISONS

SYSTEM IDENTITY	CONFIGURATION (See Users' Guide 4:030.100)	MONTHLY RENTAL $	GENERALIZED FILE PROCESSING PROBLEM A (See Users' Guide 4:200.100) — Activity 0.0	0.1	1.0	SORTING (See Users' Guide 4:200.200) — 10,000 80-Char. Records — Standard Estimate	Available Routines
			Minutes per 10,000 Records			Minutes	
Burroughs B 200	I	4,525	—	—	67.	—	—
	II	5,895	2.2	2.9	26.	22.	—
	III	8,840	1.4	2.8	26.	9.5	14.
Burroughs B 5500	III	23,340	1.2	2.0	19.	—	—
	V	25,250	1.2	2.0	19.	—	—
	VIIA	30,995	0.55	1.7	17.	2.9	2.8
	VIIB	28,705	0.55	0.69	1.8	2.9	2.8
CDC 6400	VIIA	34,000	0.38*	0.38*	2.0*	2.5	—
	VIIIA	47,145	0.19*	0.19*	1.0*	1.3	—
CDC 6600	VIIA	58,050	0.38*	0.38*	2.0*	2.5	—
	VIIIA	71,195	0.19*	0.19*	1.0*	1.3	—
CDC 6800	VIIA	57,740	0.38*	0.38*	2.0*	2.5	—
	VIIIA	70,885	0.19*	0.19*	1.0*	1.3	—
CDC 160	IX	2,152	—	—	—	—	—
	X	2,152	—	—	—	—	—
CDC 160-A	IX	2,902	—	—	—	—	—
	X	4,212	—	—	—	—	—
CDC 1604	VI	43,795	0.95	4.0	40.	3.2	—
	VIB	41,207	0.95	1.2	2.8	6.5	—
	VIIB	46,127	0.45	0.65	2.3	3.2	—
CDC 1604-A	VI	34,525	—	—	—	—	—
	VIB	35,107	0.40	0.58	2.3	2.6	—
	VIIB	38,637	0.15	0.24	1.7	0.90	—
	VIIIB	54,265	0.15	0.19	1.7	0.90	—
CDC 3100	VI	10,865	0.47	2.7	27.	3.1	—
	VIIB	15,885	0.36	0.56	2.4	2.4	—
CDC 3200	VI	12,695	0.47	2.7	27.	3.1	—
	VIIB	17,715	0.36	0.56	2.4	2.4	—
CDC 3300	VI	INA	0.47	2.7	27.	3.1	—
	VIIB	INA	0.36	0.56	2.4	2.4	—
CDC 3400	VI	25,445	0.56	1.96	16.	3.7	—
	VIIA	34,600	0.56	1.62	16.	3.7	—
	VIIB	34,679	0.56	0.77	2.6	3.7	—
	VIIIB	52,395	0.29	0.33	1.0	1.8	—
CDC 3600	VIB	58,599	0.19	0.28	1.2	1.4	—
	VIIB	61,899	0.19	0.28	1.2	2.0	—
	VIIIB	73,910	0.19	0.19	1.0	1.4	—
GE 215	I	4,885	—	—	67.	—	—
	II	6,220	3.7	5.4	28.	37.	—
	III	7,375	3.7	3.7	28.	25.	—
	VI	8,325	3.7	3.7	28.	25.	—
GE 225	I	5,115	—	—	67.	—	—
	II	7,450	3.7	3.7	25.	37.	24.
	III	10,155	1.6	2.5	25.	10.	14.
	IV	19,320	0.80	1.8	18.	5.3	8.5
	VI	12,805	1.6	2.5	25.	10.	14.
GE 235	III	11,870	1.5	2.5	25.	10.	—
	IV	18,385	0.77	1.7	17.	5.	—
	VI	15,120	1.5	2.5	25.	10.	—
GE 415	I	4,625	—	—	75.	—	—
	II	6,360	2.4	2.4	15.	24.	—
	III	7,900	1.8	1.8	15.	13.	—
	IV	13,385	0.47	1.5	15.	3.	—
	VIIA	14,630	0.47	1.5	15.	3.	—
GE 425	I	5,875	—	—	61.	—	—
	II	7,610	2.4	2.4	15.	25.	—
	III	8,850	1.8	1.8	15.	13.	—
	IV	14,335	0.47	1.4	15.	3.1	—
	VIIA	15,780	0.47	1.4	15.	3.1	—
GE 435	III	11,350	1.8	1.8	15.	13.	—
	IV	16,835	0.47	1.4	15.	3.1	—
	VIIA	19,180	0.47	1.4	15.	3.1	—

Note: The indicated rentals were those in effect when the Computer System Report on each system was last revised. Some of the older computer systems are now offered at lower prices: consult manufacturers' representatives for details.

* Indicated time is for the tape-to-tape main processing run only; it is assumed that the required on-line card-to-tape and tape-to-printer transcriptions will be performed concurrently with these or other programs.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGU-RATION (See Users' Guide 4:030.100)	MONTHLY RENTAL $	MATRIX INVERSION (See Users' Guide 4:200.300)				GENERALIZED MATHEMATICAL PROBLEM A (See Users' Guide 4:200.400)		
			Standard Estimate		Available Routines		Computation Factor for 10% Output		
			Array Size						
			10	40	10	40	1	10	100
			Minutes				Milliseconds		
Burroughs B 200	I	4,525	—	—	—	—	—	—	—
	II	5,895	—	—	—	—	—	—	—
	III	8,840	—	—	—	—	—	—	—
Burroughs B 5500	III	23,340	0.0025	0.14	0.006	0.25	74.	74.	330.
	V	25,250	0.0025	0.14	0.006	0.25	74.	74.	330.
	VIIA	30,995	0.0025	0.14	0.006	0.25	74.	74.	330.
	VIIB	28,705	0.0025	0.14	0.006	0.25	9.5*	39.*	330.
CDC 6400	VIIA	34,000	0.00022	0.011	—	—	13.*	13.*	13.*
	VIIIA	47,145	0.00022	0.011	—	—	6.2*	6.2*	6.2*
CDC 6600	VIIA	58,050	0.00003	0.0014	—	—	13.*	13.*	13.*
	VIIIA	71,195	0.00003	0.0014	—	—	6.2*	6.2*	6.2*
CDC 6800	VIIA	57,740	0.000007	0.0003	—	—	13.*	13.*	13.*
	VIIIA	70,885	0.000007	0.0003	—	—	6.2*	6.2*	6.2*
CDC 160	IX	2,152	0.4	18.	1.0	44.	3,000.	8,500.	67,000.
	X	2,152	0.4	18.	1.0	44.	1,300.	7,500.	67,000.
CDC 160-A	IX	2,902	0.47	19.	1.0	44.	3,000.	8,500.	63,000.
	X	4,212	0.070	3.7	—	—	700.	1,500.	9,200.
CDC 1604	VI	43,795	0.0013	0.075	0.002	0.12	—	—	—
	VIB	41,207	0.0013	0.075	0.002	0.12	9.5	34.	270.
	VIIB	46,127	0.0013	0.075	0.002	0.12	12.	34.	270.
CDC 1604-A	VI	34,525	0.0013	0.075	0.002	0.12	—	—	—
	VIB	35,107	0.0013	0.075	0.002	0.12	7.8	30.	280.
	VIIB	38,637	0.0013	0.075	0.002	0.12	6.5	30.	300.
	VIIIB	54,265	0.0013	0.075	0.002	0.12	6.5	30.	200.
CDC 3100	VI	10,865	0.012	0.63	—	—	—	—	—
	VIIB	15,885	0.012	0.63	—	—	—	—	—
CDC 3200	VI	12,695	0.0009	0.048	—	—	50.	50.	260.
	VIIB	17,715	0.0006	0.048	—	—	11.	31.	260.
CDC 3300	VI	INA	0.0006	0.025	—	—	50.	50.	160.
	VIIB	INA	0.0006	0.025	—	—	11.	19.	160.
CDC 3400	VI	25,445	0.0004	0.026	—	—	65.	65.	145.
	VIIA	34,600	0.0004	0.026	—	—	65.	65.	145.
	VIIB	34,679	0.0004	0.026	—	—	12.	23.	145.
	VIIIB	52,395	0.0004	0.026	—	—	9.9	23.	145.
CDC 3600	VIB	58,599	0.0003	0.017	—	—	6.0	6.5	61.
	VIIB	61,899	0.0003	0.017	—	—	6.0	6.5	61.
	VIIIB	73,910	0.0003	0.017	—	—	6.0	6.5	61.
GE 215	I	4,885	0.70	33.	—	—	—	—	—
	II	6,220	0.70	33.	—	—	—	—	—
	III	7,375	0.70	33.	—	—	—	—	—
	VI	8,325	0.07	3.2	—	—	—	—	—
GE 225	I	5,115	0.31	15.	0.60	38.	—	—	—
	II	7,450	0.31	15.	0.60	38.	—	—	—
	III	10,155	0.31	15.	0.60	38.	—	—	—
	IV	19,320	0.31	15.	0.60	38.	—	—	—
	VI	12,805	0.033	1.7	0.030	1.9	—	—	—
GE 235	III	11,870	0.07	3.5	—	—	—	—	—
	IV	18,385	0.07	3.5	—	—	—	—	—
	VI	15,120	0.005	0.22	—	—	—	—	—
GE 415	I	4,625	—	—	—	—	—	—	—
	II	6,360	—	—	—	—	—	—	—
	III	7,900	—	—	—	—	—	—	—
	IV	13,385	—	—	—	—	—	—	—
	VIIA	14,630	0.0029	0.17	—	—	120.	280.	1,800.
GE 425	I	5,875	—	—	—	—	—	—	—
	II	7,610	—	—	—	—	—	—	—
	III	8,850	—	—	—	—	—	—	—
	IV	14,335	—	—	—	—	—	—	—
	VIIA	15,780	0.0021	0.12	—	—	100.	240.	1,400.
GE 435	III	11,350	—	—	—	—	—	—	—
	IV	16,835	—	—	—	—	—	—	—
	VIIA	19,180	0.0016	0.09	—	—	74.	190.	1,300.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGURATION NUMBER (See Users' Guide 4:030. 100)	MONTHLY RENTAL $	GENERALIZED FILE PROCESSING PROBLEM A (See Users' Guide 4:200. 100) — Activity 0.0 (Minutes per 10,000 Records)	Activity 0.1	Activity 1.0	SORTING (See Users' Guide 4:200. 200) — 10,000 80-Char. Records: Standard Estimate (Minutes)	Available Routines
GE 625	VIIA	41,700	0.47*	0.70*	2.8*	3.1	—
	VIIIA	57,705	0.26*	0.26*	1.4*	1.7	—
GE 635	VIIA	44,700	0.47*	0.70*	2.8*	3.1	—
	VIIIA	61,045	0.26*	0.26*	1.4*	1.7	—
Honeywell 120	I	3,630	—	—	190.	—	—
	II	3,415	4.0	6.4	28.	41.	—
	III	6,030	2.1	4.7	27.	14.	—
Honeywell 200	I	3,885	—	—	160.	—	—
	II	4,785	3.4	3.4	21.	33.0	—
	III	7,145	0.9	2.1	21.	6.8	7.9
	IV	13,925	0.39	1.7	17.	2.5	2.8
Honeywell 1200	I	4,745	—	—	160.	—	—
	II	5,645	3.4	3.4	21.	33.0	—
	III	7,570	0.9	2.1	21.	6.8	—
	IV	14,125	0.39	1.7	17.	2.5	—
	VI	10,085	0.9	2.1	21.	6.8	—
	VIIA	15,080	0.39	2.1	21.	2.5	—
	VIIB	15,125	0.39	0.5	2.	2.5	—
Honeywell 2200	III	8,545	0.9	2.1	21.	6.8	7.1
	IV	15,305	0.39	1.7	17.	2.5	2.7
	VIIA	17,385	0.39	2.1	21.	2.5	2.8
	VIIB	16,940	0.39	0.5	2.	2.5	2.8
Honeywell 4200	III	15,565	0.9	2.1	21.	6.8	—
	IV	21,250	0.39	1.7	17.	2.5	—
	VIIA	21,590	0.39	2.1	21.	2.5	—
	VIIB	21,165	0.39	0.49	2.	2.5	—
	VIIIB	34,895	0.30	0.30	1.1	2.1	—
Honeywell 8200	VIIA	37,155	0.35*	0.35*	0.43*	2.3	—
	VIIIA	52,340	0.28*	0.28*	0.33*	1.8	—
Honeywell 400	II	7,615	2.0	4.0	24.	12.	—
	III	9,805	2.0	3.0	20.	8.9	—
	IV	15,580	1.1	2.4	20.	5.2	—
	VI	11,005	2.0	3.0	20.	8.9	—
Honeywell 1400	II	11,150	1.6	3.7	24.	9.5	—
	III	12,290	1.6	2.8	20.	8.0	—
	IV	20,980	0.57	1.9	20.	4.4	—
	VI	14,530	1.6	2.8	20.	8.0	—
Honeywell 800	VI	20,329	0.60	2.0	17.	6.3	—
	VIIA	36,070	0.34	2.0	17.	2.4	—
	VIIB	28,475	0.30	0.42	3.1	2.4	—
	VIIIA	54,000	0.20	2.0	17.	1.5	—
	VIIIB	46,925	0.20	0.42	3.1	1.5	—
Honeywell 1800	VI	30,100	—	—	—	—	—
	VIIA	37,050	0.33	1.8	18.	—	—
	VIIB	37,575	0.33	0.33	1.5	—	—
	VIIIA	56,900	0.22	1.8	18.	—	—
	VIIIB	56,025	0.22	0.22	1.5	—	—
IBM 360, Model 20	I	2,300	—	—	67.	—	—
	II	3,475	6.0	7.0	21.	61.	—
IBM 360, Model 30	I	4,005	—	—	67.	—	—
	II	4,600	3.7	3.7	20.	40.	—
	III	6,585	1.5	2.0	20.	9.7	—
	V	10,085	—	—	—	—	—
IBM 360, Model 40	II	6,890	1.5	2.0	20.	13.	—
	III	7,800	1.5	2.0	20.	9.7	—
	V	11,300	—	—	—	—	—
	VI	11,100	1.5	2.0	20.	9.7	—
IBM 360, Model 44	V	11,215	1.5	2.0	20.	55.	—
	VI	10,315	1.5	2.0	20.	55.	—
	VIIA	13,730	0.38	2.0	20.	28.	—
	XI	9,320	1.5	5.0	50.	55.	—
IBM 360, Model 50	III	14,785	1.5	2.0	20.	9.7	—
	IV	20,565	0.38	1.5	15.	2.3	—
	VIIA	18,775	0.38	2.0	20.	2.3	—
	VIIB	20,885	0.27	0.41	2.0	2.3	—
IBM 360, Model 65	VIIB	33,835	0.40	0.59	2.0	2.4	1.2
	VIIIB	49,790	0.22	0.22	1.1	1.8	—
IBM 360, Model 75	VIIB	46,175	0.40	0.59	2.0	2.4	0.73
	VIIIB	62,130	0.22	0.22	1.1	1.8	0.73

* Indicated time is for the tape-to-tape main processing run only; it is assumed that the required on-line card-to-tape and tape-to-printer transcriptions will be performed concurrently with these or other programs.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGURATION NUMBER (See Users' Guide 4:030.100)	MONTHLY RENTAL $	MATRIX INVERSION (See Users' Guide 4:200.300)				GENERALIZED MATHEMATICAL PROBLEM A (See Users' Guide 4:200.400)		
			Standard Estimate		Available Routines				
			Array Size				Computation Factor for 10% Output		
			10	40	10	40	1	10	100
			Minutes				Milliseconds		
GE 625	VIIA	41,700	0.0005	.028	—	—	13.*	18.*	149.*
	VIIIA	57,705	0.0005	.028	—	—	8.*	18.*	149.*
GE 635	VIIA	44,700	0.0004	.021	—	—	13.*	14.*	113.*
	VIIIA	61,045	0.0004	.021	—	—	8.*	14.*	113.*
Honeywell 120	I	3,630	—	—	—	—	—	—	—
	II	3,415	—	—	—	—	—	—	—
	III	6,030	—	—	—	—	—	—	—
Honeywell 200	I	3,885	—	—	—	—	—	—	—
	II	4,785	—	—	—	—	—	—	—
	III	7,145	—	—	—	—	—	—	—
	IV	13,925	—	—	—	—	—	—	—
Honeywell 1200	I	4,745	—	—	—	—	—	—	—
	II	5,645	—	—	—	—	—	—	—
	III	7,570	—	—	—	—	—	—	—
	IV	14,125	—	—	—	—	—	—	—
	VI	10,085	0.0043	0.23	—	—	88.	88.	720.
	VIIA	15,080	0.0043	0.23	—	—	88.	88.	720.
	VIIB	15,125	0.0043	0.23	—	—	18.	80.	720.
Honeywell 2200	III	8,545	—	—	—	—	—	—	—
	IV	15,305	—	—	—	—	—	—	—
	VIIA	17,385	0.0028	0.17	—	—	88.	88.	490.
	VIIB	16,940	0.0028	0.17	—	—	15.	58.	490.
Honeywell 4200	III	15,565	—	—	—	—	—	—	—
	IV	21,250	—	—	—	—	—	—	—
	VIIA	21,590	—	—	—	—	88.	88.	200.
	VIIB	21,165	0.002	0.10	—	—	5.1	21.	200.
	VIIIB	34,895	0.002	0.10	—	—	—	—	—
Honeywell 8200	VIIA	37,155	0.0002	0.012	—	—	75.	75.	75.
	VIIIA	52,340	0.0002	0.012	—	—	75.	75.	75.
Honeywell 400	II	7,615	0.15	8.0	—	—	—	—	—
	III	9,805	0.15	8.0	—	—	—	—	—
	IV	15,580	0.15	8.0	—	—	—	—	—
	VI	11,005	0.15	8.0	—	—	—	—	—
Honeywell 1400	II	11,150	0.16	8.5	—	—	—	—	—
	III	12,290	0.16	8.5	—	—	—	—	—
	IV	20,980	0.16	8.5	—	—	—	—	—
	VI	14,530	0.035	2.0	—	—	—	—	—
Honeywell 800	VI	20,329	0.003	0.17	—	—	90.	90.	600.
	VIIA	36,070	0.003	0.17	—	—	90.	90.	600.
	VIIB	28,475	0.003	0.17	—	—	—	—	—
	VIIIA	54,000	0.003	0.17	—	—	72.	90.	600.
	VIIIB	46,925	0.003	0.17	—	—	—	—	—
Honeywell 1800	VI	30,100	0.0013	0.0066	—	—	—	—	—
	VIIA	37,050	0.0013	0.066	—	—	75.	75.	130.
	VIIB	37,575	0.0013	0.066	—	—	6.7	14.	130.
	VIIIA	56,900	0.0013	0.066	—	—	75.	75.	130.
	VIIIB	56,025	0.0013	0.066	—	—	5.9	14.	130.
IBM 360 Model 20	I	2,300	—	—	—	—	—	—	—
	II	3,475	—	—	—	—	—	—	—
IBM 360, Model 30	I	4,005	0.025	1.2	—	—	100.	480.	4,230.
	II	4,600	0.025	1.2	—	—	100.	480.	4,230.
	III	6,585	0.025	1.2	—	—	100.	480.	4,230.
	V	10,085	0.025	1.2	—	—	100.	480.	4,230.
IBM 360, Model 40	II	6,890	0.0071	0.39	—	—	100.	150.	2,000.
	III	7,800	0.0071	0.39	—	—	100.	150.	2,000.
	V	11,300	0.0071	0.39	—	—	100.	150.	2,000.
	VI	11,100	0.0071	0.39	—	—	100.	150.	2,000.
IBM 360, Model 44	V	11,215	0.0017	0.10	—	—	100.	100.	280.
	VI	10,315	0.0017	0.10	—	—	100.	100.	280.
	VIIA	13,730	0.0017	0.10	—	—	100.	100.	280.
	XI	9,320	0.0017	0.10	—	—	100.	100.	280.
IBM 360, Model 50	III	14,785	0.0017	0.07	—	—	100.	100.	400.
	IV	20,565	0.0017	0.07	—	—	100.	100.	400.
	VIIA	18,775	0.0017	0.07	—	—	100.	100.	400.
	VIIB	20,885	0.0017	0.07	—	—	9.7	31.	280.
IBM 360, Model 65	VIIB	33,835	0.00022	0.012	—	—	9.7	9.7	64.
	VIIIB	49,790	0.00022	0.012	—	—	6.5	6.5	64.
IBM 360, Model 75	VIIB	46,175	0.00016	0.0089	—	—	9.7	9.7	35.
	VIIIB	62,130	0.00016	0.0089	—	—	6.5	6.5	35.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGURATION (See Users' Guide 4:030.100)	MONTHLY RENTAL $	GENERALIZED FILE PROCESSING PROBLEM A (See Users' Guide 4:200.100) — Activity — Minutes per 10,000 Records			SORTING (See Users' Guide 4:200.200) — 10,000 80-Char. Records — Minutes	
			0.0	0.1	1.0	Standard Estimate	Available Routines
IBM 1130	I	1,275	—	—	—	—	—
	IX	925	—	—	—	—	—
IBM 704	VI	28,450	—	—	—	—	—
	VIIB	48,157	—	—	—	—	—
IBM 709	VIIB	53,770	1.6	1.6	9.4	11.	—
	VIIIB	69,045	1.6	1.6	9.4	4.7	—
IBM 1401	I	4,330	—	—	100.	—	—
	II	5,920	3.7	7.5	40.	41.	35.
	III	10,830	2.4	4.2	26.	15.	13.
	IV	11,540	2.0	2.6	20.	12.	10.
IBM 1401-G	I	2,375	—	—	139.	—	—
IBM 1410	I	6,115	—	—	80.	—	—
	II	8,415	2.7	3.2	20.	30.	—
	III	12,240	1.4	2.0	20.	9.0	9.7
	IV	19,060	1.0	2.0	20.	6.0	6.0
	VI	15,790	1.4	2.0	20.	9.0	7.0
	VIIB	23,560	0.85	1.2	3.3	—	7.0
IBM 1440	I	3,295	—	—	135.	—	—
	II**	4,050	3.8	10.7	73.	40.	—
	III**	5,920	2.9	5.1	48.	19.	—
IBM 1460	III	11,735	1.4	3.6	26.	9.1	—
IBM 1620-I	IX	2,455	—	—	—	—	—
	X	3,580	—	—	—	—	—
IBM 1620-II	IX	3,090	—	—	—	—	—
	X	4,275	—	—	—	—	—
IBM 7010	III	19,175	1.4	2.0	20.	8.5	—
	IV	27,225	0.56	1.3	13.	3.8	—
	VI	22,175	1.4	2.0	20.	8.5	—
	VIIB	28,355	0.64	0.96	3.2	4.8	—
IBM 7040	VI	20,715	1.4	2.3	20.	15.	—
	VIIA	27,190	—	—	—	3.8	—
	VIIIB	47,145	0.33	0.75	5.5	2.2	—
IBM 7044	VIIA	36,690	—	—	—	2.7	—
	VIIIB	56,645	0.39	0.39	1.9	1.9	—
IBM 7070	III	19,400	1.3	6.7	67.	8.5	5.7
	VIIB	29,755	0.45	0.80	4.5	3.0	2.0
	VIIIB	45,030	0.38	0.80	4.5	2.4	2.0
IBM 7072	VIIB	32,915	1.2	1.7	5.7	8.3	—
	VIIIB	49,890	1.2	1.7	5.7	8.3	—
IBM 7074	VIIB	40,465	0.45	0.6	2.2	3.0	1.5
	VIIIB	72,840	0.18	0.18	1.7	1.2	1.2
IBM 7080	VIIB	51,745	0.42	0.58	2.	2.6	1.2
	VIIIB	79,325	0.18	0.2	1.4	1.3	0.42
IBM 7090	VIIB	66,770	0.47	0.61	1.9	3.2	—
	VIIIB	89,215	0.21	0.21	1.6	1.5	—
IBM 7094-I	VIIB	72,395	0.47	0.61	1.9	3.2	—
	VIIIB	95,065	0.21	0.21	0.96	1.5	—
LGP-30	IX	1,100	—	—	—	—	—
	X	1,365	—	—	—	—	—
Monrobot XI	I	800	2,700.	3,000.	6,000.	—	—
	IX	885	2,000.	2,300.	4,800.	—	—
NCR 315	I	5,700	—	—	80.	—	—
	II	5,925	3.3	5.1	29.	30.	26.
	III	8,145	1.3	3.0	26.	14.	7.9
	IIIC	8,250	1.5	3.7	24.	—	—
	IV	19,290	0.4	1.9	18.	2.6	2.6
NCR 315-100	I	5,000	—	—	80.	—	—
	II	4,350	3.6	7.8	53.	30.	—
	IIIC	7,750	1.6	3.8	25.	—	—
NCR 315 RMC	III	11,345	1.2	2.3	23.	14.	—
	IIIC	11,550	1.3	2.3	23.	—	—
	IV	20,490	0.25	1.9	19.	2.6	—
PB 250	IX	1,675	—	—	—	—	—
	X	2,455	—	—	—	—	—

** Using 1311 Disk Storage Drives in place of magnetic tape.

SYSTEM PERFORMANCE COMPARISONS (CONTD.)

SYSTEM IDENTITY	CONFIGURATION (See Users' Guide 4:030.100)	MONTHLY RENTAL $	MATRIX INVERSION (See Users' Guide 4:200.300) — Standard Estimate		— Available Routines		GENERALIZED MATHEMATICAL PROBLEM A (See Users' Guide 4:200.400) — Computation Factor for 10% Output		
			Array Size 10	40	10	40	1	10	100
			Minutes				Milliseconds		
IBM 1130	I	1,275	0.045	2.6	—	—	640.	1,300.	6,700.
	IX	925	0.045	2.6	—	—	2,800.	3,400.	8,900.
IBM 704	VI	28,450	—	—	—	—	180.	300.	1,700.
	VIIB	48,157	—	—	—	—	67.	160.	1,500.
IBM 709	VIIB	53,770	0.009	0.58	—	—	35.	190.	1,800.
	VIIIB	69,045	0.009	0.58	—	—	35.	190.	1,800.
IBM 1401	I	4,330	0.33	—	—	—	520.	5,000.	50,000.
	II	5,920	0.33	—	—	—	—	—	—
	III	10,830	0.33	—	—	—	520.	5,000.	50,000.
	IV	11,540	0.33	—	—	—	—	—	—
IBM 1401-G	I	2,375	—	—	—	—	—	—	—
IBM 1410	I	6,115	0.17	9.0	—	—	—	—	—
	II	8,415	0.17	9.0	—	—	—	—	—
	III	12,240	0.17	9.0	—	—	—	—	—
	IV	19,060	0.17	9.0	—	—	—	—	—
	VI	15,790	0.17	9.0	—	—	—	—	—
	VIIB	23,560	0.17	9.0	—	—	—	—	—
IBM 1440	I	3,295	—	—	—	—	—	—	—
	II*	4,050	—	—	—	—	—	—	—
	III*	5,920	—	—	—	—	—	—	—
IBM 1460	III	11,735	0.17	—	—	—	—	—	—
IBM 1620-I	IX	2,455	1.2	55.	—	—	3,700.	20,000.	20,000.
	X	3,580	0.35	18.	—	—	1,000.	7,500.	70,000.
IBM 1620-II	IX	3,090	0.25	15.	—	—	1,800.	4,200.	30,000.
	X	4,275	0.08	5.0	—	—	480.	1,800.	18,000.
IBM 7010	III	19,175	0.06	3.5	—	—	—	—	—
	IV	27,225	0.06	3.4	—	—	—	—	—
	VI	22,175	0.06	3.4	—	—	—	—	—
	VIIB	28,355	0.06	3.4	—	—	—	—	—
IBM 7040	VI	20,715	0.002	0.10	—	—	100.	150.	1,300.
	VIIA	27,190	0.002	0.10	—	—	17.	150.	1,300.
	VIIIB	47,145	0.002	0.10	—	—	16.	150.	1,300.
IBM 7044	VIIA	36,690	0.001	0.068	—	—	13.	47.	450.
	VIIIB	56,645	0.0010	0.068	—	—	7.7	47.	400.
IBM 7070	III	19,400	0.037	2.1	0.055	3.6	—	—	—
	VIIB	29,755	0.037	2.1	0.055	3.6	63.	600.	6,000.
	VIIIB	45,030	0.037	2.1	0.055	3.6	63.	600.	6,000.
IBM 7072	VIIB	32,915	0.0037	0.24	—	—	25.	45.	400.
	VIIIB	49,890	0.0037	0.24	—	—	25.	45.	400.
IBM 7074	VIIB	40,465	0.003	0.17	—	—	11.	37.	350.
	VIIIB	72,840	0.003	0.17	—	—	11.	37.	350.
IBM 7080	VIIB	51,745	—	—	—	—	—	—	—
	VIIIB	79,325	—	—	—	—	—	—	—
IBM 7090	VIIB	66,770	0.001	0.062	—	—	8.5	30.	270.
	VIIIB	89,215	0.001	0.062	—	—	7.7	30.	270.
IBM 7094-I	VIIB	72,395	0.0004	0.029	—	—	7.7	17.	140.
	VIIIB	95,065	0.0004	0.029	—	—	7.7	17.	140.
LGP-30	IX	1,100	37.	—	18.	—	58,000.	380,000.	—
	X	1,365	37.	—	18.	—	50,000.	370,000.	—
Monrobot XI	I	800	23.	—	—	—	—	—	—
	IX	885	23.	—	—	—	46,000.	350,000.	3,300,000.
NCR 315	I	5,700	0.09	—	0.077	—	23.	190.	2,000.
	II	5,925	0.09	—	0.077	—	32.	200.	2,000.
	III	8,145	0.09	—	0.077	—	32.	200.	2,000.
	IIIC	8,250	0.09	—	0.077	—	32.	200.	2,000.
	IV	19,290	0.09	5.	0.077	4.	23.	190.	2,000.
NCR 315-100	I	5,000	0.09	—	—	—	—	—	—
	II	4,350	0.09	—	—	—	—	—	—
	IIIC	7,750	0.09	—	—	—	—	—	—
NCR 315 RMC	III	11,345	—	0.3	—	—	45.0	200.	1,600.
	IIIC	11,550	—	0.3	—	—	45.0	200.	1,600.
	IV	20,490	—	0.3	—	—	45.0	200.	1,600.
PB 250	IX	1,675	2.0	190.	—	—	10,000.	25,000.	200,000.
	X	2,455	2.0	190.	—	—	—	—	—

SYSTEM PERFORMANCE COMPARISONS (CONTD.)

SYSTEM IDENTITY	CONFIGU-RATION NUMBER (See Users' Guide 4:030.100)	MONTHLY RENTAL $	GENERALIZED FILE PROCESSING PROBLEM A (See Users' Guide 4:200.100)			SORTING (See Users' Guide 4:200.200)	
			Activity			10,000 80-Char. Records	
			0.0	0.1	1.0	Standard Estimate	Available Routines
			Minutes per 10,000 Records			Minutes	
Philco 2000-210	VIIB	33,765	0.18	0.60	4.8	1.4	—
	VIIIB	53,025	0.18	0.60	4.8	1.4	—
Philco 2000-211	VIIB	38,315	0.19	0.55	4.5	1.4	—
	VIIIB	64,475	0.19	0.20	1.9	1.4	—
Philco 2000-212	VIIB	52,315	0.19	0.38	2.0	0.75	—
	VIIIB	87,145	0.073	0.095	0.95	0.50	—
RCA Spectra 70/15	I	3,400	—	—	66.	—	—
	II	4,700	1.8	2.2	22.	19.	15.
RCA Spectra 70/25	II	5,865	1.4	2.2	22.	15.	15.
	III	6,465	1.4	2.2	22.	10.	10.
	IV	12,265	0.7	1.3	13.	2.5	2.5
RCA Spectra 70/35	I	4,830	—	—	64.	—	—
	II	6,305	1.4	2.2	22.	15.0	—
	III	6,905	1.4	2.2	22.	10.0	—
	VIIA	12,930	0.7	1.3	13.	2.5	—
RCA Spectra 70/45	III	8,450	1.4	2.2	22.	9.4	—
	IV	13,950	0.36	1.3	12.	2.4	—
	VI	10,250	1.4	2.2	22.	9.4	—
	VIIA	13,775	0.36	2.2	22.	2.4	—
	VIIB	15,700	0.36	0.52	2.1	2.4	—
RCA Spectra 70/55	III	13,430	1.4	2.2	22.	9.4	—
	IV	18,330	0.36	1.3	13.	2.4	—
	VI	13,430	1.4	2.2	22.	9.4	—
	VIIA	16,830	0.36	2.2	22.	2.4	—
	VIIB	19,080	0.36	0.52	2.1	2.4	—
	VIIIB	32,945	0.18	0.18	0.85	1.2	—
RCA 301	I	4,271	—	—	200.	—	—
	II	5,084	5.7	10.1	49.	60.	—
	III	9,687	1.5	4.3	32.	15.	—
	IV	20,290	1.5	4.3	32.	13.	—
	VI	12,880	1.5	4.3	32.	15.	—
RCA 3301	III	11,390	0.61	1.9	18.	4.0	—
	IV	18,940	0.37	1.9	18.	2.7	—
	VI	14,265	0.61	1.9	18.	4.0	—
	VIIA	21,265	0.29	1.9	18.	1.9	—
	VIIB	21,604	0.29	0.29	1.3	1.9	—
Recomp II	IX	2,495	—	—	—	—	—
	X	3,095	—	—	—	—	—
Recomp III	IX	1,495	—	—	—	—	—
	X	2,175	—	—	—	—	—
RPC-4000	IX	1,750	—	—	—	—	—
	X	2,450	—	—	—	—	—

* Indicated time is for the tape-to-tape main processing run only; it is assumed that the required on-line card-to-tape and tape-to-printer transcriptions will be performed concurrently with these or other programs.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGURATION NUMBER (See Users' Guide 4:030.100)	MONTHLY RENTAL $	MATRIX INVERSION (See Users' Guide 4:200.300) Standard Estimate, Array Size 10	Standard Estimate 40	Available Routines 10	Available Routines 40	GENERALIZED MATHEMATICAL PROBLEM A (See Users' Guide 4:200.400) Computation Factor for 10% Output 1	10	100
			Minutes				Milliseconds		
Philco 2000-210	VIIB	33,765	0.0014	0.075	0.002	0.10	6.0	40.	400.
	VIIIB	53,025	0.0014	0.075	0.002	0.10	6.0	40.	400.
Philco 2000-211	VIIB	38,315	0.001	0.08	—	—	7.2	22.	200.
	VIIIB	64,475	0.0007	0.055	—	—	1.1	8.0	80.
Philco 2000-212	VIIB	52,315	0.0002	0.010	—	—	13.	13.	40.
	VIIIB	87,145	0.0002	0.010	—	—	5.8	5.8	30.
RCA Spectra 70/15	I	3,400	—	—	—	—	—	—	—
	II	4,700	—	—	—	—	—	—	—
RCA Spectra 70/25	II	5,865	—	—	—	—	—	—	—
	III	6,465	—	—	—	—	—	—	—
	IV	12,265	—	—	—	—	—	—	—
RCA Spectra 70/35	I	4,830	0.13	6.0	—	—	47.	350.	3,300.
	II	6,305	0.13	6.0	—	—	47.	350.	3,300.
	III	6,905	0.13	6.0	—	—	47.	350.	3,300.
	VIIA	12,930	0.13	6.0	—	—	47.	350.	3,300.
RCA Spectra 70/45	III	8,450	0.0053	0.30	—	—	47.	100.	1,150.
	IV	13,950	0.0053	0.30	—	—	42.	100.	1,150.
	VI	10,250	0.0053	0.30	—	—	47.	100.	1,150.
	VIIA	13,775	0.0053	0.30	—	—	47.	100.	1,150.
	VIIB	15,700	0.0053	0.30	—	—	9.5	100.	1,150.
RCA Spectra 70/55	III	13,430	0.0015	0.08	—	—	47.	47.	280.
	IV	18,330	0.0015	0.08	—	—	42.	42.	280.
	VI	13,430	0.0015	0.08	—	—	47.	47.	280.
	VIIA	16,830	0.0015	0.08	—	—	47.	47.	280.
	VIIB	19,080	0.0015	0.08	—	—	9.5	29.	280.
	VIIIB	32,945	0.0015	0.08	—	—	4.8	29.	280.
RCA 301	I	4,271	0.37	20.	0.19	11.	—	—	—
	II	5,084	0.37	20.	0.19	11.	—	—	—
	III	9,687	0.37	20.	0.19	11.	—	—	—
	IV	20,290	0.37	20.	0.19	11.	—	—	—
	VI	12,880	0.020	1.0	—	—	300.	590.	3,700.
RCA 3301	III	11,390	—	—	—	—	—	—	—
	IV	18,940	—	—	—	—	—	—	—
	VI	14,265	0.0010	0.040	—	—	65.	65.	210.
	VIIA	21,265	0.0010	0.040	—	—	65.	65.	210.
	VIIB	21,604	0.0010	0.040	—	—	8.3	26.	210.
Recomp II	IX	2,495	1.2	30.	7.4	400.	1,700.	9,900.	89,000.
	X	3,095	1.2	30.	7.4	400.	1,000.	9,900.	89,000.
Recomp III	IX	1,495	—	—	—	—	12,000.	47,000.	400,000.
	X	2,175	1.0	42.	2.2	150.	1,300.	8,000.	75,000.
RPC-4000	IX	1,750	6.8	180.	—	—	14,000.	56,000.	470,000.
	X	2,450	6.8	180.	—	—	12,000.	50,000.	470,000.

SYSTEM PERFORMANCE COMPARISONS (CONTD.)

SYSTEM IDENTITY	CONFIGURATION NUMBER (See Users' Guide 4:030.100)	MONTHLY RENTAL $	GENERALIZED FILE PROCESSING PROBLEM A (See Users' Guide 4:200.100)			SORTING (See Users' Guide 4:200.200)	
			Activity			10,000 80-Char. Records	
			0.0	0.1	1.0	Standard Estimate	Available Routines
			Minutes per 10,000 Records			Minutes	
UNIVAC SS 80/90-I	I	4,325	—	—	130.	—	—
	II	7,125	3.0	4.6	24.	29.	—
	III	7,400	3.0	4.6	24.	19.	—
UNIVAC SS 80/90-II	II	8,640	2.7	2.9	24.	29.	—
	III	9,540	2.7	2.9	24.	19.	—
	IV	15,940	1.4	2.2	24.	10.	—
UNIVAC III	III	19,000	0.19	2.1	20.	1.7	1.2
	VI	20,400	0.19	2.1	20.	1.7	1.2
	VIIA	25,000	0.19	2.1	20.	1.2	1.2
	VIIIB	38,730	0.19	0.19	1.5	1.2	1.2
UNIVAC 418	III	7,125	1.6	2.4	24.	11.	—
	VIIA	17,875	0.42*	0.68*	3.7*	2.8	—
UNIVAC 490	III	19,780	2.3	2.3	21.	15.	—
	VIIA	31,270	0.27*	0.42*	2.4*	1.7	—
	VIIIA	48,120	0.27*	0.42*	2.4*	1.7	—
UNIVAC 491/492	III	13,345	0.82	2.2	22.	5.1	—
	VIIA	23,715	0.32*	0.50*	2.2*	2.1	—
	VIIIA	41,915	0.32*	0.34*	2.2*	2.1	—
UNIVAC 494	III	25,765	0.82	2.2	20.	5.1	—
	VIIA	32,715	0.32*	0.50*	1.9*	2.1	—
	VIIIA	47,165	0.32*	0.34*	1.7*	2.1	—
UNIVAC 1004	I	1,800	—	—	100.	—	—
	II	2,725	3.2	5.3	27.	—	—
UNIVAC 1050	I	3,470	—	—	100.	—	—
	II	5,030	1.0	2.9	24.	10.	—
	III	6,660	0.82	2.4	24.	5.5	—
	IV	18,720	0.53	2.1	21.	3.6	—
UNIVAC 1107	VI	39,740	2.4	2.4	24.	16.	—
	VIIA	47,990	0.28	2.4	2.4	1.8	—
	VIIIB	61,890	0.28	0.28	1.4	1.8	—
UNIVAC 1108	VIIA	45,245	0.27*	0.43*	1.5*	1.9	—
	VIIIA	58,395	0.27*	0.27*	1.3*	1.9	—

* Indicated time is for the tape-to-tape main processing run only; it is assumed that the required on-line card-to-tape and tape-to-printer transcriptions will be performed concurrently with these or other programs.

SYSTEM PERFORMANCE COMPARISONS (Contd.)

SYSTEM IDENTITY	CONFIGURATION NUMBER (See Users' Guide 4:030.100)	MONTHLY RENTAL $	MATRIX INVERSION (See Users' Guide 4:200.300) Standard Estimate		Available Routines		GENERALIZED MATHEMATICAL PROBLEM A (See Users' Guide 4:200.400) Computation Factor for 10% Output		
			Array Size 10	40	10	40	1	10	100
			Minutes				Milliseconds		
UNIVAC SS 80/90-I	I	4,325	—	—	—	—	—	—	—
	II	7,125	—	—	—	—	—	—	—
	III	7,400	—	—	—	—	—	—	—
UNIVAC SS 80/90-II	II	8,640	—	—	—	—	—	—	—
	III	9,540	—	—	—	—	—	—	—
	IV	15,940	—	—	—	—	—	—	—
UNIVAC III	III	19,000	0.024	1.4	—	—	25.	250.	2,500.
	VI	20,400	0.024	1.4	—	—	25.	250.	2,500.
	VIIA	25,000	0.024	1.4	—	—	25.	250.	2,500.
	VIIIB	38,730	0.024	1.4	—	—	—	—	—
UNIVAC 418	III	7,125	—	—	—	—	—	—	—
	VIIA	17,875	—	—	—	—	—	—	—
UNIVAC 490	III	19,780	0.023	1.0	—	—	100.	290.	3,400.
	VIIA	31,270	0.023	1.0	—	—	55.*	290.	3,400.
	VIIIA	48,120	0.023	1.0	—	—	55.*	290.	3,400.
UNIVAC 491/492	III	13,345	0.018	0.8	—	—	75.	290.	2,700.
	VIIA	23,715	0.018	0.8	—	—	45.*	290.	2,700.
	VIIIA	41,915	0.018	0.8	—	—	45.*	290.	2,700.
UNIVAC 494	III	25,765	0.001	0.05	—	—	75.	75.	75.
	VIIA	32,715	0.001	0.05	—	—	7.3*	7.3*	58.*
	VIIIA	47,165	0.001	0.05	—	—	7.3*	7.3*	58.*
UNIVAC 1004	I	1,800	—	—	—	—	—	—	—
	II	2,725	—	—	—	—	—	—	—
UNIVAC 1050	I	3,470	—	—	—	—	—	—	—
	II	5,030	—	—	—	—	—	—	—
	III	6,660	—	—	—	—	—	—	—
	IV	18,720	—	—	—	—	—	—	—
UNIVAC 1107	VI	39,740	0.0007	0.040	—	—	100.	100.	100.
	VIIA	47,990	0.0007	0.040	—	—	100.	100.	130.
	VIIIB	61,890	0.0007	0.040	—	—	8.6	18.	120.
UNIVAC 1108	VIIA	45,245	0.00017	0.0089	—	—	7.0*	7.0*	21.*
	VIIIA	58,395	0.00017	0.0089	—	—	7.0*	7.0*	21.*

DIRECTORIES

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DIRECTORIES

CONTENTS

ROSTER OF ORGANIZATIONS IN THE COMPUTER FIELD

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(Cumulative, information as of April 15, 1966)

The purpose of this Roster is to report organizations in the computer field: organizations making or developing computing machinery or data-processing machinery, and organizations supplying significant components used in the computer field if related to the field (for example, ferrite cores would be such a component).

For listings of organizations supplying services in the computer field, please see the following surveys and rosters, elsewhere in this Directory: Roster of Electronic Computing and Data Processing Services; Survey of Consulting Services; Survey of Software Suppliers; and Roster of School, College, and University Computer Centers.

Entries. Each Roster entry if complete contains: Name of the organization, its address / Telephone number / Description of its main activities, main products in the field, any comments / Size (expressed in number of employees) / Year established. In cases where we do not have complete information, we put down what we have.

Accuracy. We have tried to make each entry accurate to the extend of information in our possession. We shall be grateful for any more information or additions or corrections that anyone is kind enough to send us. Although we have tried to be accurate and complete, we assume no liability for any statements expressed or implied.

Abbreviations

The key to the abbreviations follows:

S — Size (number of employees)

E — Established (year of establishment)

*C This organization has kindly furnished us with information expressly for the purpose of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking) / 66: information furnished in 1966 / 65:information furnished in 1965 / etc.

Organization Entry Form

The form to be completed for an entry in the Roster of Organization follows:

1. Your organization's name?

____

2. Street address?______________________________

____

3. Telephone number: area code?______________
4. City, state, zip code?______________________

____

5. Types of computers, data processors, computer components, data processing supplies or services, etc., that you produce or offer?______________

____

____

6. Approximate number of your employees?________
7. Year organization was established?____________
8. Listings for three of your executives:

President:______________________________

Public Relations Director:______________________

Advertising Manager:__________________________

This data supplied by______________________________

Title____________________ Date______________

ROSTER

A

Abacus Information Management Co., P.O. Box 399, New York, N. Y. 10008 / - / *C 65
Technical and managerial guidance for civilian and military systems. Functions served include appraisal, audit, professional criticism, review, crystallization of procedures and standards, and financial valuation / S 2 / E 1962

ABL Inc., P.O. Box 11193, Palo Alto, Calif. / - / *C 65
Engineering and consulting service in the processing of analog, audio, digital and optical signals / S 2 / E 1961

The Acratod Co., 2708 Bagby (P.O. Box 66847), Houston, Texas 77006 / 713-JAckson 4-3111 / *C 65
Punched card and tape handling equipment and supplies, including control panels, wires, magnetic tape, ribbons, binders, etc. Used D.P. machines / S 10 / E 1939

AC Spark Plug Div. General Motors Corp., 7929 S. Howell Ave., Milwaukee, Wis. 53201 / 414-762-7000 / *C 65
Design, development and production of general purpose and special purpose digital computers for space and airborne systems and other applications / S 7600 / E 1948

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / 617-783-1100 / *C 66
Hybrid stored-program signal-processing computer linkage, DAC's, ADC's, multiplexer, operational amplifiers / S 270 / E 1957

ADB Institutet (Scandinavian Automatic Data Processing Institute), Chalmers University of Technology, Gibraltargatan 5, Gothenburg S, Sweden / 031-200410 / *C 64
University training in automatic data processing. Consulting, programming, coding and running problems on Alwac III E (Wegematic 1000) and SAAB D27 computers for industries in Scandinavia / S 25 / E 1957

Adcom Corp., 20945 Plummer St., Chatsworth, Calif. / 213-341-4635 / *C 65
Design and manufacture of computer data acquisition systems employing high-speed A to D converters, D to A converters, digital multiplexers, analog memories, and hybrid interfaces / S 58 / E 1964

Addo-X, Inc., 845 Third Ave., New York, N.Y. 10022 / 212-Plaza 3-6680 / *C 66
Addo-X data capture & control equipment; Addo-X tape reader; Addo-X optical font adding machine; Addo-X 990 key data collection system; check digit verifier Mod. 7-11 / S ? / E 1947

Advanced Circuitry Div., Litton Industries, 4811 Kearney St., Springfield, Mo. / 417-UN 9-1806 / *C 65
Custom printed circuits, multiplanar interconnects, weldable circuits and packaged assemblies / S 100 / E 1943

Advance Data Systems, 9261 W. Third St., Beverly Hills, Calif. 90213 / 213-273-7650 / *C 66
Special purpose computers, computer operated revenue control devices, i.e., money machines, gates, etc. Magnetic cards and tickets. Consulting services / S 150 / E 1961

Advanced Scientific Instruments, Div. of EMR, 8001 Bloomington Freeway, Minneapolis, Minn. 55420 / 612-888-9581 / *C 65
Digital computers / S 200 / E 1961

Aero Geo Astro Div., Keltec Industries, Inc., Edsall and Lincolnia Rds., Alexandria, Va. 22314 / 703-354-2000 / *C 65
Special purpose computers, radar programmers, coordinate digital converters, data loggers, data acquisition systems of all types for industry and government, special computer interface products / S 700 / E 1958

Aetna Products Co., Inc., 11 Commercial St., P.O. Box 438, Hicksville, N.Y. / 516-WE 1-3120 / *C 65
Inked ribbons for computers, data processing, etc. / S ? / E 1941

Aircraft Armaments, Inc., York Rd., Cockeysville, Md. 21030 / 301-666-1400 / *C 66
Special purpose computers, simulators, training systems, test equipment, instrumentation; special purpose devices for missiles, space vehicles and other military weapons systems, air traffic control, anti-submarine warfare, etc., based on custom specifications / S 1250 / E 1950

Airpax Electronics, Inc., P.O. Box 8488, Fort Lauderdale, Fla. 33310 / 305-587-1100 / *C 66
Telemetry, electronic tachometry / S 400 / E 1947

Aladdin Electronics, 703 Murfreesboro Rd., Nashville, Tenn. 37210 / 615-242-3411 / *C 66
Pulse and wideband transformers / S 200 / E 1925

The William C. Allen Corp., 1875 Connecticut Ave., N.W., Washington, D.C. 20009 / - / *C 65
Management consultants / S ? / E ?

Allied/Egry Business Systems, Inc., 429 East Monument Ave., Dayton, Ohio 45402 / 513-223-3133 / *C 66
Continuous forms / S 1000 / E 1893

American Bosch Arma Corp., ARMA Div., Roosevelt Field, Garden City, N.Y. 11532 / 516-742-2000 / *C 66
Data management systems, digital computers, gyro compasses, gyros, accelerometers, ASW systems, sonics equipment, ground support equipment, displays, heading references / S 845 / E 1918

American Data Services, Inc., 0110 S.W. Bancroft St., Portland, Ore. 07201 / 503-226-6851 / *C 65
System design, programming, data processing and machine services provided business, governmental and scientific groups. Computers used are Burroughs 205 and IBM 1401 / S 20 / E 1959

American Hydromath Co., 24-20 Jackson Ave., Long Island City, N.Y. 11101 / 212-Ex 2-4242 / *C 65
Mechanical and electro-mechanical analog computer: special purpose slide rules, quality control computer, mechanical nomographs / S 10 / E 1940

American Telephone & Telegraph Co. and Associated Bell System Telephone Companies, (Hq) 195 Broadway, New York 7, N.Y. / - / *C 65
Complete communications services for data processing systems / S 735,000 / E ?

AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / 717-564-0101 / *C 66
Solderless terminals, wiring devices, capacitors, power supplies, converters, pulse forming networks / S 7000 / E 1941

Ampex Corp., 401 Broadway, Redwood City, Calif. (HQ) / 415-367-2011 / *C 66
Research, development, production by several divisions includes Videofile System, recording systems, tape recorders (all types), recording heads, servomechanisms, scanners, and magnetic tape; converters, core memories, tape handling systems / S ? / E ?

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / 213-836-5000 / *C 66
Core memories, tape handling systems / S 900 / E 1960

Amphenol-Borg Electronics Corp., 2801 S. 25th Ave., Broadview, Ill. 60155 / 312-261-2000 / *C 65
Connectors of all types, coax cable, multiconductor cable, RF connectors, coax switches, precision potentiometers, integrated circuits, harness assemblies / S over 500 / E 1958

Amplifier Corp. of America, 75 Frost St., Westbury, N.Y. 11590 / 516-333-9100 / *C 66
Tape recorders, tape decks, tape cartridges, transistorized electronic modules and plug-in boards, transistorized power supplies, transistorized amplifiers; flutter meters, demagnetizers; instruments to order / S 25 (affiliate of Keystone Camera Co., Inc.; additional personnel and facilities readily available) / E 1936

AmTron Inc., 14631 S Waverly Ave., Midlothian, Ill. / 264-5835 / *C 65
Analog and digital electronic controls for process application in industrial plants / S 50 / E 1959

Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn. / - / *C 66
Delay line memories / S ? / E ?

Anelex Corp., Anelex Bldg., 150 Causeway St., Boston, Mass. 02114 / 617-742-4585 / *C 66
Printers and printer systems, disk file memories, electronic communications devices for data processing and communications industries / S 1100 / E 1952

API Instruments Co., 7100 Wilson Mills Rd., Chesterland, Ohio 44026 / 216-423-3131 / *C 66
Indicating and controlling instruments used as safety devices and "balance wheels" to prevent drift of electronic circuits in computers and to warn of malfunctioning / S 600 / E 1945

Applied Control Corp., 293 Fairview Ave., Cedar Grove, N. J. 07009 / 201-239-3851 / *C 65
Test equipment, digital, in circuit, non loading, visual indication of computer component contents, bench tester and panel mounting versions / S 10 / E 1958

Applied Data Research, Inc., Route 206 Center, Princeton, N.J. 08540 / 609-921-8550 / *C 66
Data processing consultants; computer systems analysis & programming services; software systems development; information retrieval; data processing systems evaluation for management information controls / S 60 / E 1959

Applied Magnetics Corp., 749 Ward Drive, Santa Barbara, Calif. 93105 / 805-967-0123 / *C 66
Custom designed precision magnetic recording heads for computer and instrumentation applications / S 325 / E 1957

Approved Business Machines Co., Inc., 16 Hudson St., New York 13, N.Y. / WAlker 5-9813 / *C 65
Used business machines, including punch card machines; scanners; adding machines; analog, digital and special purpose computers; data processing machinery; forms handling equipment / S ? / E ?

Argonaut Associates, Inc., P.O. Box K, Beaverton, Ore. / 503-CY 2-3149 / *C 66
Analog computers, function generators / S 17 / E 1959

Aries Corp., Westgate Research Park, McLean, Va. 22101 / 703-893-4400 / *C 66
Systems consultants, analysts, and programmers providing professional support to computer users for management information systems, software development and modification, scientific problems, statistical analysis, information retrieval, real-time applications and data conversion / S 125 / E 1962

Arkay Engineering, Inc., 11800 W. Olympic Blvd., Los Angeles 64, Calif. / GRanite 9-8028 / *C 65
Engineering and consulting services. Experienced in designing and shipping hardware. Semiconductor circuits, data systems, automatic checkout and control, complete computers, telemetry, instruments, value analysis, proposals / S 12 / E 1958

ARMA Div., American Bosch Arma Corp. - name changed to American Bosch Arma Corp., ARMA Div., which see

The Arnold Engineering Co., P.O. Box G, Marengo, Ill. 60152 / 312-568-7251 / *C 65
Magnetic materials / S 750 / E 1936

The Artronic Instrument Co., 11232 Triangle Lane, Silver Spring, Md. 20902 / 301-949-1131 / *C 65
Delay lines, encapsulated circuit modules, magnetic core memory devices, pulse transformers, shift registers / S ? / E 1959

Arvey Corp., Lamcote Div., 3500 N. Kimball Ave., Chicago, Ill. 60618 / 312-463 1400 / *C 66
Perforator tape; Mylar reinforced paper, foil, and metallized foil combinations / S 300 / E 1905

ASI Computer Div., Electro-Mechanical Research Inc. -- name changed to Electro-Mechanical Research Inc., ASI Computer Div., which see

Astrodata, Inc., 240 E Palais Rd., Anaheim, Calif. 92803 / 714-772-1000 / *C 66
Analog computers, digital computers, data processors, data acquisition systems, telemetry systems, timing systems, amplifiers, A/D and D/A converters, multiplexers, signal conditioning equipment, discriminators, oscillators, simulators, decommutators, time code generators, translators, displays, tape search systems, power supplies, computer interface systems / S 1100 / E 1961

Audio Devices, Inc., 235 East 42nd St., New York, N.Y. / 212-687 0890 / *C 66
Magnetic computer tape / S 400 / E 1937

Audio Instrument Co., Inc. 220 E. 23rd St., New York, N.Y. 10010 / 212-MU 9-5518 / *C 65
Analog time delay devices; logarithmic converters; autocorrelation recorder / S 9 / E 1949

Auerbach Corp., 121 N. Broad St., Philadelphia, Pa. 19107 / 215-491-8200 / *C 66
Full range of EDP consulting services and publication of analytic reference services for computer users / S 250 / E 1957

Auerbach Corp., 1634 Arch St., Philadelphia, Pa. 19103 / 215-LO 3-7737 / *C 65
Consulting services in system engineering, computer programming, business information systems, product and market planning, programmed teaching, computer analysis (Auerbach standard EDP reports) / S 175 / E 1957

Autographic Business Forms, Inc., 45 E. Wesley St., S. Hackensack, N.J. 07606 / 201-489-6500 / *C 65
Continuous business forms / S 400 / E 1883

Automated Business Forms Corp., 24 Forge St., Jamesburg, N.J. / - / *C 66
Continuous tabulating forms / S ? / E ?

Automated Data Processing Services, Inc., 1104 Spring St., Silver Spring, Md. / 301-779-5500 / *C 66
Service Bureau operations; all type of data processing and conversion services; IBM 1440, 16K, 2-tape, 2 disk, 1403 printer, 2 card read/punches, NCR 420-1 optical scanner / S 35 / E ?

Automated Systems International Ltd., P.O. Box 5201, Seven Oaks Station, Detroit, Mich. 48235 / 313-933-9791 / *C 66
Parts inventory control and replenishment systems service and operation for automotive parts; accounting and management reporting systems for automative dealers / S 20 / E 1960

Automation Dynamics Corp., 35 Industrial Parkway, Northvale, N.J. 07647 / 201-768-9200 / *C 65
Support test equipment / S 25 / E 1957

Automation Engineers, 344 W. State St., Trenton 8, N.J. / 695-2628 / *C 65
Consultants in automatic control machinery, automatic materials handling equipment, information handling equipment, and random card file equipment. Designers of specialized data processing equipment, including office machinery coupling mechanisms. Analysis of automation economics; supervision of installations / S 20 / E 1942

Automation Institute of America, Inc., Suite 600, 760 Market St., San Francisco, Calif. 94102 / 415-GA 1-6285 / *C 66
Training courses in data processing offered in most metropolitan areas throughout the United States / S ? / E 1959

Automation Sciences, Inc., 275 Madison Ave., New York, N.Y. 10016 / 212-686-7122 / *C 65
Service company: systems analysis, computer programming, engineering and feasibility studies for computer, simulation, data reduction, command control and special data processing systems / S 60 / E 1963

Autonetics Div., North American Aviation, Inc., 3370 Miraloma Ave., Anaheim, Calif. 92803 / 714-772-8111 / *C 65
General purpose digital computers, special purpose digital computers, digital differential analyzers, special purpose analog computers, modular command and control systems, airborne/spaceborne recorders/reproducers / S 24,000 / E 1928 (parent co.)

Auto-trol Corp., 5566 Harlan St., Arvada, Colo. 80002 / 303-421-3726 / *C 66
Digitizers (X,Y & Z coordinate measuring & recording); X-Y coordinate data plotters (Automated drafting machines); paper tape perforators; photo-optical shaft encoders; serial card readers (low cost, low speed) / S 30 / E 1962

Avtron Manufacturing, Inc., 10409 Meech Ave., Cleveland, Ohio 44105 / 216-641-0310 / *C 65
Design, development and manufacture of special and general digital indication/control equipment; solid-state power computers and multipliers; semi-automatic test equipment / S 75 / E 1954

B

Babcock Electronics Corp., 1640 Monrovia Ave., Costa Mesa, Calif. / LIberty 8-0611 / *C 65
Command control and guidance systems including receivers, transmitters, encoders, decoders, signal generators and support equipment / S 1000 / E 1947

Bailey Meter Co., 29801 Euclid Ave., Wickliffe, Ohio 44092 / 216-943-5500 / *C 65
Automatic control equipment, special purpose computers, data processing equipment, analog and digital information systems / S 2000 / E 1916

Baltimore Business Forms, Inc., 3132 Frederick Ave., Baltimore, Md. 21229 / 301-233-8000 / *C 66
Forms -- continuous and datacard sets / S 685 / E 1916

Basic Systems Inc., 880 Third Ave., New York, N.Y. 10022 / 212-752-4600 / *C 65
Consulting services to design custom training courses to meet client training requirements and the design of self-instructional texts for individual purchasers / S 125 / E 1960

Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio / - / *C 65
Digital and analog research in systems engineering, servomechanism, automatic control machinery, and automatic materials handling machinery / S 2300 / E 1929

Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634 / - / *C 65
Analog, hybrid integrated and real-time digital computers; high-and medium-speed data acquisition and processing systems; communications and telemetry decommutation equipment; analog and digital data systems and components / S ? / E ?

Bermak Plastics, 7424 Santa Monica Blvd., Los Angeles, Calif. 90046 / 213-876-1770 / *C 65
Plastic holders for punched cards / S 25 / E 1952

Bell & Howell Micro-Data Div., 6800 McCormick Rd., Chicago, Ill. 60645 / 312-539-7300 / *C 65
Microfilm recorders and readers designed to complement computer and tab printers / S ? / E 1961

Bell Telephone Mfg. Co., Automation Systems Div., Berkenrodelel 33, Hoboken, Belgium / (03) 37-78-35 / *C 66
Data peripheral equipment (mainly magnetic tape transports; mail handling equipment, postal automation; document handling equipment, banking automation) / S 150 (ASD); 12,000 (company) / E 1950 (ASD); 1882 (company)

The Bendix Corp., Bendix-Pacific Div., 11600 Sherman Way, N. Hollywood, Calif. 91605 / 213-765-1010 / *C 66
Telemetry decoding and processing components, systems and services / S 3200 / E 1937

The Bendix Corp., Eclipse-Pioneer Div., Teterboro, N.J. 07608 / 201-288-2000 / *C 65
Airborne digital computers, analog-to-digital converters, transducers, motor generators, memory storage devices, automatic and manual checkout systems / S 9000 / E 1916

The Bendix Corp., Industrial Controls Div., 8880 Hubbell Ave., Detroit, Mich. / 313-272-3710 / *C 66
Numerical control systems / S 300+ / E 1957

Benson-Lehner Corp., 14761 Califa St., Van Nuys, Calif. 91401 / 213-781-7100 / *C 65
Data reduction, handling and translating equipment: record readers (oscillographic, film, etc.), CRT printer/plotter; data display devices including line drawing plotters, point and symbol plotters, special readers including map and blue print readers, digital microscopes and comparators; shaft rotation-to-digital converters; electrically controlled typewriters / S 140 / E 1950

Berkeley Enterprises, Inc., 815 Washington St., Newtonville, Mass. 02160 / 617-332-5453 or 332-3928 / *C 66
Publisher of "Computers and Automation" and other publications. Scientific kits for educational purposes: Brainiac (computer construction kit); Probability and Statistics kit; Teaching Machines and Programmed Learning kit / S 12 / E 1954

E. J. Bettinger Co., 20 S. 15 St., 7th floor, Philadelphia, Pa. / 215-LO4-0700 / *C 65
Personnel consultants to the EDP industry / S 20 / E 1955

Boonshaft & Fuchs -- name changed to Weston-Boonshaft and Fuchs, which see

Booz, Allen Applied Research Inc., 135 S. LaSalle St., Chicago, Ill. 60603 (also Bethesda, Md. and Cleveland, Ohio) / 312-FRanklin 2-1728 / *C 66
Broad range of computer services including computer and hardware systems design, installation management, computer feasibility, applications, systems analysis, software design, data processing, and scientific computation / S 525 / E 1955

Booz, Allen & Hamilton Inc., 135 S. LaSalle St., Chicago, Ill. 60603 (offices also in New York, Washington, D. C., Cleveland, Detroit, San Francisco, and Los Angeles) / 312-FInancial 6-1900 / *C 66
Management consultants, technical and management services in electronic and automatic data processing for integrated management information and control systems for industry, commerce, government, and institutions; feasibility studies, system design, equipment selection, implementation, systems conversion, EDP audit and review / S 400 / E 1914

Bonner & Moore Associates, Inc., 500 Jefferson Bldg., Houston, Tex. 77002 / 713-CApitol 8-0871 / *C 66
Consulting firm specializing in computer technology and management sciences; services ranging from conceptual system design and development through implementation, installation and project management / S 40 / E 1956

Bowmar Instrument Corp., 8000 Bluffton Rd., Ft. Wayne, Ind.; Acton Laboratories, Inc. (subsidiary), Acton, Mass.; TIC of Calif. (subsidiary), Newbury Park, Calif. / 219-747-3121 / *C 65
Precision servo components and assemblies, counters, electronic devices, measurement and test instruments, solid state digital computer readouts / S 1000 (including subsidiaries) / E 1951

W. H. Brady Co., 727 W. Glendale Ave., Milwaukee, Wisc. 53209 / 414-332-8100 / *C 65
Tab machine labels, key punch correction seals, computer tape control tabs, tape reel labels, file folder labels, pert symbols (all self-adhesive) / S ? / E 1914

Brandon Applied Systems, Inc., 30 E. 42nd St., New York, N.Y. 10017; 1130 17th St., N.W., Washington, D.C. 20036 / New York: 212-Yukon 6-1518; Washington: 202-296-0678 / *C 66
A data processing consulting firm providing wide range of services, including programming, systems design, equipment selection, technical writing, hardware systems engineering. BASI also publishes, with Moody's, the Moody's Computer Industry Survey, and conducts training courses / S 35, including London office / E 1964

The Bristol Co., Waterbury, Conn. 06720 / 203-756-4451 / *C 66
Special purpose computers; data recording; high speed printers; scanners; servo mechanisms; systems engineering; and telemeters / S 1800 / E 1889

Brooks Instrument Div., Emerson Electric Co., 407 W. Vine St., Hatfield, Pa. / 215-855-5174 / *C 65
Flow meters, variable area, turbine, and positive displacement with associated readout and control equipment / S 250 / E 1946

Charles Bruning Div., Addressograph Multigraph Corp., 1800 W. Central Rd., Mt. Prospect, Ill. 60058 / 312-CL 5-1900 / *C 65
Dry diazo, moist diazo and electrostatic copiers for use in communicating computer printout by reproduction methods / S 3000 / E 1897

Bryant Computer Products, Div. of Ex-Cell-O Corp., 850 Ladd Rd., Walled Lake, Mich. 48088 / 313-624 4571 / *C 66
Computer storage devices, rotating drum and disc file, random access, mass data; and related electronic interfaces / S 600 / E 1953

Bulova Watch Co., Inc., Systems and Instruments Div., 62-10 Woodside Ave., Woodside, N.Y. 11377 / 212-NE 9-5700 / *C 65
Timers and timing devices; development of automatic fabrication and control processes and machinery; research and development of special-purpose electro-optical and electromechanical devices; precision manufacturing and assembly / S 500 / E 1950

The Bunker-Ramo Corp., 277 Park Ave., New York, N.Y. 10017 / 212-826-7171 / *C 66
Digital computers for military use; input/output devices; on-line EDP services (information utility or data bank); bank automation equipment and systems; integrated circuits; systems study, research and development / S 2500 / E 1928

The Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304 / 213-346-6000 / *C 66
Militarized general-purpose digital computers; computer/display devices; display consoles; hybrid thin-film microcircuits / S 1300 / E 1964

J. H. Bunnell & Co., 920 Essex St., Brooklyn, N.Y. 11208 / 212-NI 9-1717 / *C 65
Tape punch / S 45 / E 1873

Burlingame Associates, Ltd., 510 S. Fulton Ave., Mt. Vernon, N.Y. 10550 / MO 4-7530 / *C 65
Analog computers, computing amplifiers and power supplies, analog recorders, analog-to-digital converters, digital voltmeters / S 40 / E 1928

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / 602-294-1431 / *C 66
Proprietory and custom analog computers and simulators, all silicon DC operational and instrumentation amplifiers, analog and hybrid function modules, power supplies and accessories / S 185 / E 1956

Burroughs Ann Arbor Lab., P.O. Box 1307, Ann Arbor, Mich. / 313-426-4621 / *C 65
Design, development, and production of digital display equipment and systems. Demonstrated capability in TV scan conversion, computer driven microfilm recorders, multiple station inquiry systems, direct view command and control consoles, human factor simulators, and bulk information storage and retrieval. Display components available: symbol generators, line generators, display monitors, light pens / S 25 / E 1955

Burroughs Corp., 6071 Second Ave., Detroit, Mich. 48232 / 313-875-2260 / *C 65
Electronic data processing and data communications systems and equipment for every general purpose, scientific and military data handling application. Specialized systems and components include input/output systems, magnetic tape storage systems, on-line disc file memory systems, high speed printers and multiple tape listers, paper tape readers and punches, punch card readers and punches, automatic record processors, MICR item processing and document sorter systems, hybrid micro-circuit modules, numerical readouts, alpha-numeric displays, counting and decoding tubes and devices, memory stacks, and magnetic drums, disks, tapes, cores and thin films / S 34,000 / E 1886

Burroughs Corp., Electronic Components Div., P.O. Box 1226, Plainfield, N.J. 07061 / 201-757-5000 / *C 66
Ferrite memory cores, planes and stacks; visual readout devices and systems; electronic counters -- uni- and bi-directional with visual readout and electronic outputs / S ? / E 1955 (division)

Butler Roberts Associates, Inc., Sub. of Oki Electronics of America, Inc., 500 S.E. 24 St., Ft. Lauderdale, Fla. 33316 / 305-523-7202 / *C 65
All computer and EDP peripheral equipment, including high speed line printers, input-output devices both on-line and off-line, etc. / S 12,000 (parent & subs.); 11 (Butler-Roberts Inc.) / E 1881 (parent); 1960 (Butler-Roberts Inc.)

C

Cadre Industries Corp., 20 Valley St., Endwell, N.Y. 13763 / 607-PI 8-3373 / *C 65
Cable harnesses, cable assemblies, wiring harnesses, custom manufacturing: amplifiers, plug-in modules and panels, test equipment, communications equipment and systems / S 814 / E 1951

CAE Industries, Ltd., Box 6166, Montreal 3, Quebec, Canada / 514-875-5522 / *C 66
Solid state telegraph equipment, translators, selectors, etc. Supervisory control and telemetry systems; flight simulators; computers / S 3000 / E 1947

CALMA Co., 346 Mathew St., Santa Clara, Calif. 95050 / 408-244-0960 / *C 66
Analog graphical data digitizing systems / S 20 / E 1960

California Computer Products, Inc., 305 N. Muller St., Anaheim, Calif. 92803 / 714-774-9141 / *C 66
Digital plotting equipment / S 200 / E 1959

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138 / 617-876-2800 / *C 66
Digital system design, digital logic modules, printed circuit boards, board racks and digital hardware accessories / S 472 / E 1941

Camwil, Inc., 11821 Pico Blvd., Los Angeles, Calif. 90064 / 213-GR 3-9648 / *C 66
Special type heads for IBM selectric mechanisms. Type heads made up in computer and teletype codes; foreign languages; mathematical, chemical and electronic symbols / S 12 / E 1962

Canadian Aviation Electronics, Ltd., P.O. Box 6166, Montreal 3, Quebec, Canada / 514-631-6781 / *C 65
Code translators, supervisory control and telemetry equipment, printed circuit boards, flight systems simulators, traffic control equipment, A to D converter / S 1000 / E 1947

Canadian Research Institute, 85 Curlew Dr., Don Mills, Ont., Canada / 416-447-5561 / *C 65
Analog computers; analog to digital converters / S 20 / E 1938

Carlton Controls Corp., 15 Sagamore Rd., Worcester, Mass. 01605 / 617-791-6544 / *C 66
Photoelectric perforated tape reader for either paper or mylar tape / S 25 / E 1958

C-E-I-R, Inc., One Farragut Square, S., Washington, D.C. 20006 / 212-EXecutive 3-1111 / *C 65
Data processing service bureaus, scientific and economic studies, statistical analysis, consultants in computer and management sciences / S 900 / E 1954

Celanese Plastics Co., 744 Broad St., Newark, N.J. 07102 / 201-642-6800 / *C 66
CELANAR ® polyester film — base film used in the manufacture of magnetic tape / S ? / E ?

Celestron Associates, Inc., 4 Broadway, Valhalla, N.Y. 10595 / 914-761-3456 / *C 66
Consulting; Programming/Analysis services; Software; Applications; Design Automation; Automatic Program Translation (X-ACT System); Debugging Aids; Automatic Segmentation for Multi Programming / S 20 / E 1959

Centralab, the Electronics Div. of Globe-Union Inc., P.O.Box 591, Milwaukee, Wisc. 53201 / W02-9200 / *C 65
PEC ® integrated circuits — typical functions; flip-flop, NOR gate, pulse shrinker, pulse stretcher, TDL NAND, monostable multivibrator. Also produce ceramic capacitors, variable resistors and rotary switches /

S 3000 / E 1928
Century Electronics & Instruments, Inc. 6540 E. Apache St., Tulsa 15, Okla. / 918-TE 5-9951 / *C 65
Multi-channel recording oscillographs of direct writing electrophotographic and conventional photographic types; vibration and stress analysis systems; data recording equipment and cameras; input-output devices; galvanometers; null balance recording potentiometers, UV direct writing oscillograph, hi-speed digital printer, telemetry calibrator, precision oscillator / S 650 / E 1945
CG Electronics Div., Gulton Industries, Inc. 15000 Central Ave., East, Albuquerque, N. Mex. 87108 / 505-299-7601 / *C 65
Digital data acquisition and reduction systems; missile and satellite-borne low and high-level PCM telemetry systems; low level-solid state multiplexers; high security digital command and monitoring systems; high speed A/D, D/A converters; digital timers; supervisory control systems; physiological data collection systems; automatic checkout and testing systems; computer linkage; data translation and formatting systems, digital serializer and visual readout devices; printed circuits, microwelded, copper deposition modules / S 180 / E 1957
Certron Corp., 2233 Barry Ave., Los Angeles, Calif. 90064 / 213-478-1001 / *C 66
Magnetic tape certification, recertification and rehabilitation; new certified magnetic tapes for sale / S 30 / E 1964
Chalco Engineering Corp., 15126 S. Broadway, Gardena, Calif. 90247 / 213-FA 1-9021 / *C 66
Punched tape reading equipment and regulated solid state power supplies / S 120 / E 1951
Cheshire, Inc., 408 Washington Blvd., Mundelein, Ill. 60060 / 312-566-7880 / *C 65
Machines which cut and apply computer-printed forms to mailing pieces as labels or heat-transferred address, imprints at speeds to 20,000 per hour / S 75 / E 1928
Chrono-log Corp., 2583 West Chester Pike, Broomall, Pa. 19008 / 215-ELgin 6-6771 / *C 66
Programmable clock/calendars for use on IBM series 7000, CDC 3000 computers and other digital computers. Digital counters, clocks, calendars, time code generators and readers / S 25 / E 1957
Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio 45214 / 513-241-5500 / *C 65
Fire alarms, master time and program systems, time recorders, indicating wall clocks, signaling devices, automatic parking control equipment, service supplies and data collection systems / S 300 / E 1896
C. P. Clare & Co., 3101 W. Pratt Blvd., Chicago, Ill. 60645 / 312-AM 2-7700 / *C 65
Relays, sealed contact reed relays, mercury wetted contact relays, telephone type relays, stepping switches / S 1500 / E 1937
Clary Corp., 408 Junipero St., San Gabriel, Calif. CUmberland 3-2724 / *C 65
Solid state scientific computers, arithmetic center, high-speed line printers, solenoid printers, graphic arts products, construction automation machinery, missile components and tape perforating equipment / S 344 / E 1939
Clifton Precision Products, Division of Litton Industries, Marple at Broadway, Clifton Heights, Pa. 19018 / 215-622-1000 / *C 66
Converters—analog to digital, digital to analog; mechanical counters; sine-cosine resolvers; servomechanisms; synchros / S 1300 / E 1945
Codamite Corp., P.O.Box 2518, Anaheim, Calif. 92804 / 714-774-4707, 714-776-5432 / *C 65
Code generators and translators / S 30 / E 1962
Cognitronics Corp., 549 Pleasantville Rd., Briarcliff Manor, N. Y. / 914-RO 9-7900 / *C 66
Full line of composing room computers; remote optical scanners; digital to audio devices — "Speechmaker" units / S 35 / E 1961
Cohu Electronics, Inc., Box 623, San Diego, Calif. 92112 / 714-277-6700 / *C 66
Data amplifiers, analog to digital converters, digital couplers, input scanners, digital voltmeter/ratiometers / S 240 / E 1944
Collins Radio Co., Dallas, Tex. 75207 / 214-Adams 5-9511 / *C 66
Complete line of equipment and systems for communication, computation and control / S 18,000 / E 1933
Collins Radio Co., Information Science Center, 19700 San Joaquin Rd., Newport Beach, Calif. / KImberly 9-2911 / *C 65
Collins Kineplex data communications systems for transmission of punched card, magnetic tape and other digital information over telephone line, radio circuit or other voice channels. Commercial and military communication and data processing systems and equipment including airborne data systems, teletype and other message switching systems / S 1000 / E 1950
Colorado Instruments, Inc., Garden Office Center, Broomfield, Colo. 80020 / 303-466-7333 / *C 65
Digital data acquisition systems (special-purpose, designed to meet customer requirements) and computer data entry keyboards (C-Dek) / S 25 / E 1961
Columbia Ribbon & Carbon Mfg. Co., Inc., Herb Hill Rd., Glen Cove, N.Y. / 516-OR 6-2730 / *C 66
Fabric and film base ribbons for high speed printers; carbon paper and film base ribbons for MCR systems; continuous spirit and offset duplicating masters / S 500 / E 1905
Columbia Technical Corp., 50 St. at 25 Ave., Woodside, N. Y. 11377 / 212-932-0800 / *C 66
Delay networks for use in computers; hybrid cermet networks for use in computers; HUMISEAL line of insulating coatings for protection of electronic assemblies against environmental stresses / S 124 / E 1950
COMCOR, Inc., 1335 S. Claudina St., Anaheim, Calif. 92803 / 714-772-4510 / *C 66
Analog computers; hybrid computers; operational amplifiers; plug-in computing components; maintenance services / S 225 / E 1959
Commerce Clearing House, Inc., 4025 W. Peterson Ave., Chicago, Ill. 60646 / 312-CO 7-9010 / *C 66
Loose leaf automation reporter / S 1800 / E 1913
Components Corp., 106 Main St., Denville, N.J. 07834 / 201-627-0290 / *C 66
Decade counting units, DIGI-KLIPS ®(printed circuit connectors), DIGI-GUIDES (printed circuit guide rails) / S 10 / E 1943
Computer Applications Inc., 555 Madison Ave., New York, N.Y. 10022 / 212-PLaza 9-1310 / *C 66
Computer service and consulting, data processing services, service bureau equipment: IBM 1410, 1401, CDC 160A, GL ACD Plotter, SC 4020 / S 1100 / E 1960
Computer Associates, Inc., Lakeside Office Park, Wakefield, Mass. 01880 / 617-245-9540 / *C 66
Computing services; consulting services; programming services / S 50 / E 1961
Computer Co. of America, 121 Gill Rd., Haddonfield, N.J. 08033 / — / *C 66
Desktop computers / S ? / E ?
Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / 617-879-2600 / *C 66
Computers and special-purpose digital systems for space, engineering, training, scientific and business applications. Digital modules, test instruments, magnetic core memories. Space vehicle instrumentation, simulation and data handlers; information storage and retrieval; missile tracking and positioning; signal processing and time compression; language translators; industrial process and machine tool control; business data processing; pulse pattern and range time code generation; computer training devices / S 1500 / E 1953
Computer Devices Corp., 6 West 18th St., Huntington Sta., N.Y. 11746 / 516-AR 1-0666 / *C 65
Serial memories (wire sonic delay line type); other delay lines for trim and time adjustment; word generators / S 30 / E 1961
Computer Fulfillment, 225 East St., Winchester, Mass. 01890 / 617-729-4650 / *C 66
Specialized services and data processing for the publishing industry; subscription fulfillment, circulation file maintenance and analysis; reader inquiry processing, consulting / S ? / E 1963
Computer International Sales Co., 2708 Bagley (P.O. Box 66847), Houston, Tex. 77006 / 713-JA 4-3111 / *C 66
Sell used computers on commission for owners / S 8 / E 1964
Computer Logic Corp., 1528 20th St., Santa Monica, Calif. 90404 / 213-451-9754 / *C 66
Digital logic cards; associated hardware and software, such as power supplies and chassis / S 15 / E 1960
Computer Sciences Corp., 650 N. Sepulveda Blvd., El Segundo, Calif. 90245 / 213-678-0592 / *C 66
Wide range of capabilities in the Information Sciences; programming, analysis and consultation services to manufacturers and users of computing and peripheral equipment; emphasis is given to production of compiler feasibility analyses and consultation with manufacturers to assess the direction of integrated hardware-software packages / S 1400 (approx.) / E 1959
Computer Systems Institute, Inc., 300 Sixth Ave., Suite 275, Pittsburgh, Pa. 15222 / 412-261-6110 / *C 66
Training of computer programmers on RCA 301, IBM 1401-1410 systems / S 12 / E 1962
Computing & Software, Inc., TSI Division, 8155 Van Nuys Blvd., Panorama City, Calif. 91402 / 213-781-7960 / *C 66
Computing and programming services. Equipment includes 3-IBM 7094's, a #B5000, IBM 7044, IBM 7040; a Univac 1108; SDS 9300, SDS 930, SDS 910; an IBM 1440, 4-IBM 1401's, 2-IBM 1620's; a GE 235; a microwave high-speed date link, 5-Electronic Associate 231-R Analog Computers; several automatic telemetry data reduction systems, plus wide variety of scientific raw data optical data measurement systems / S 600 / E 1947
Computron, Inc., Member of the BASF Group, 122 Calvary St., Waltham, Mass. 02154 / 617-899-0880 *C 66
Magnetic tape for computers and instrumentation / S 250 / E 1960 (Computron, Inc.); 1865 (BASF)
COMRESS, Inc., 2120 Bladensburg Rd., N.E., Washington, D.C. 20018 / 202-529-0360 / *C 66
Systems design, software development, hardware/software evaluation. Developers of SCERT (Systems and Computers Evaluation and Review Technique), a simulation system used in hardware/software evaluation and management; TRANSIM, a machine-to-machine 100% translator; DOPIC, a documentation program used in program debugging, flow charting and documentations / S 59 / E 1962
Connecticut Technical Corp., 3000 Main St., Hartford, Conn. 06120 / 203-522-6167 / *C 66
Input-output typewriters, keyboards, tape perforation systems, data logging typewriters, tape listing printers, special card perforators and readers, and services to design computer peripheral equipment / S 25 / E 1960
Consolidated Avionics, 800 Shames Dr., Westbury, N.Y. 11590 / 516-ED 4-8400 / *C 65
Transistorized power supplies, automatic test equipment, digital systems, logic modules, magnetic card readers, engine generator control modules / S 150 / E 1957
Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. 91109 / 213-796-9381 / *C 66
Electronic instruments for measurement, analysis and control; instrumentation for dynamic testing; amplifiers; analog and special purpose computers; automatic control equipment; data processing, data recording and data reduction equipment; information retrieval devices; input-output devices; electronic multipliers; regulated power supplies; magnetic tape recorders, readers, storage systems and reels, tape handlers; magnetic tape; recording papers; research; telemetering systems; transducers / S 3000 / E 1937
Continental Connector Corp., 34-63 56th St., Woodside, N.Y. 11377 / 212-TW 9-4422 / *C 66
Precision electronic connectors for computers and data processing equipment: printed circuit, rack and panel, power, special designs, micro-circuit module sockets / S 525 / E 1952
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / 612-888-5555 / *C66
General purpose and special purpose digital computers and systems, hybrid computer systems, all types of peripheral equipment, magnetic tape certifiers, certified magnetic tape, micro-miniature digital computers, automatic check-out systems, lasers, computer components, all types of software, and data centers / S 11,000 / E 1957
Control Data Corp., Control Systems Div., 4455 Miramar Rd., La Jolla, Calif. 92037 / — / *C 66
Electronic data processing and systems design consulting services of all kinds / S 315 / E 1956
Control Data Corp., Data Display Div., 2401 N. Fairview Ave., St. Paul, Minn. / 612-631-0550 / *C 66
Control Data 280 microfilm recorder & display system; Control Data 210 inquiry retrieval display system; Control Data 250 multistation display system / S 372 / E 1958
Control Data Corp., Government Systems Div., 3101 E. 80th St., Minneapolis, Minn. 55440 / — / *C 66
Special purpose digital computers and systems / S ? / E ?
Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / 617-444-7550 / *C 66
Digital logic modules, custom digital systems, digital instrumentation including multiplexers, A/D converters, output buffers, data loggers, similar data processing instrumentation / S 25 / E 1956
Control Logic, Inc., 3 Strathmore Rd., Natick, Mass. / 617-655-1170 / *C 66
Digital circuit modules, digital circuit cards, microcircuit logic cards, programmable digital equipment, special purpose digital systems / S 40 / E 1961
Controlomag Laboratories, 2459 Susquehanna St., Roslyn, Pa. 19001 / 215-884-8098 / *C 65
Custom digital counters and controls / S 18 / E 1959
Control Science Corp., 5150 Duke St., Alexandria, Va. / 703-354-9000 / *C 65
Decoders, encoders; active solid-state filters; displays, electronic and electro-mechanical; telemetering systems / S 35 / E 1961
Control Systems Div., Control Data Corp. — name changed to Control Data Corp., Control Systems Div., which see
Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. 90804 / 213-433-3360 / *C 66
Computer software; digital, analog and hybrid simulation studies and services; consulting services; courses; research studies; structural design and drafting software / S 20 / E 1960
Cook Electric Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / 312-967-6600 / *C 66
Systems engineering assistance; computer peripheral equipment including photoelectric paper tape readers, incremental and continuous digital magnetic tape transports with read and write capability; magnetic drum recorders; recorder development, design and manufacture capability / S 1500 / E 1897
Cornell-Dubilier Electronics, Div. Federal Pacific Electric Co., 50 Paris St., Newark, N.J. 07101 / 201-624-7500 / *C 66
Full line of capacitors for computer application; delay lines / S 3300 / E 1920
Corning Glass Works, 3900 Electronics Drive, Raleigh, N.C. / 919-828-0511 / *C 65
Microcircuits, capacitors, resistors, glass memory delay lines, printed circuit boards / S ? / E ?
Creed & Co. Ltd., Hollingbury, Brighton, Sussex, England / BRighton 507111 / *C 66
Teleprinters and range of paper tape equipment

for tape preparation, duplication, editing, translation and verification / S 2850 / E 1912
Crystalonics, Inc., 147 Sherman St., Cambridge 40, Mass. / 617-491-1670 / *C 65
Semiconductors, solid circuits / S 100 / E 1959
James Cunningham Son & Co., Inc., 10 Carriage St., Honeoye Falls, N.Y. / 716-624-2000 / *C 66
Computer components: scanners, switch matrix, automatic controls keyboards, systems engineering / S 125 / E 1838
Cybernetics General Co., 4247 Park Blvd., San Diego, Calif. 92103 / 714-297-4593 / *C 65
Technical services in programming, systems engineering and computer and data processing requirements analysis / S 11 / E 1963
Cyber-tronics, Inc., 915 Broadway, New York, N.Y. 10010 / 212-OR 4-9150 / *C 65
All computers and punch-card machines; rental and sale / S 130 / E 1961
Cybertype Corp., 80 Fifth Ave., New York, N.Y. 10011 / — / *C 66
Consultants and engineers supplying computer systems, applications, programs and data processing / S ? / E ?
Cybetronics Inc., 132 Calvary St., Waltham, Mass. 02154 / 617-899-0012 / *C 66
Magnetic tape rehabilitation services, tape certifiers, cleaners and rewinders; magnetic tape testers, magnetic tape cleaner, digital system for controls, consulting services, special-purpose computer and peripheral memory systems / S 30 / E 1960
Cycle Equipment Co., 130-B E. Sunnyoaks Dr., Campbell, Calif. 95008; mail address: P.O. Box 307, Los Gatos, Calif. 95030 / 408-378-4220 / *C 66
Perforated tape winders, unwinders, feeders, tape transports, reels, tape supply indicators / S 10 / E 1948

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DA-PEX Company, 334 Francis Bldg., Louisville, Ky. 40202 / 502-451-7457 or 585-5454 / *C 66
Used computer broker – consult and advise owner-users buying or selling used computers and punched card machines / S ? / E 1960
Data-American Equipment Co., 333 No. Michigan Ave., Chicago, Ill. 60601 / 312-CE 6-2525 / *C 65
Data-Vault, a safe and vault for the protection of computer tapes, disc packs and microfilm from fire, explosion and moisture / S ? / E 1961
Data Communications, Inc., Church Rd., P.O. Box 29, Moorestown, N. J. 08057 / 609-235-6650, 51, 52 / *C 66
Digital communication and terminal equipment. Data transmission terminals; time division multiplex terminals; high speed teleprinters; and cryptic devices / S 25 plus manufacturing / E 1962
The Data Corp. 4050 Wilshire Blvd., Los Angeles, Calif. 90005 / 213-385-9255 / *C 65
Consultants, methods analysts, systems analysts, programmers for major computer manufacturers. In house IBM 1460/360, SDS 910, Philco and REI Optical scanners. Representation in principal cities / S 150 / E 1962
Data Display Div., Control Data Corp., – name changed to Control Data Corp., Data Display Div., which see
Data Dynamics, Inc., 305 Webster St., Monterey, Calif. 93940 / 408-375-4133 / *C 65
Mathematical, operations and systems analysis and programming / S 110 / E 1962
Data-Link Corp., 4546 El Camino Real, Los Altos, Calif. 94022 / 415-327-2616 / *C 66
D-L 40 Splicer-Guage-Punch-punched tape splicer with tape registration guage, manual code hole punch; D-L 35 and D-L 71 Winders, electric 35 or 70 C.P.S. with split reels or demountable reels; D-L 45 Unwinder, center feed; Splice and Correct tape, self adhering, for 5, 6, 7 & 8 channel punched tape / S 20 / E 1964
Data Machines, Inc., 1590 Monrovia Ave., Newport Beach, Calif. / 714-646-9371 / *C 65
DATA 600 series general purpose, stored program scientific computers / S 6 / E 1964
Datamation Assistants Co., Inc., Ninianne Blvd. & Rt. 1, Princeton, N.J. 08540 / 609-452-2211 / *C 66
Consultation hardware/software, service bureau job processing, keypunch/optical scanning conversions, information retrieval and total management system specialists / S 160 / E 1965
Datamec Corp., – name changed to Hewlett-Packard Co., Datamec Div., which see
Data Processing Equipment Exchange Co., – see DA-PEX Co.
Data Processing Management Assoc., 505 Busse Highway, Park Ridge, Ill. 60068 / 825-8124 / *C 66
The association representing the management level data processing user group / S 25 / E 1951
Data Products Corp., 8535 Warner Dr., Culver City, Calif. 90321 / 213-837-4491 / *C 66
High-speed LINE/PRINTERS ®; random access memory DISCFILES ®; on-line and off-line print stations / S 500 / E 1962
Datapulse Inc., Datapulse Div., 509 Hindry Ave., Inglewood, Calif. 90306 / 213-671-4334, 678-4275 / *C 66
Pulse generators, data generators, word, frame and character generators / S 100 / E 1962
Datapulse Inc., KRS Instruments Div., 780 S. Arroyo Parkway, Pasadena, Calif. 91105 / 213-792-4142, 681-7416 / *C 66
Data recording instrumentation utilizing continuous-loop magnetic tape cartridges / S 50 / E 1962
Data Systems Analysts, Inc., 5900 Westfield Ave., Pennsauken, N.J. 08110 / 609-665-6088 / *C 66
Development of computer controlled communication systems and message switching programs / S 30 / E 1963
Data Systems Div. of Litton Industries — see Litton Industries, Data Systems Div.
Data Systems Inc., 10700 Puritan Ave., Detroit, Mich. 48238 / 313-341-6900 / *C 65
Design, develop and manufacture digital computers and systems for computer communications and information converters / S 50 / E 1961
Data Trends, Inc., 1259 Route 46, Parsippany, N.J. / 201-334-1515 / *C 66
Computer/communications systems; remote I/O terminal devices; data collection systems; optical scanners (hand printed) / S 28 / E 1963
Davidson Electronic Development Co., 2211 Peninsula Dr., Erie, Pa. 16505 / 814-833-9818 / *C 66
Front end specialists (parameter measurements, scanning, data reduction and sequencing for computer input, tape or cards) / S 20 / E 1951
Dayton Electronic Products Co., Inc., 117 E. Helena St., Dayton, Ohio 45404 / 513-224-1416 / *C 65
250 KC and 1 MC logic circuits, custom circuits, control systems, data acquisition systems and digital logic training devices / S 95 / E 1951
Decision Control, Inc., 1590 Monrovia Ave., Newport Beach, Calif. / 714-646-9371 / *C 65
Coincident current core memory systems, logic modules, digital systems / S 50 / E 1956
Decision Systems Inc., 1490 Queen Anne Rd., Teaneck, N.J. 07666 / 201-833-2690 / *C 66
Systems development, computer programs and programming systems, analog and digital data processing services, computer application and feasibility studies, systems analysis, information retrieval, and automatic programming development / S 60 / E 1960
Delco Radio Div., General Motors Corp., 700 E Firmin St., Kokomo, Ind. / 312-GL7-8461 / *C 65
(Semiconductors) silicon and germanium power transistors, silicon rectifiers, digital circuits and support equipment; data format converters; data acquisition and recording systems; digital circuit modules to 10 m.c. speeds; special purpose digital systems; solid state industrial control systems / S 6000 / E 1936
Dennison Manufacturing Co., Machines Systems Div., 300 Howard St., Framingham, Mass. 01702 / 617-873-3511 / *C 66
Cummins-Dennison Dat-A-Read / S 3800 / E 1844
Design Automation, Inc., 4 Tyler Rd., Lexington, Mass. 02173 / 617-862-8998 / *C 66
Computer analysis of electronic circuit performance; electronics consulting for design review; and electronics consulting for design / s 3 / E 1965
The G. C. Dewey Corp., 202 E. 44 St., New York, N.Y. 10017 / 212-MU 2-7369 / *C 65
Digital, analog computers / S 125 / E 1955
Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y. 11237 / 212-HYacinth 7-7600 / *C 65
Indicator lights, pilot lights, ultra-miniature indicator lights ("Datalites") for computer and automation fields. Data-Strip and Data-Matrix for computers, etc. Telephone light strips and indicator lights; transistorized indicator lights. Illuminated pushbutton switches. Oil-tight indicator lights for heavy-duty industrial applications. Single plane numeric readout / S 250 / E 1937
Dialtron Corp., 203 Harrison Pl., Brooklyn 37, N.Y. / HYacinth 7-7600 / *C 65
Time delay relays for computers, data processing and automation equipment / S 230 / E 1938
Diamonite Products Mfg. Co., McConkey St. Ext., Shreve, Ohio / 216-547-4211 / *C 65
Computer components of alumina ceramics, high strength, low loss, high density, electrical insulating, vacuum tight, readily metallized. Sizes available, subminiature through normal size requirements / S 175 / E 1940
DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / 617-288-7700 / *C 66
Computer keyboard, lister-printers, magnetic core memories, core transistor logic modules, digital magnetic cards (shift registers, binary counters, logic, etc.) / S 250 / E 1958
Dian Laboratories, Inc., 611 Broadway, New York 12, N.Y. / VI 6-4155 / *C 65
D.C. analog computers – analog computing services. Analog computing services; general purpose analog computers. Design and construction of special purpose computers, simulators, and trainers / S 10 / E 1955
The Diebold Group, Inc. 430 Park Ave., New York, N.Y. 10022 / 212-PLaza 5-0400 / *C 65
Full range of integrated services in the fields of modern management and management science. Areas of specialization include automation, automatic data processing, programming, information technology, product and business planning analyses. Subsidiary companies in 13 cities on two continents / S 150 / E 1954
Digital Development Corp., 5575 Kearny Villa Rd., San Diego, Calif. 92123 / 714-278-9920 / *C 66
Magnetic disc and drum memories / S 150 / E 1959
Digital Devices, Inc., 200 Michael Dr., Syosset, L.I., N.Y. / 516-921-7100 / *C 66
Delay lines, magnetostrictive, supplied as components with or without recirculation and interface electronics; also complete memory systems / S 75 / E 1955
Digital Electronics Inc., 2200 Shames Dr., Westbury, N.Y. 11590 / 516-ED 3-2115 / *C 66
Digital computers and digital to analog and analog to digital converters / S 50 / E 1961
Digital Electronic Machines, Inc., 2130 Jefferson, Kansas City, Mo. 64108 / 816-421-3181 / *C 66
Card read unit (CRU); card to tape unit (CTU); tape preparation unit (TPU); instrumentation / S 24 / E 1963
Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / 617-897-8821 / *C 66
Solid state, general purpose digital computers, memory test systems, special purpose systems, digital circuit modules; input-output equipment, including CRT displays, light pens, magnetic tape systems, various memory options / S 1000 / E 1957
Digitronics Corp., 1 Albertson Ave., Albertson, L.I., N.Y. 11507 / 516-HT 4-1000 / *C 66
Data communication terminals, paper tape readers and handlers and source data acquisition equipment / S 350 / E 1957
Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / 305-565-5511 / *C 66
Digital plotters; digital coordinate readers; film readers; binary to decimal converters; digital systems, custom; data minimizers / S 50 / E 1962
Documentation Inc., 4833 Rugby Ave., Bethesda, Md. 20014 / 301-656-9500 / *C 66
Consulting, systems design and engineering, indexing, abstracting, cataloging, microfilming, mechanized publishing, microfilm, microfiche readers, reader-printers / S 700 / E 1951
Dolin Metal Products, Inc., 315 Lexington Ave., Brooklyn, N.Y. 11216 / 212-638-9472 / *C 66
Manufacturers of stock size data tape store units; special sizes mobile storage systems; tabulating card files / S 80 / E 1948
Douglas Randall Inc., a subsidiary of Walter Kidde & Co., Inc. 441 Pawcatcuk Ave., Westerly, R.I. 02891 / 203-599-1750 / *C 65
Reed relays, coils / S ? / E 1950
Drake Mfg. Co., 4626 N. Olcott, Harwood Hts., Ill. 60656 / 312-867-7227 / *C 66
Miniature lighting specialists– indicator, instrument and read-out lights, lenses, lampholders, accessories specified in commercial as well as military equipment / S 130 / E 1932
Dresser Products, Inc., 112-114 Baker St., Providence, R.I. 02905 / 401-781-4430 / *C 66
Data processing equipment and supplies (paper tape handling equipment, paper tape splicers and splicing tape, paper tape filing supplies— folders, envelopes, etc.) / S 9 / E 1955
Drexel Dynamics Corp., Maple Ave., Horsham, Pa. 19044 / 215-927-6200 / *C 66
Card readers, sub systems OEM, components, card feeders / S 200 / E 1956
E.I. duPont de Nemours & Co., 1007 Market St., Wilmington, Del. 19898 / 302-PR 4-2421 / *C 65
Differential analyzers, recording papers / S 100,000 / E 1802
Dura Business Machines, 32200 Stephenson Highway, Madison Heights, Mich. / 313-588-1100 / *C 66
Dura MACH 10 automatic typewriters; Dura code converters / S 400 / E 1961
Durant Mfg. Co., 600 N. Cass St., Milwaukee, Wisc. 53201 / 414-271-9300 / *C 65
Digital read-out instrument counters and indicators / S 300 / E 1879
Dymec Div. of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. 94306 / — / *C 66
Digital data plotting systems / S ? / E ?

E

E-A Industrial Corp., 2326 South Cotner Ave., Los Angeles, Calif. 90064 / 213-477-5078 / *C 65
Digital systems and computers for process control / S ? / E 1962
Eastman Kodak Co., 343 State St., Rochester, N.Y. 14650 / 716-325-2000 / *C 65
Photographic equipment, staple synthetic and organic chemicals and dyestuffs; facsimile equipment (photocopy); recording paper / S 50,000 / E 1889
Ebasco Services, Inc., 2 Rector St., New York, N.Y. 10006 / 212-344-4400 / *C 66
Consulting and engineering services: systems analysis and design; commercial, scientific, engineering EDP applications; data communications; feasibility studies; plant automation; data processing and computing services / S 1500 / E 1907
E D P Corp., 1900 N. Mills Ave., Orlando, Fla. 32803 / 305-241-5324 / *C 65
Code translators and digital displays. Time Code-Generators-Encoders-Decoders. Sequences and event programmers. Monitoring and remote control systems / S 75 / E 1959
EDP Management, Inc., P.O. Box 393, New York, N.Y. 10008 / - / *C 65
Consulting services: computer type communication systems; economic research; information engineering; programming; research; and systems engineering / S ? / E ?
ELCO Corp., Maryland Rd. & Computer Ave., Willow Grove, Pa. 19090 / 215-659-7000 / *C 65
VARICON* Connectors, BI/CON* Connectors,

MICROCON* Connectors, MODUCON* Micro-modules, VARIMATE* Connectors, VARIPLATE* Connectors, VARIPAK * Card Cages, E-Z MATE* Tube Sockets (*Trade Mark) / S 700 / E 1947

Electric Indicator Co., Inc., Camp Ave., Stamford, Conn. 06879 / 203-322-1671 / *C 65
Sub-fractional and fractional A/C and D/C motors, generators and blowers used in computers / S 170 / E 1926

Electro Instruments, Inc., 8611 Balboa Ave., San Diego, Calif. 92112 / 714-277-6590 / *C 65
Digital voltmeters, ohmeters, ratiometers; analog-to-digital converters; wideband DC amplifiers, X-Y recorders, monitor oscilloscopes, digital data systems / S 647 / E 1954

Electro-Mechanical Research, Inc., P.O. Box 100 (1900 Main St.), Sarasota, Fla. 33578 (company divisions include: Telemetry Div., Sarasota, Fla.; ASI Computer Div., Minneapolis, Minn.; Photoelectric Div., Princeton, N.J.; Aerospace Services, College Park, Md.; Magnetics, Van Nuys, Calif.) / 813-955-8153 / *C 66
General purpose and special purpose digital computers and associated peripheral equipment; telemetry components and systems; data acquisition, data handling and data processing systems / S 1408 / E 1941

Electro-Mechanical Research, Inc., ASI Computer Div., 8001 Bloomington Freeway, Minneapolis, Minn. 55420 / 612-888-9581 / *C 66
General purpose computers for scientific, engineering and on-line systems applications / S 250 / E 1961

N. V. Electrologica, 4 Bordewijkstraat, Rijswijk (ZH), The Netherlands / 070-906720 / *C 66
EL X2, EL X4, EL X8 computers; EL 1000 tape-reader; disc-storage-drive for interchangeable disc-packs / S 500 / E 1956

N. V. Electrologica, 214 Stadhoudersplantsoen, The Hague, The Netherlands / 070-514641 / *C 65
EL X2, EL X3, EL X4, El X5 and EL X8 computers, EL 1000 high speed tape reader / S 500 / E 1956

Electro-Miniatures Corp., 600 Huyler St., So. Hackensack, N.J. 07606 . 201-488-7770 / *C 66
Commutator switches. Metal segments and rings embedded in plastic compounds / S 152 / E 1955

Electronic Administrative Services, Inc., 1745 Saratoga Ave., San Jose, Calif. 95129 / 408-257-4800 / *C 66
Full scale E.A.M. installation. User contracts: IBM 1401, 1410, 7040, 7090; on order, IBM 360 Model 20. General business consulting services; administrative services; management consulting services / S ? / E 1960

Electronic Associates Inc., West Long Branch, N.J. / 201-222-1100 / *C 65
Analog, digital and hybrid computers, digital plotting equipment, computing services / S 2500 / E 1945

Electronic Development Corp., 423 West Broadway, So. Boston, Mass. 02127 / 617-268-9696 / *C 66
Voltage to digital converters (decimal and binary); data logging systems / S 25 / E 1958

Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif. 92702 / 714-547-5501 / *C 66
A/D, D/A converters, magnetic core memories, multiplexers, data acquisition systems, computer format control buffers, paper tape readers, tape search and control equipment / S 300 / E 1949

Electronic Management, Computerology Corp. (Emc^2), 6900 Wisconsin Ave., Washington, D.C. 20015 / 301-OL6-0540 / *C 66
Consultants in military and civilian functionally encompassing systems / S 8 / E 1964

Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif. 90250 / 213-772-50-1 / *C 66
Memory systems, stacks and cores for commercial, military and space application / S 700 / E 1961

Electronic Modules Corp., 1949 Greenspring Drive, Timonium, Md. 21093 / CL 2-22900 / *C 65
Computers and special purpose digital control systems for military, government and commercial applications. Digital process and machine controls. Digital logic modules 250 kc to 10 mc / S 170 / E 1961

Electron Ohio, Inc., 1278 W. 9th St., Cleveland, Ohio 44113 / 216-MA 1-5377 / *C 66
"Shoptrol" data collection system; bar chart recorder; magnetic drums; electro-magnetic counters / S 8 / E 1961

Electropac, Inc., a subsidiary of Computer Control Company, Inc., Industrial Park, Peterborough, N.H. 03458 / 603-924-3821 / *C 65
Contract manufacturer of electronic and electromechanical equipment (computer, aerospace, industrial, medical). Production or prototype construction wiring or circuit assembly to commercial or Mil specifications / S 220 / E 1960

Elgenco, Inc., 1550 Euclid St., Santa Monica, Calif. 90404 / 213-451-1635 / *C 66
Low frequency gaussian noise generators / S 15 / E 155

EL-RAD Manufacturing Co., 4300 N. California Ave., Chicago, Ill. 60618 / 312-478-7300 / *C 66
Delay lines and pulse transformers for computer applications / S 250 / E 1944

Encoder Div., Litton Precision Products, Inc., 7942 Woodley Ave., Van Nuys, Calif. 91406 / 213-781-2111 / *C 66
Digital shaft encoders of the magnetic, optical and contact types. Output codes include self-decoded, binary, BCD, gray and V Scan binary / S 175 / E 1963

Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / 714-547-5651 / *C 66
Digital logic cards and modules, IC logic cards, custom systems, custom packaging and welding, and rotary thumbwheel switches / S 200 / E 1954

English Electric-Leo-Marconi Computers Ltd., Kidsgrove, Stoke-on-Trent, Staffs, England / Kidsgrove 2141 / *C 65
Data processing systems for commerce, industry and science. Time high facilities at Computer Bureau. Back-up Service Centres. Commercial, technical and management science bureau services / S 3250 / E ?

Entelek, Inc., 42 Pleasant St., Newburyport, Mass. 01950 / 617-465-3000 / *C 66
Keypunch performance aids, programmed instruction in computer-based management, computer-assisted instruction / S 10 / E 1961

Epsco, Inc., 411 Providence Hwy., Westwood, Mass. 02090 / 617-329-1400 / *C 65
Computer components and equipment; special purpose computers, monitoring systems, computer linkages and format recorders, 1 and 5 megacycle digital circuit cards, wide-board amplifier series, portable data gathering systems, high speed A/D converters, volt-meters, reference sources. Pulse code modulation air and ground telemetry systems / S 275 / E 1954

Essex Systems Co., Inc., 40 E. 49th St., New York, N.Y. 10017 / - / *C 66
Continuous tabulating forms / S ? / E ?

ESS GEE, Inc., 1 Holland Ave., White Plains, N.Y. / WH 6-1200 / *C 65
Airborne data processing equipment and instrumentation. Instrumentation and recording equipment for operation into computers, A/D converters, and computer interconnection components. Ground data handling systems / S 75 / E 1959

Evershed & Vignoles Ltd., Acton Lane Works, Chiswick, London W. 4, England / Chiswick 3670 / *C 65
Special purpose analog computers, data loggers, industrial telemetry, process control, servo-system components / S 2300 / E 1895

Exact Electronics Inc., 455 S.E. 2nd Ave., Hillsboro, Ore. 97123 / - / *C 66
Waveform generators / S 27 / E 1957

Executone, Inc., 47-37 Austell Place, Long Island City, N.Y. 11101 / 212-EX 2-4800 / *C 66
Electronic voice communication, sound, signalling and pocket page systems / S 450 / E 1937

E-Z Sort Systems, Ltd., 45 Second St., San Francisco, Calif. 94105 / 415-GA1-8005 / *C 65
Edge-punched cards for filing and sorting data. Special cards for correlation of facts. Control systems for a number of electronic computers. Teaching machines, program scheduling / S 186 / E 1935

F

F & F Enterprises, Inc., Chicago Switch Div., 2035 Wabansia Ave., Chicago, Ill. 60647 / 312-489-5500 / *C 66
Switches / S 60 / E 1954

Fabri-Tek Inc., 5901 S. County Rd. 18, Box 24035, Minneapolis, Minn. 55424 / 612-935-8811 / *C 66
Memory systems, stacks and planes, educational digital, trainers and related equipment, Bio-medical and nuclear physics research instruments / S 2500 / E 1957

Fabri-Tek Inc., Box 645, Amery, Wisc. / 715-268-7155 / *C 65
Core memory planes, stacks and systems, thin film system / S 2000 / E 1957

Facit-Odhner Inc., a subsidiary of Atvidabergs Industries of Sweden, 222 East 44 St., New York, N.Y. 10017 / 212-867-7171 / *C 65
Sale of the Facit high-speed tape reader, tape punch and tape duplicator / S 10,000 / E 1922

Fairchild Controls, Div. of Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, L.I., N.Y. 11802 / 516-WE 8-5600 / *C 65
Especially for computing and data processing industries — a complete new line of single turn, multi-turn potentiometers and trimmers (FAIRCON) / S 500 / E 1945

Fairchild Space and Defense Systems, Div. of Fairchild Camera and Instrument Corp., 300 Robbins Lane, Syosset, L.I., N.Y. / 516-WE 1-4500 / *C 65
Reconnaissance, mapping and ground data handling systems; special purpose computers; digital controls and electronics; data block readers; data annotation; special fixed memory devices; frequency control and time-base generators / S 1300 / E 1920

Farrington Electronics, Inc., Shirley Industrial Park, Springfield, Va. / 703-354-5000 / *C 65
Optical character recognition equipment, series 9SP; ID' IP; SD and source data recorders / S 300 / E 1953

Ferranti Electric, Inc., East Bethpage Rd., Plainview, N.Y. 11803 / 516-293 8383 / *C 66
Agent for Ferranti Ltd., Hollinwood, Lancashire Eng. Argus 400 and 500 general purpose and process control computers, silicon integrated circuits, moire fringe measuring systems, viscometers, magnetic tape bulk erasers, high resolution CRT display tubes / S 16,000 / E 1896

Ferranti Ltd., Manchester, Lancashire & Brackwell, Berkshire, England / Failsworth 2071 or Bracknell 2020 / *C 65
Real time digital computers and data handling systems / S over 5000 / E 1882

Ferranti-Packard Electric Ltd., Industry St., Toronto 15, Ontario, Canada / 416-762-3661 / *C 66
FP6000 general purpose computer, special purpose computer systems (reservations systems, process control), photo-electric tape readers, magnetic flip disc displays, special digital systems design and manufacture / S 1100 (company); 220 (Electronics) / E 1912 (company); 1949 (Electronics)

Ferroxcube Corp., Saugerties, N.Y. 12477 / 914-246 2811 / *C 66
Ferrite cores, planes, stacks, memory systems and recording head assemblies / S 1000 / E 1950

Fischer & Porter Co., County Line Rd., Warminster, Pa. / OSborne 5-6000 / *C 65
Industrial and military data acquisition equipment. Digital computer process control. Multiple pressure measuring systems. Vehicular traffic data recorders and systems. Meteorological data recorders and systems. Electronic integrator / S 15,000 / E 1937

Floating Floors, Inc., (subsidiary of National Lead Co.), 22 E. 42nd St., New York, N.Y. 10017 / 212-986-9050 / *C 66
Raised floors, surface cable ducts, computer air conditioning units, computer room floor cleaner polish / S over 5000 / E 1957 (parent 1891)

Dr Ivan Flores, 931 President St., Brooklyn 15, N.Y. / -- / *C 65
Consulting services / S ? / E ?

The Foxboro Co., 38 Neponset Ave., Foxboro, Mass. 02035 / 617-543-9750 / *C 65
Process computer systems, data logging and alarming computers, alarm scanners, computer set point stations / S 3000 / E 1903

Franklin Electronics Inc., East Fourth St., Bridgeport, Pa. 19405 / 215-272-4800 / *C 66
Digital printers -- 40 columns maximum / S 85 / E 1953

Friden, Inc., a subsidiary of the Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / 415-357-6800 / *C 66
Data processing and data collecting systems, including: Flexowriter* automatic writing machine; Collectadata* data collection network; 6010 electronic computer and 6018 magnetic disc file; Computyper* writing/computing machine, Model CTP and Model 5010 (electronic); Teledata* data transmitter/receiver; Selectadata* selective reader; code converter; Add-punch* adding machine/tape punch; remotely controlled input-output devices and printers; special Flexowriter writing machines. Equipment for reading, punching, verifying, converting, regenerating and transmitting paper tape, edge-punched cards or tabulating cards. Supplies used with data processing equipment. Adding machines, 10-key and special type style for optical reader. Electronic and rotary desk calculators. *Trademark / S 11,600 / E Incorporated 1934

G

G-E Communication Products Dept., Lynchburg, Va. / 703-VI 6-7311 / *C 65
TDS-91 Data Communications / S ? / E ?

General Atronics Corp., 1200 E. Mermaid Lane, Philadelphia, Pa. 19118 / 215-248-3700 / *C 66
Memory systems, electronic; Automatic counting & sorting systems; Photoelectric readers; Oscilloscopes & cameras for recording data / S 250 / E 1956

General Computers, Inc., 5990 W. Pico Blvd., Los Angeles, Calif. 90035 / 213-939-7687 / *C 66
Analog computers and analog computing components / S 50 / E 1957

General Devices, Inc., Box 253, Princeton, N.J. 08540 / 609-924-2500 / *C 66
Digital data acquisition systems, tape to tape translators, computer input devices, telemetering systems / S 75 / E 1953

General Dynamics/Electronics, 3302 Pacific Highway, P.O. Box 127, San Diego 12, Calif. / 714-298-4641 / *C 65
Computer readout devices, high speed electronic printers, high speed communications printers, microfilm recorders, plug-in and potted circuits, digital devices for display of computer information, input and visual output devices (the CHARACTRON® shaped beam tube), facsimile systems / S 1200 / E 1955

General Dynamics/Electronics, 1400 North Goodman St., Rochester, N.Y. 14601 / 716-FI 2-8000 / *C 65
Digital computers, process control computers, statistical analog computers, data transmission systems, data logging systems / S 4000 / E 1894

General Electric Co., Capacitor Dept., P.O. Box 158, Irmo, S.C. 29063 / 803-253-3830 / *C 65
Capacitors for computers / S 750 / E 1898

General Electric Co., Computer Dept., 13430 N. Black Canyon Highway, Phoenix, Ariz. 85001 / 602-941-2900 / *C 65
GE-115, 205, 215, 225, 235, 415, 425, 435, 625, 635. Complete data-processing systems, includ-

AUERBACH ®

ing full line of peripherals. Computer services offered non-computer customers through six Information Processing Centers in major metropolitan areas / S 4400 / E 1956

General Electric Co., Electronic Components Sales Operation, 1 River Rd., Schenectady, N.Y. 12305 / 518-FRanklin 4-2211 / *C 66
Sells electronic components and devices to electric and electronic product manufacturers / S 250,000 / E 1892

General Electric Co., Laminated Products Dept., Coshocton, Ohio / MAin 2-5310 / *C 65
Flooring for free-access floors / S 700 / E ?

General Electric Co., Process Computer Business Section, 2255 W. Desert Cove Rd., Phoenix, Ariz. 85002 / 602-941-2900 / *C 66
Process computers and systems; remote scanners; data loggers; explosion-proof ID card reader; network analyzer; contract programming / S? / E ?

The General Fireproofing Co., E. Dennick Ave., Youngstown, Ohio 44501 / 216-746-7271 / *C 65
Data processing accessory equipment / S 2600 / E 1902

General Instrument Corp., Defense & Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N.Y. 11802 / 516-OVerbrook 1-4300 / *C 66
General and special purpose computational and data processing systems and equipment utilizing conventional modular and/or microelectronic packaging / S 9000 / E 1922

General Instrument Corp., Magne-Head/Systematics Div., 13040 S.Cerise Ave., Hawthorne, Calif. 90250 / 213-679-3377 / *C 66
Tape to card converters, card to tape converters, data communication equipment / S 300 / E 1955

General Instrument Corp, Radio Receptor Div., 100 Andrews Rd., Hicksville, N.Y. 11802 / 516-681-4300 / *C 66
Custom designed general support equipment, automated test equipment, special purpose computer components and computer systems, digital systems using small-medium general purpose computers / S 600 / E 1922

General Precision, Inc., GPL Div., Bedford Rd., Pleasantville, N.Y. 10570 / 914-RO 9-5000 / *C 66
PARD (Precision Annotation & Retrieval Display) systems; microtelivisor; character vector generator; airborne computers for use with dopplar radar systems; lenticolor (real-time color display using black and white film or TV source); TV hard copy printer / S 1000 / E 1946

General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / 201-256-4000 / *C 66
Analog, digital, and hybrid computers. Programmed measurement and checkout equipment. Digital data communication, high-speed logic, and range instrumentation systems. Data acquisition and recording systems. Analog to digital converters. Servomechanisms and systems. Digital electroluminescent solid state readout devices (alpha-numeric). Resolvers, transolvers, synchros, servo motors, motor tach generators, servo amplifiers, QR circuits, dc power supplies, choppers, mag-amps, signal comparators and sensors, and summing-isolation amplifiers / S 6000 / E 1917

General Precision, Inc., Librascope Group, 808 Western Ave., Glendale, Calif. / 213-240-2117 / *C 66
Military computers and data-processing systems; mass memories; peripheral computer disc memories; optical systems; encoders / S 2000 / E 1937

General Precision, Inc., Link Group, Colesville Rd., Binghamton, N.Y. 13902 / 607-772-3100 / *C 66
Aircraft and missile simulators, video and photographic storage/retrieval and processing systems, space information systems, range timing and instrumentation systems, graphic data conversion systems, special purpose analog/digital computing systems and ancillary equipments, computer simulation, and scientific programming services / S 4000 / E 1935

General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / 617-EM 9-4400 / *C 66
Electronic measuring and test instruments, including frequency counters, digital-to-analog converters and printers / S 1000 / E 1915

Genisco Technology Corp., Systems Div., 18435 Susana Rd., Compton, Calif. 90221 / 213-774-1850 / *C 66
Tape recording and reproducing systems; telemetry checkout equipment / S 450 / E 1947

Geo Space Corp., 5803 Glenmont Drive, Houston, Tex. / 713-MO 6-1611 / *C 66
Digital photographic plotters; 21 channel to System/360 format controller; geophysical data processing equipment / S 600 / E 1957

The Geotechnical Corp., 3401 Shiloh Rd., Garland, Tex. 75040 / 214-278-8102 / *C 65
Slow-speed, low-frequency analog magnetic tape recorder/reproducers / S 650 / E 1936

The Gerber Scientific Instrument Co., 83 Gerber Rd., South Windsor, Conn. (P.O. Box 305, Hartford, Conn.) / 203-644-1551 / *C 66
Plotters (plotting boards), automatic drafting machines, graphic to digital converters, digital to graphic converters, data reduction equipment, scanners / S 275 / E 1948

Giannini Controls Corp., 1600 S. Mountain Ave., Duarte, Calif. 91010 / 213-681-2311 / *C 65
Data acquisition devices, encoders, numerical controls; measurement and control devices; instruments; timing devices; ultrasonic devices; nucleonic devices / S 2000 / E 1945

Giannini Scientific Corp., Flight Research Div., P.O. Box 1-F, Richmond, Va., 23201 / 703-737-4163 / *C 66
Photo instrumentation, systems and analog to digital converters / S 80 / E 1948

Government Systems Div., Control Data Corp. -- see Control Data Corp., Government Systems Div.

GPS Instrument Co., Inc., 188 Needham St., Newton, Mass. 02164 / 617-969-9405 / *C 66
High-speed, high-accuracy repetitive analog computers, statistical and iterative types; computer center and services rental; computer components, function and noise generators, multiplier/divider, etc. / S 60 / E 1951

Graphic Controls Corp., 189 Van Rensselaer St., Buffalo, N.Y. 14210 / 853-7500 / *C 65
GC data processing forms; continuous, manifold data processing forms / S 360 / E 1957

H. J. Gruy & Associates, Inc., 2501 Cedar Springs Rd., Dallas, Tex. 75201 / 214-RI 2-1421 / *C 66
Petroleum engineering consultants; equipment includes 1620 II-40K, 1443 printer, 1311 disc drive, calcomp plotter with SPS & Fortran compilers / S 70 / E 1959

The GYREX Corp., 3003 Pennsylvania Ave., Santa Monica, Calif. / 213-EXbrook 3-0462 / *C 65
Computer input systems (high speed data processors); time and frequency standards and control systems; pulse generators and time markers / S 30-35 / E 1956

H

Haddonfield Research & Mfg. Co., 121 Gill Rd., Haddonfield, N.J. 08033 / 609-429-9218 / *C 66
Production of ferrite products used in the memory area, consultation in ferrite magnetics, manufacture of small-scale computer systems marketed under the name "Compulator" / S 10 / E 1962

Hagan Controls Corp., 250 Mt. Lebanon Blvd., Pittsburgh, Pa. 15228 / 415-563-6120 / *C 66
Data loggers, alarm indicating monitors, recorders / S 521 / E 1918

Halbrecht Associates, Inc., 4977 Battery Lane, Bethesda, Md. 20014 / 301-656-9170 / *C 65
Personnel consulting, recruiting and placement in EDP fields (software, engineering and management), operations research, management sciences, mathematics / S 10 / E 1957

Hammond Manufacturing Co. Ltd., 394 Edinburgh Rd. North, Guelph, Ontario, Canada / 519-822-2960 / *C 66
Transformer and sheet metal components of all types for electronic and electrical computer sub and main systems / S 350 / E 1927

Philip Hankins & Co., Inc., 800 Massachusetts Ave., Arlington, Mass. 02174 / 617-648-2330 / *C 65
Computer consulting, software development and programming / S 35 / E 1959

Philip Hano Co., Inc., 85 Sargeant St., Holyoke, Mass. 01040 / 413-JE 3-7141 / *C 66
Continuous forms marginally punched; included are custom, standard, stock tab and tab imprints / S ? / E 1888

Harman Kardon, Inc.— name changed to the Roback Corp., which see

Hayden Book Co., Inc., 116 W. 14th St., New York, N. Y. 10011 / 212-OR-5-5020 / *C 66
Texts and trade books on programming, digital tape recording, digital computers and systems, analog computers, data transmission and systems / S 75 / E 1934

The A. W. Haydon Co., 232, No. Elm St., Waterbury, Conn. 06720 / 203-756-4481 / *C 65
Electromechanical and electronic time code generators and systems; stepping motors, devices and systems; timing motors, devices and systems / S 460 / E 1946

Heath Co., Benton Harbor, Mich. / 616-YU-3-3961 / *C 65
Educational analog computer / S 575 / E 1946

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304 / 415-326-7000 / *C 65
Design and manufacture of general purpose electronic test equipment including electronic counters, digital recorders, frequency synthesizers, digital to analog converters, pulse generators, oscilloscopes, sampling oscilloscopes, switching time testers, electronic voltmeters, clamp-on dc millimeters, oscillators, audio signal generators, microwave sweep oscillators and signal generators, microwave power and SWR meters, wave guide and coaxial equipment, data acquisition systems, X-Y recorders, strip-chart recorders, magnetic tape recording systems, multi-channel recording systems / S 7300 / E 1939

Hewlett-Packard Co., Datamec Div., 345 Middlefield Rd., Mountain View, Calif. 94041 / 415-968-7291 / *C 66
Digital magnetic tape units; mark sense card and page readers; source data acquisition systems; electromechanical computer peripherals and associated electronics / S 135 / E 1961

The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio 44108 / 216-514-8060 / *C 66
Computer and data processing test and repair instruments / S 700 / E 1914

Hoffman Electronics Corp., Semiconductor Div., Hoffman Electronic Park, El Monte, Calif. 91734 / 686-0123 / *C 65
Photoelectric tape and card readers; semiconductor devices including diodes, regulators, temperature compensated reference devices / S 429 / E 1941

Allen Hollander Co., Inc., 385 Gerard Ave., Bronx, N.Y., 10451 / 212-MO 5-1818 / *C 66
Pressure sensitive pinfeed labels for data processing / S 200 / E 1948

Hollander Associates, P.O. Box 2276, Fullerton, Calif. 92663 / 714-LA 5-8777 / *C 65
Design and consulting in general and special purpose computers and their application to business, control, communications switching, and defense; including technical liaison overseas. Research on methodologies for system design and optimization / S 9 / E 1961

Holley Computer Products Co., Subsidiary of Control Data Corp., 1480 N. Rochester Rd., Rochester, Mich. 48063 / 313-651-8811 / *C 66
High and medium speed digital drum printers / S 200 / E 1961

Honeywell, Denver Div., 4800 E. Dry Creek Rd., Denver, Colo. 80217 / 303-771-4700 / *C 65
Incremental digital magnetic tape recorders / S 1000 / E 1886

Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / 617-CE 5-7450 / *C 66
Card reader; card reader/punch; mass memory file; magnetic tape unit; high speed printers; memory tester; tape transmission terminal; data station, remote communications terminal / S 6000 / E 1955

Honeywell Inc., Industrial Div., 1100 Virginia Dr., Fort Washington, Pa. 19034 / 215-643-1300 / *C 66
General purpose digital computers for on-line real-time applications, special purpose analog computers, and programming and maintenance of these systems / S about 3500 / E 1863

Honeywell, Special Systems Div., Queen & So. Bailey Sts., Pottstown, Pa. 19464 / 215-323-4000 / *C 65
General purpose digital computers for on-line real-time applications, special purpose analog computer systems, MGF, programming, and maintenance of these systems / S 350 / E 1958

The Hoover Co., Electronics Div. -- name changed to Novatronics, Inc. which see

Houston Fearless Corp., 11801 Olympic Blvd., Los Angeles, Calif. 90064 / 213-272-4331 / *C 66
Computer-peripheral equipment, microfilm storage-retrieval-display systems, filmcard (microfiche) camera-processors, film processors, and TV camera pedestals, heads, and tripods; precision measuring microscopes, projectors, and photogrammetric equipment / S 720 / E 1940

HRB-Singer, Inc., Box 60, Science Park, State College, Pa. 16801 / 815-238-4311 / *C 66
Services and special equipment in the areas of operations research, system analysis, and system measurement and evaluation / S 1250 / E 1946

I

Image Instruments, Inc., 2300 Washington St., Newton Lower Falls, Mass. 02162 / 617-969-8440 / *C 66
Storage tube systems for man-machine interface, off-line processing, temporary storage or multiple display purposes in conjunction with computer. / S 13 / E 1958

IMC Magnetics Corp., Western Div., 6058 Walker Ave., Maywood, Calif. / 213-LUdlow 3-4785 / *C 65
Linear and rotary solenoids, step-servo motors, synchros, resolvers, digital to shaft angle converters / S 150 / E 1946

Inductor Engineering, Inc., 117 Schley Ave., Lewes, Del. 19958 / 302-645-6251 / *C 65
Magnetic amplifiers, transformers, toroids, electronic filters, pulse transformers, converters / S 25 / E 1956

Industrial Control Co., Central Ave. at Pinelawn, E. Farmingdale, L.I., N.Y. 11735 / 516-MY 4-3000 / *C 65
Servo multipliers, function generators, servo digitizers / S 25 / E 1949

Industrial Electronic Engineers, Inc., 7720 Lemona Ave., Van Nuys, Calif. 91405 / 213-787-0311 / *C 66
Rear-projection readout and display devices and systems; binary to decimal driver/decoders; readout and display accessories; illuminated switch status indicator; bina-view self-decoding readout / S 200 / E 1946

Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus, Ohio 43202 / 614-267-6351 / *C 65
AccuRay industrial process measurement and automatic control systems, data reduction and readout systems for paper, plastics, metal and other industries / S 550 / E 1950

Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / 213-783-7500 / *C 66
Specialists in on-line real-time time sharing software applications, implementation and analysis; provide design, analysis, programming and implementation of computer-based systems for government and industry / S 250 / E 1962

Information Displays, Inc., 102 E. Sandford Blvd., Mt. Vernon, N.Y, 10550 / 914-OW 9-5515 / *C 66
CRT display systems -- computer aided graphics / S 40 / E 1946

Information for Industry, Inc., 1000 Connecticut Ave., N.W., Washington, D.C. 20036 / 202-296-4936 / *C 66
Sole owners of data base covering all U.S. chemically related patents issued since 1950 to date. Programs available for IBM, Burroughs and CDC equipment / S 6 / E 1955
Information International Inc., 200 Sixth St., Cambridge, Mass. 02142 / 617-868-9810 / *C 66
Automatic programmable film readers, applications programming for PFR systems, software development (compiler, assemblers, etc.) / S 38 / E 1962
Information Processing Systems, Inc., 200 W. 57th St., New York, N.Y. 10019 / 212-CI 6-2267 / *C 66
Brokerage of used computer systems; consulting on purchases and sales of EDP equipment; leases on EAM and EDP systems / S ? / E 1963
Information Products Corp., Subsidiary of Renwell Industries, New Ludlow Rd., So. Hadley Falls, Mass. / 413-536-1800 / *C 65
Random access file interrogators, computer input and display equipment, data editing equipment / S ? / E ?
Information Retrieval Corp., 1000 Connecticut Ave., N.W., Washington, D.C. 20036 / 202-296-4936 / *C 65
Information retrieval devices; information services, and information engineering / S 20 / E 1961
Infotran, Inc., 860 Fifth Ave., New York, N.Y. 10021 / 212-LE 5-7724 / *C 66
Special purpose computers, data communications and control systems; planning, design and development of total information systems; new product development; educational services / S 6 / E 1964
Innovation Consultants, Inc., 4 E. State St., Doylestown, Pa. 18901 / 215-FIllmore 8-2324 / *C 66
Management consulting, systems design, programming, management education / S 160 (including associated entities) / E 1960
Institute for Computing Sciences, Preston Forest Tower, P.O. Box 30245, Dallas, Tex. 75230 / AD 1-1012 / *C 66
Educational programs for management; career training / S 15 / E 1965
Intectron, Inc., 2300 Washington St., Newton Lower Falls, Mass. 02162 / 617-969-9311 / *C 65
Microphotometric instruments, granularity computer, analog multiplier, optical correlation analyzer, optical fourier transformer, analog computers / S 10-20 / E 1960
International Accountants Society, Inc., Business Electronics Div., 209 W. Jackson Blvd., Chicago, Ill. 60606 / HArrison 7-5322 / *C 66
Home study courses in programming for computers, and applications of business problems to computers / S 100 / E 1955 (division)
International Business Machines Corp., Data Processing Div., 112 E. Post Rd., White Plains, N.Y. 10601 / 914-WH 9-1900 / *C 65
Complete line of data processing systems and equipment, including the IBM System/360, the IBM RAMAC 305 (model 2), 1401-G, 1401, 1440, 1460, 1410, 1620, 1620 (model 2), 7010, 7040, 7044, 7070, 7072, 7074, 7080, 7090, 7094, 7094II, data processing systems; 7700 data acquisition system; 1420 bank transit system; 1240 bank data processing system; 1062 teller terminal; 1230 optical mark scoring reader; 1231 optical mark page reader; 1282 optical reader card punch; 1418 optical character reader; random access disk and drum storage units; 7770 audio response unit; 1070 process communication system, 2321 data cell drive; 1015 inquiry display terminal; 2250 display console; 2671 paper tape reader; 1710 control system; magnetic character inscribing and sensing equipment; airline reservations systems; Tele-processing devices and systems including data collection and transmission equipment; Hypertape; mark sensing equipment; and a full line of punched card equipment, including the low-cost Series 50 line. Also printers, Micro-processing, punched cards, magnetic tape, magnetically encoded paper checks and other supplies used with data processing equipment / S 116,000 / E 1911
International Business Machines Corp., Federal Systems Div., 326 E. Montgomery Ave., Rockville, Md. / 301-GA 4-6700; 301-HA 7-4110 / *C 65
Electronic information handling and control systems for U.S. government space, defense, and civil programs. Systems management, systems development, research, engineering, production, installation, and field support / S ? / E 1955
International Computers and Tabulators Ltd., 839 Stewart Ave., Garden City, New York, N.Y. 11533 / 516-CH8-5656 / *C 66
I.C.T. 1900 series of digital computers. Computer peripheral and ancillary equipment for O.E.M. / S 20,000 / E 1959
International Computers and Tabulators, Ltd., I.C.T. House, Putney, London S.W. 15, England / Putney 7272 / *C 65
Punched card equipment and electronic digital computers, card to paper tape converters, paper tape to card converters, data collection and recording equipment, magnetic drums, input-output devices, memory systems, office equipment, line-a-time high speed printers, magnetic character, paper tape and punch card readers, magnetic tape filing systems, readers, and recorders / S 20,000 / E 1959
International Data Corp., 355 Walnut St., Newtonville, Mass. 02160 / 617-332-8840 / *C 65
Market research and publishing activity in computer field / S 10 / E 1964
International Diode Corp., 90 Forrest St., Jersey City, N.J 07304 / 201-432-7151 / *C 66
Fast switching computer diodes with high forward conductance. / S 13 / E 1959
International Electro-Magnetics, Inc., Eric Drive & Cornell Ave., Palatine, Ill. 60067 / 312-358-4622 / *C 65
Magnetic record, playback and erase heads for computers, telemetering, data recording, video and audio equipment / S 25 / E 1959
International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91502 / 213-849-2481 / *C 66
Analog to digital converters / S 350 / E 1950
International Rectifier, 233 Kansas St., El Segundo, Calif. 90246 / 213-678-6281 / *C 66
Zener voltage regulators, controlled rectifiers, transient protectors, photoelectric readouts / S 1100 / E 1947
International Resistance Co., 401 N. Broad St., Philadelphia, Pa. 19108 / 215-WA 2-8900 / *C 66
Resistors (composition, film, power and precision wire wound and special application); potentiometers, displacement transducers; low pressure cell; rectifiers; pressure transducers, diodes, frequency and time standards / S 2500 / E 1927
Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / 617-899-2380 / *C 66
Tape punches, tape readers: typewriter transmitter/receiver, photoelectric keyboards, reperforation, verification data communications, and similar systems / S 75 / E 1959
Itek Corporation, 10 Maguire Rd., Lexington 73, Mass. / 617-862-6200 / *C 65
Research, development and manufacture of digital computers, graphic to digital converters, information retrieval devices, mass memory systems, high speed printers, film readers, scanners, translating equipment, and visual output devices / S 2100 / E 1957
ITI Electronics, Inc., 369 Lexington Ave., Clifton, N.J / - / *C65
IT-271 remote cathode-ray indicator; IT-284 high level video amplifier; IT-277 large screen cathode-ray indicator; custom manufacturing / S ? / E ?
ITT Data Services, a division of International Telephone and Telegraph Corp., P.O. 402, Rt. 17 & Garden State Pkwy., Paramus, N.J. / 201-262-8700 / *C 66
Full range of data processing services (scientific and commercial) including programming, computational services and data center management / S 550 / E 1965
ITT Federal Laboratories, a div. of International Telephone and Telegraph Corp., 500 Washington Ave., Nutley, N.J. 07110 / 201-284-0123 / *C 65
Medium and large scale real time data processors for on-line applications; ITT 025 data processor, ITT 525 Versatile Automatic Data Exchange / S ITT, 173,000; ITTFL, 5,000 / E 1920
ITT General Controls, 801 Allen Ave., Glendale, Calif. 91201 / 213-842-6131 / *C 65
Automatic controls for product or process. Counters and counting devices, actuators, magnetic valves, Hydramotor ® electrohydraulic valves and actuators, industrial controls and instruments, mercury switches, Klikswitch ® snap-acting switches, time switches (sequency), transformer-relays, contactors, limit controls (temperature) / S 3000 / E 1930

J

Janus Control Corp., 296 Newton St., Waltham, Mass. 02154 / - / *C 66
Electronic decade and instrument counters and counter-related products; numerical displays / S 30 / E 1963
Jay-El Products, Inc., 1859 W. 169th St., Gardena, Calif. 90247 / 213-323-7130 / *C 65
Illuminated push button switches, indicator lights, time delays, time delay relays, flashers, color coated lamps / S 45 / E 1956
JB Electronic Transformers Inc., 2310 W. Armitage Ave., Chicago, Ill. 60647 / 312-276 0444 / *C 65
Computer components / S 100 / E 1959
Jonker Corp., 26 N. Summit Ave., Gaithersburg, Md. 20760 / 301-948-9440 / *C 66
Information and data retrieval equipment based on the principal of optical coincidence or superimposable cards; equipment for drilling holes into cards and reading out holes from the cards; manual and automatic hardware / S 70 / E 1960

K

Kearfott Products Div., General Precision, Inc. -- name changed to General Precision, Inc., Kearfott Products Div., which see
George Kelk Ltd., 48 Lesmill Rd., Don Mills, Ontario, Canada / 416-445-5850 / *C 66
Special purpose computers for on line industrial control; shaft to digital converters / S 45 / E 1953
Keystone Computer Associates, Inc., 409 N Easton Rd., Willow Grove, Pa. 19090 / 215-657-0400 / *C 66
Specialize in systems design, systems analysis, and computer programming; offer services in scientific, engineering and data processing applications, as well as management consulting / S 40 / E 1965
Walter Kidde & Co., Inc., Aerospace Div. -- see Douglas Randall, Inc., a subsidiary of Walter Kidde & Co., Inc.
A. Kimball Co., Div. of Litton Industries - name changed to Kimball Systems, Inc.-- Div. of Litton Industries, which see
Kimball Systems, Inc., Div. of Litton Industries, 215 Daniel St., Farmingdale, N.Y. 11735 / 516-MYrtle 4-7300 / *C 65
High-speed punched tag reader, PM "75" machine, hard pack / S 450 / E 1876
Kleinschmidt Div., SCM Corp., Lake-Cook Rd., Deerfield, Ill. 60015 / 312-945-1000 / *C 65
Communications and data processing hardware, including high- and medium-speed printers, tape perforators, and systems / S ? / E ?
Kyros Corp , 5428 Lake Mendota Drive, P.O. 406, Madison, Wis. / 608-238 3587 / *C 66
Kyread tape developer; Kysolve specialty solvents for "stripping" computer tapes; consulting services / S 3 / E 1961

L

Leach Corp., Controls Div., 717 N. Coney Ave., Azusa, Calif. / 213-334-8211 / *C 66
Data recording systems for aerospace and industrial applications; specializing in light-weight, portable, high environmental applications; compatible with all computer formats / S 450 / E 1960
Lear Siegler, Inc., Power Equipment Div., P. O. Box 6719, Cleveland, Ohio 44101 / 216-662-1000 / *C 66
Magnetic particle clutches or brakes / S 1200 / E 1940
Ledex Inc., 123 Webster St., Dayton, Ohio 45402 / 513-224-9891 / *C 65
Research, development, design, and production of remote switching and actuating components and subsystems, such as intervalometers, automatic checkout, mode selectors, programmers, sequence controls, positive/negative circuit searching, pulsing devices, guidance control, power transfer, switching and/or actuating subsystems to meet extreme environments. Standard products include: rotary and medium stroke linear solenoids, protected silicon bridge rectifiers, transient controls, stepping and servostep motors, open and hermetically sealed switches for multi-circuit switching, arc suppressors / S 340 / E 1942
Leeds & Northrup Co., Sumneytown Pike, North Wales, Pa. 19454 / 215-699-5353 / *C 66
Industrial computer control systems—digitally directed analog mode and direct digital control, LN 4100, LN 4200-also, a line of industrial data loggers, LN 1000, LN 1500 / S 3100 / E 1899
Lenkurt Electric Co., Inc. 1105 County Rd., San Carlos, Calif. 94070 / 415-591-8461 / *C 65
Microwave, Multiplex and data transmission systems / S 2500 / E 1943
LFE Electronics, 1075 Commonwealth Ave., Boston, Mass. 02215 / 617-254-4233 / *C 66
Batch-fabricated core memories; CRT displays; delay line memories / S 1050 / E 1946
Librascope Group, General Precision, Inc. — see General Precision,Inc., Librascope Group
Licon Div., Illinois Tool Works Inc., 6615 W. Irving Park Rd., Chicago, Ill. 60634 / 312-AV 2-4040 / *C 65
Full line of precision snap-action switches, illuminated pushbutton switches, environment-free switches / S 150 / E 1955
Link Group, General Precision, Inc., Systems Div., Binghamton, N. Y. 13902 / 607-RA 3-9311 / *C 65
GP-4 digital computer, wave-form display analyzer, and graphic display systems / S 2900 / E 1935
Lipps, Inc., 1630 Euclid St., Santa Monica, Calif. 90404 / 213-EX3-0449 / *C 66
Complete line of instrumentation and audio heads for professional equipment — magnetic recording heads / S 50 / E 1947
Liskey Aluminum, Inc., P.O. Box 580, Glen Burnie, Md. 21061 / 301-796-3300 / *C 66
Raised flooring, modular air conditioning, partitions, design and engineering for planning computer room / S 250 / E 1958
Litton Industries, Data Systems Div., 8000 Woodley Ave., Van Nuys, Calif. 91406 / 213-781-8211 / *C 66
Air data computers; general purpose micro-electronic computer; data links; IFF decoders; microelectronic power supplies; command and control system engineering, development and production; automated test equipment; displays; tape recorders / S 3200 / E 1961
Litton Industries, Monroe DATALOG Div., 343 Sansome, San Francisco, Calif. / - / *C 66
The Monroe DATALOG ultra high speed optical printer / S ? / E ?
Litton Industries, Triad Distributor Div., 305 N. Briant St., Huntington, Ind. 46750 / 219-356-6500 / *C 66
Transformers, filter reactors, integrated circuit cards, card extractors, component lead benders / S 500+ / E 1947

Litton Industries, USECO div., 13536 Saticoy St., Van Nuys, Calif. / 213-786-9381 / *C 66
Terminals, handles, knobs, pushbutton switches special machined and molded products / S 200 / E 1942

Litton Industries, Winchester Electronics Div., Main St. & Hillside Ave., Oakville, Conn. / 203-274-8891 / *C 66
Connectors and accessories; round, rectangular miniature, subminiature, printed circuit, coax, crimp contact; special application types / S 500 / E 1941

Litton Systems, Inc., Mellonics Systems Development Div., 1001 W. Maude Ave., Sunnyvale, Calif. 94086 / 408-245-0795 / *C 66
Data systems engineering and computer programming services in the analysis, design and development of command and control systems; data handling networks; scientific and commercial data processing systems; information management systems; digital computer simulation systems / S 60 / E 1961

Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles, Calif. / 213-722-6810 / *C 66
Printed circuit boards, etched, plated, plated through holes, flush commutators, transducers, core memory products / S 700 / E 1959

Logitek, Inc., 42 Central Dr., Farmingdale, L.I., N.Y. 11735 / 516-MY4-3080 / *C 66
Time code generators, magnetic tape search and control, time code translators, digital clocks / S 55 / E 1961

Loral Electronic Systems, a division of Loral Corp., 825 Bronx River Ave., Bronx, N.Y. 10472 / TI 2-9500 / *C 65
Special purpose digital and analog computers / S 2255 / E 1948

Lufkin Research Laboratories, 210 W. 131st St., Los Angeles, Calif. 90061 / 213-321-6283 / *C 66
Digital magnetic tape recorders; tape-to-tape converters; magnetic tape readers / S 35 / E 1963

M

F. B. MacLaren & Co., Inc., 15 Stepar Pl., Huntington Sta., L.I., N.Y. 11746 / 516-HAmilton 3-4433 / *C 66
Special purpose analog computers / S 15 / E 1950

Mac Panel Co., 2060 Brentwood St., High Point, N.C. 27262 / 919-882-8138 / *C 65
Magnetic computer tape, control panels, wires, plugboard programming systems / S 100 / E 1958

Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630 / 312-AV 2-5500 / *C 65
High speed relays for computers / S 125 / E 1951

Magne-Head/Systematics Div., General Instrument Corp. — see General Instrument Corp., Magne-Head/ Systematics Div.

Magnetics Inc., Butler, Pa. 16001 / 412-285-4711 / *C 66
Powder cores, tape wound cores, ferrite cores, isolation amplifier / S 400 / E 1949

Management Systems Corp., 209 Griffin St., Dallas, Tex. 75202 / 214-RI 2-8251 / *C 66
Data processing consultants in systems and applications; installation management; contract programming; computing services and time sales; complete bureau services / S 20 / E 1964

F. L. Mannix & Co., Inc., Suite 1132, Park Square Bldg., Boston, Mass. 617-542-5033 / *C 65
Executive and technical placement in the field of data processing. Consultants in wage and salary programs; organization and personnel administration / S ? / E ?

Mardix, 1160 Terra Bella Ave., Mountain View, Calif. / - / *C 65

Marksmen, Inc., 21 West 10th St., Kansas City, Mo. 64105 / 816-842-4150 / *C 66
Data collection and conversion systems; incremental, block and digital recorders interfaced with typewriter, adding machine, badge reader or time recorder; data recorded on ¼" magnetic tape cartridges / S 25 / E 1964

Massey Dickinson Co., Inc., 9 Elm St., Saxonville, Mass. 01706 / 617-877-2511 / *C 65
Programming and data acquisition equipment for behavioral, physiological, psychological, and visual research / S 25 / E 1957

Mast Development Co., 2212 E. 12th St., Davenport, Iowa 52803 / 319-323-9729 / *C 65
Random access projectors / S 40 / E 1945

Mathematischer Beratungs- und Programmierungsdienst GmbH., Kleppingstr. 26, Dortmund, Germany / 528697 / *C 65
Electrologica XI / S 65 / E 1957

McDonnell Automation Center, P.O. Box 516, St. Louis, Mo. 63166 / 314-731-2121 / *C 66
A complete data processing service center offering consulting, systems design, programming, administrative data processing and scientific computing services / S over 1000 / E 1960

Melcor Electronics Corp., 1750 New Highway, Farmingdale, N.Y. / 516-694-5570 / *C 65
Amplifiers and power supplies for analog computers / S 85 / E 1960

Mellonics Systems Development, Div. of Litton Systems, Inc. -- see Litton Systems, Inc., Mellonics Systems Development Div.

Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif. 95052 / 408-248-3344 / *C 66
Precision magnetic computer tape and tape accessories / S 475 / E 1960

Methods Research Corp., 105 Willow Ave., Staten Island, N. Y. 10305 / 212-442-4900 / *C 66
Visual control systems / S 25 / E 1852

M-H Standard Corp., 400 Heaton St., Hamilton, Ohio 45011 / 513-894-7171 / *C 65
Palletflo and Versarack, components for computer controlled live storage racks / S 50 / E?

Micro-Lectric, Inc., 19 Debevoise Ave., Roosevelt, L.I., N.Y. 11575 / 516-FR 8-3222 / *C 65
Precision wire-wound potentiometers, linear and non-linear, sine cosine / S 19 / E 1951

Micronetic Corp., 3127 Colvin St., Alexandria, Va. 22314 / 703-549-3033 / *C 66
Magnetic tape / S 30 / E 1965

Microsonics, Inc., 60 Winter St., Weymouth, Mass. 02188 / 617-337-4200 / *C 65
Delay lines memory systems up to 20 mc; quartz crystal computer clocks / S 50 / E 1957

Microspace, Inc., 170 S. Van Brunt St., Englewood, N.J. 07631 / 201-567-7454 / *C 65
Information discs, analog to digital conversion encoders, energy coupled encoder, visual readout equipment, light sources / S 27 / E 1962

MICRO SWITCH, a Div. of Honeywell, 11 W. Spring St., Freeport, Ill. 61032 / 815-232-1122 / *C 66
Precision snap-action switches; mercury switches; lighted and unlighted pushbuttons; pushbutton assemblies; toggle switches; keyboards; multi-lighted Coordinated Manual Controls equipped with dry-circuit or electronic duty contact blocks; microsecond "one shot" circuits (electronic package) / S ? / E 1935

Midwestern Instruments, Subsidiary of Tele Corp., 41st and Sheridan, Tulsa, Okla., 74101 / 918-627-1111 / *C 66
Tape transport systems / S 300+ / E 1951

Missouri Research Laboratories, Inc., 2109 Locust St., St. Louis, Mo. 63103 / 314-241-7875 / *C 66
Binary-to-decimal converter/display, digital interface, digital address selector / S 400 / E 1946

Mohawk Data Sciences Corp., Harter St., Herkimer, N.Y. 13350 / 315-866-6800 / *C 66
Model 700 buffered tape unit / S 250 / E 1965

Monarch Metal Products, Inc., MacArthur Ave., New Windsor, N.Y. 12550 / 914-562-3100 / *C 66
Data processing accessory equipment including items for filing, sorting, storage and moving of punched cards, control panels, disk packs and magnetic tape reels / S 85 / E 1945

Monroe Computer Systems Division, 550 Central Ave., Orange, N.J. / 201-673-6600, Ext. 469 / *C 66
Monroe XI, a desk sized general purpose digital computer for business, engineering and educational use and other computers for special purposes; the magnetic Monro-Card System, an optional supplementary storage system for Monrobot XI / S 1000 / E 1964 (division)

Monroe DATALOG Div. of Litton Industries — see Litton Industries, Monroe DATALOG Div.

Monroe Data Processing Inc., 550 Central Ave., Orange, N.J. / 201-673-6600 / *C 66
Nationwide data processing services offered through accountants to small and medium sized businesses; process all paperwork necessary for general business accounting and financial statements; deliver sales analysis for management guidance; also DATATAX, a computerized personal income tax preparation service / S 100+ / E 1960

Monroe International, Inc. Division Litton Industries, 550 Central Ave., Orange, N.J. 07051 / 201-673-6600 / *C 65
Monrobot XI desk-sized electronic computer for scientific and business use, Monro-Card Processor for additional high-capacity storage. Electro-mechanical and electronic office machines / S ? / E 1912

Moog Inc., Industrial Div., 44 Hamburg St., East Aurora, N.Y. / 716-652-0220 / *C 66
Memory access servo components and systems / S 50 / E 1950

Moore Associates, Inc., 893 American St., San Carlos, Calif. 94070 / 591-5363 / *C 66
Telemetering and data transmission systems / S 50 / E 1957

Moore Business Forms, Inc., Research Div., 1001 Buffalo Ave., Niagara Falls, N.Y.; Denton, Tex.; Emeryville, Calif.; Park Ridge, Ill.; Toronto, Ont.; Winnipeg, Manitoba / — / *C 65
Business forms and systems, data processing forms-systems, forms handling equipment / S 10,000 / E 1882

F. L. Moseley Co., 409 No. Fair Oaks, Pasadena, Calif. / SY 2-1176 / *C 64
X-Y recorders (with time base); strip chart recorders, logarithmic amplifiers, curve followers, computer accessories / S 300 / E 1951

The Mosler Safe Co., 320 Park Ave., New York, N.Y. 10022 / 212-Plaza 2-4500 / *C 65
Protection for data processing tapes, disk packs, etc., from fire, smoke, moisture; mechanized card files / S 2200 / E 1848

Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. 85008 / - / *C 66
Computer components / S 6600 / E 1955

Ray Myers Corp., 1302 E. Main St., Endicott, N.Y. 13760 / 607-PI8-0424, PI8-4273 / *C 66
Data processing accessory equipment. Systems development and production programs for input/output departments in data handling. Complete floor plan service / S 50 / E 1955

N

Nash and Harrison Ltd., 1355 Wellington St., Ottawa 3, Ont., Canada / 613-722-6544 / *C 66
Digital, process control computers designed around standard modular components which may be adapted to a wide variety of control applications. Special designs and consulting services quoted on request / S 12 / E 1957

Natel Engineering Co., Inc., 7129 Gerald Ave., Van Nuys, Calif. / ST 2-4161 / *C 65
AC, DC, frequency signal conditioning components for automatic controls, handling, monitoring and alarm systems / S 35 / E 1959

National Blank Book Co., Water St., Holyoke, Mass. 01040 / 413-539-9811 / *C 66
Data processing accessories / S 1000 / E 1843

The National Cash Register Co., Main & K Sts., Dayton, Ohio 45409 / 513-449-2000 / *C 66
Wide range of business machines and systems for businesses of all sizes; large and small digital computer systems, cash registers, adding machines, accounting machines, and supplies / S 73,000 / E 1884

National Computer Analysts, Inc., U.S. Hghwy 1, Lynwood Dr., Princeton, N.J. 08540 / 609-452-2800 / *C 66
Consulting, programming and computing services / S 40 / E 1962

National Physical Laboratory, Mathematics Div., Teddington, Middx, England / TEDdington Lock 3222 / *C 66
Computing service using ACE and KDF9 / S 60 / E 1945

New Era Ribbon & Carbon Co., Inc., 1228 Cherry St., Philadelphia, Pa. 19107 / 215-LO 3-1973-4 / *C 65
All types of computer and tabulator ribbons / S 15 / E 1959

Simon M. Newman, 1411 Hopkins St., N.W., Washington, D.C. 20036 / 202-387-4672 / *C 66
Documentation consulting-indexing and information retrieval, including application of automation to retrieval problems / S ? / E 1961

Nexus Research Laboratory, Inc., 480 Neponset St., Canton, Mass. 02021 / 617-828-9000 / *C 66
Solid-state encapsulated d-c operational amplifiers, logarithmic modules and related components for analog applications; low-profile cases (.375" high) for card rack mounting; analog computer building blocks. Applications department to assist customers with special designs / S 160 / E 1962

Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif. 92014 / 714-755-1134 / *C 65
Digital voltmeters, ohmmeters, ratiometers; electronic measurement instruments for missile, nuclear, scientific and manufacturing fields; digital readouts, data processing and recording equipment, scanners, visual output devices, analog to digital converters, digital to analog converters, digital clocks, binary to decimal converters, AC and DC amplifiers (precision), statistical digital voltmeters, digital telemetering, digital counters / S 350 / E 1952

Norden Div. of United Aircraft Corp., Helen St. Norwalk, Conn. 06852 / 203-838-4471 / *C 65
Sense amps, differential amps, servo amps, gates, custom analog and digital circuits, all fabricated as monolithic integral circuits; TO-5 or flat package / S 2100 / E 1928

North Atlantic Industries, Inc., 200 Terminal Dr., Plainview, N.Y. 11803 / 516-681-8600 / *C 66
Resolver/synchro computer interface equipment / S 125 / E 1956

Northrop Corp., Nortronics Div., 2301 W. 120th St., Hawthorne, Calif. / 213-757-5181 / *C 66
Airborne digital computers, input/output devices, support equipment, software, programming, systems integration and test / S 4200 (division) / E 1939 (Northrop Est.), 1957 (Nortronics Div.)

Norton Associates, Inc., 240 Old Country Rd., Hicksville, N.Y. 11801 / 516-OV 1-6181 / *C 66
Standard and special magnetic record, playback, and erase heads in single and multitrack arrangements for magnetic tape, film, drum, and magnetic ink character recognition / S under 50 / E 1955

Nortronics Div., Northrop Corp., 1 Research Park, Palos Verdes Peninsula, Calif. 90274 / 213-FRontier 7-4811 / *C 65
Automatic checkout equipment, airborne and other digital and analog computers, display and information systems, astro-inertial and inertial guidance systems / S 16,033 (Northrop Corp.); 6000 (Nortronics Div.) / E 1939 (Northrop Corp.); 1957 (Nortronics Div.)

Nortronics, A Div. of Northrop Corp., Precision Products Dept., 100 Morse St., Norwood, Mass. / 617-762-5300 / *C 65
Precision gyroscopes, gyro systems, inertial components, inertial sensor test facilities, standards laboratories, accelerometers / S 1200 / E 1948

Novatronics, Inc., 500 N. Andrews Ave., Ext., P.O. Box 878, Pompano Beach, Fla. 33061 / 305-942-5200 / *C 65
Research, development and manufacture of telemetry systems and components, airborne electronic instrumentation, electronic ground support and control equipment, special electronic test sets, automatic checkout equipment, instrumentation vans, precision electronic devices such as highly regulated power supplies and military ordnance and logic equipment, baluns, filters, multiplexers, transformers, vibration analysis equipment, spectrum analyzers / S 75 / E 1965

O

Edward Ochman Systems, Box 141, Fairfield, Conn. / 259-1927 / *C 65
Manufacturers and sellers of control panels and wires for IBM and Remington Rand Equipment; also data processing accessories and computer tape storage equipment / S 15 / E 1949

Ohio Envelope Co., Box 19086, Cincinnati, Ohio 45219 / 513-961-6698 / *C 66
File folders, filing supplies for storage of paper, tape and other EDT information / S 23 / E ?

Oki Electronics of America Affiliate/Oki Elec. Ind. Co. Ltd., 202 East 44th St., New York, N.Y. 10017 / 212-MU 2-2989 / *C 66
Peripheral equipment / S 10,000 / E 1881

Omni-Data, Div. of Borg-Warner Corp., 511 N. Broad St., Philadelphia, Pa. 19123 / 215-WA 5-4343 / *C 66
Digital communication systems, communication terminal equipment, photo-electric tape readers, recorders and displays / S 38,000 (Borg-Warner Corp.) / E 1960

Omnitronics, Inc., Subsidiary of Borg-Warner Corp., 511 N. Broad St., Philadelphia, Pa. 19123 / 215-925-4343 / *C 65
Digital communication systems; space electronic devices and systems; digital data handling equipment such as checkout equipment, small special purpose computers, tape-to-tape converters, editors, and buffering equipment. Communications terminal equipment such as high-speed photoelectric tape readers, recorders, and displays / S 30,000, Borg-Warner Corp. / E 1960

Opto-Electronic Devices, Inc., subsidiary Sigma Instruments, Inc., 170 Pearl St., Braintree, Mass. 02185 / 617-843-5000 / *C 65
Opto-electronic translators / S 1000 / E 1963 (subsidized)

OPTOmechanisms Inc., 40 Skyline Drive, Plainview, N.Y. 11803 / 516-433-8100 / *C 66
Photographic type processors; special cameras; photographic devices; photometric devices; optical tachometers; projectors; optical trackers; stereo viewers; satellite detectors; measuring interferometers; stereo comparators; linear measuring tables; neg. to pos. film viewers / S 120 / E 1951

P

Pacific Data Systems, Inc., 1058 E. First St., Santa Ana, Calif. 92701 / 714-547-9183 / *C 66
General purpose digital computer / S 50 / E 1963

Pacific Electro Magnetics Co., Inc. 942 Commercial St., Palo Alto, Calif. 94303 / 415-321-1177 / *C 65
Ultra-portable instrumentation magnetic tape recorders and related equipment / S 26 / E 1959

Packard Bell Computer, a div. of Packard Bell Electronics— see Raytheon Computer

PAKTRON Div. Illinois Tool Works Inc., 1321 Leslie Ave., Alexandria, Va. 22301 / 703-548-4400 / *C 66
Electronic components, capacitors / S 425 / E 1954

Paper Manufacturers Co., 9800 Bustleton Ave., Phila. Pa. 19115 / 215-673-4500 / *C 66
Perforator tape in rolls or fanfolded available in wide variety of colors, diameters and widths. Compositions available are: paper; fibre; paper/mylar/paper; mylar/aluminum foil/mylar; and mylar / S 450 / E 1905

Parzen Research, Inc., 48 Urban Ave., Westbury, L.I., N. Y. 11590 / 516-ED 4-3900 / *C 65
Precision timing systems; ultra-stable frequency combiners, frequency comparators, frequency generation equipment; special data handling, telemetry, and tone-signaling systems / S 25 / E 1962

Pastoriza Electronics, Inc., 385 Elliot St., Newton, Mass. 02164 / 617-332-2131 / *C 66
Analog to digital tape formatters and systems; A-D converters, D-A converters; amplifier manifolds, amplifiers, multiplexers; hybrid and special purpose computers; portable analog computer / S 25 / E 1960

L. A. Pearl Co., 801 Second Ave., New York, N.Y. 10017 . 212-OR 9-6535 / *C 65
IBM computers and peripherals bought for cash / S 1 / E 1945

Pergamon Press, Inc., 44-01 21st St., Long Island City, N.Y. 11101 / 212-EM 1-7900 / *C 65
Books / S 75 / E 1953

Perspective, Inc., 4400 7th Ave. So., Seattle, Wash. 98108 / 206-MA 4-7800 / *C 66
The Illustromat "1100", a computer-directed graphics instrument whose function is to produce visually and mechanically accurate perspective drawings from any viewing distance and angle; it makes mechanically accurate axonometric drawings or projections from orthographic prints / S 19 / E 1953 (incorporated)

Philbrick Researches, Inc., 34 Allied Drive at Route 128, Dedham, Mass. 02026 / 617-329-1600 / *C 66
Analog computers, operational amplifiers, nonlinear transconductors, power supplies / S 220 / E 1946

Philco Corp., Communications & Electronics Div., 3900 Welsh Rd., Willow Grove, Pa. / 215-OL 9-7700 / *C 66
Philco 2000, Philco 1000, Philco 3100 process controller, Philco 1700 message and data switching system, Philco general purpose print/reader, ZIP-code readers, mass storage systems, peripheral equipment, displays, Philco 7100 plant monitor system, computer service bureau / S 5000 / E ?

Philco Corp., Subsidiary of Ford Motor Co., Lansdale Div., Church Rd., Lansdale, Pa. 19446 / 215-855-4681 / *C 66
Integrated circuits; microwave components; diodes (switching, mixer, pin, backward, tunnel); infrared components; microwave devices and components / S 1500 / E 1966

Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y. 10550 / 914-MOunt Vernon 4-4500 / *C 65
X-ray diffractometers, spectrographs, cameras, detectors, industrial radiographic equipment, X-ray, electron microscopes, gauges, process control instrumentation, electron probe microanalyzer, automatic X-ray spectrometer which may be linked with computers to read directly in any prescribed units of measurement / S 350 / E 1942

Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N.Y. / 516-OR 6-8000 / *C 66
Tape readers and spoolers, militarized tape reader / S 450 / E 1951

Photo Magnetic Systems, 1800 R St., N.W., Washington, D. C. 20009 / — / *C 65
Information storage and retrieval / S ? / E ?

Photomechanisms, Inc., 15 Stepar Place, Huntington Sta., N. Y. 11746 / 516-HA3-4411 / *C 66
Photographic computer input-output equipment, hard copy generating systems on and off-line utilizing rapidly processed silver halide films and paper and electrostatic papers / S 55 / E 1952

Photon, Inc., 355 Middlesex Ave., Wilmington, Mass. 01887 / 617-933-7000 / *C 66
Computer-driven phototype setting machines, photographic computer printers, tape merger machines / S 300 / E 1940

Pickering & Co., Inc., Sunnyside Blvd., Plainview, N.Y. 11803 / 212-OV 1-0200 / *C 66
Magnetic drum heads / S 160 / E 1946

Planning Research Corp., 1100 Glendon Ave., Los Angeles, Calif. 90024 / 213-GR 9-7725 / *C 65
Analysis, design and implementation of programming systems for electronic computers / S 510 / E 1954

Potter Instrument Co., Inc., 151 Sunnyside Blvd., Plainview, N.Y. 11803 / 516-OVerbrook 1-3200 / *C 66
Peripheral equipment for electronic data processing, magnetic tape transports, magnetic record/playback heads for digital recording, perforated tape readers and spoolers for military and commercial applications, high speed printers and systems, random access memory systems, complete line of accessories / S 650 / E 1942

Prestoseal Mfg. Corp., 37-12 108th St., Corona, N.Y./ 212-IL 7-5566 / *C 66
Splicer for punched paper tape, 5-8 channel./ S 50 / E 1947

Procedyne Corp., 221 Somerset St., New Brunswick, N.J. 08903 / 201-249-8347 / *C 65
Fourier transform computer, frequency response analyzer, signal generators, converters and transducers, phase meters, calibration equipment / S 12 / E 1961

Profimatics, Inc., 7060 Owensmouth Ave., Canoga Park, Calif. 91303 / 213-883-6530 / *C 66
Consulting services related to industrial process control and automation, including technical and economic feasibility studies, process simulation, specification writing and bid evaluation, system design, programming, installation, training and project management / S 7 / E 1965

Programmatics Inc., 12011 San Vicente Blvd., Los Angeles, Calif. 90049 / 213-476-1956 / *C 66
Systems analysis and design, feasibility studies, management control systems, systems programming, business and scientific applications / S 14 / E 1963

Programming & Systems, Inc., 33 W. 42nd St., New York, N.Y. 10036 / 212-LW 4-0530 / *C 66
Complete EDP education and service bureau work / S 50 / E 1959

Programming Service, Inc., 18455 Burbank Blvd., Tarzana, Calif. 91356 / 213-881-1672 / *C 66
Analysis, design, development, implementation of computer: information storage and retrieval systems; scientific, process control, commercial programming / S 25 / E 1965

Q

Quest Manufacturing Co., 220 W. Monroe St., Chicago, Ill. 60606 / 312-782-7838 / *C 65
Inked ribbons for all computer/data processing and machine accounting equipment / S 30 / E 1917

Quindar Electronics Inc., 60 Fadem Rd., Springfield, N.J. 07081 / 201-379-7400 / *C 66
Communications systems and modules for data transmission, manufacturer of analog and digital telemetering systems and scanners for all types of industry / S 135 / E 1960

R

Randolph Computer Corp., 200 Park Ave., New York, N.Y. 10017 / 212-986-4722 / *C 66
Acquiring and leasing EDP equipment, specializing in IBM's Systems 360 / S 8 / E 1965

The Rapids Standard Co., Inc. 825 Rapistan Bldg., Grand Rapids, Mich. 49502 / 616-451- 2081/ *C 65
Manufacturers of materials handling equipment; conveyors, storage racks, etc. / S 300 / E ?

Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. 92704 / 714-546-7160 / *C 66
Digital computers and computer systems, hybrid computer systems, linkage systems, multiverters, analog-to-digital converters, digital-to-analog converters, digital circuit modules, BIAX memory products / S 325 / E 1958

RCA Electronic Data Processing, Cherry Hill, Camden 8, N.J. / WO 3-8000 / *C 65
Full range of digital computers, components, supplies and services / S ? / E 1955

Recognition Equipment Inc., 4703 Ross Ave., Dallas, Tex. 75204 / 214-TA3-8194 / *C 66
Optical character recognition systems / S 375 / E 1961

Records Reserve Corp., 751 Clay Rd., Rochester, N.Y. 14623 / 716-334-3644 / *C 65
Computer accessories: aluminum reels for magnetic tape, plastic reel cases, tape stoppers, shielded magnetic tape carrying and shipping cases, storage cabinets for panel boards and magnetic tape, and auxiliary tape racks / S 35 / E 1955

Redcor Corp., 7760 Deering Ave., Canoga Park, Calif. 91304 / 213-348-5892 / *C 65
Data acquisition system; A-D and D-A converters; digital logic modules / S 220 / E 1956

Reeves Instrument Co., 100 East Gate Blvd., Garden City, N.Y. 11532 / 516-PI 6-8100 / *C 66
Analog computer, capable of expansion to powerful hybrid facility; computation center for scientific analysis and simulation / S 1150 / E 1943

Reeves Soundcraft Corp., 15 Great Pasture Rd., Danbury, Conn. 06813 / 203-743-7601 / *C 66
Magnetic tape for computers / S 350 / E 1950

Rese Engineering Inc., A & Courtland Sts., Philadelphia, Pa. 19120 / 215-GL5-9000 / *C 66
Magnetic core memories; special digital systems / S 40 / E 1952

Rheem Electronics, 5250 W. El Segundo Blvd., Hawthorne, Calif. 90250 / 213-772-5321 / *C 66
Photoelectric punched tape readers and matching spooler systems / S 10,000 (incl. parent org.) / E 1960

Rixon Electronics, Inc., 2121 Industrial Pkwy., Silver Spring, Md. 20904 / 301-622-2121 / *C 65
Data Modems, teletype and computer input data multiplexers, special purpose electro-mechanical peripheral equipment for computer systems / S 200 / E 1953

RMS Associates, Div. of Information Displays, Inc.— name changed to Information Displays, Inc., which see

The Roback Corp., Huntingdon Valley, Pa. 19006 / 215-OR 6-4000 / *C 65
Digital logic modules, Facilogic ® digital breadboards, low cost digital solid state volt-ohm meters, A/D and D/A converters, multiplexers, data processors, computer formatting and buffering equipment / S 100 / E 1962

Robertshaw Controls Co., Aeronautical & Instrument Div., Santa Ana Freeway @ Euclid St., Anaheim, Calif. 92603 / 714-535-8151 / *C 66
Manufacturers of process control instrumentation including direct digital devices, recorders, controllers, transmitters, level measurement, and flow integrators / S 300 / E 1950

Robins Data Devices, Inc., 15-58 127th St., Flushing, N.Y. / 212-445-7200 / *C 66
Splicers, winders, encoders, reels, centerfeed unwinders, unwind cans, data tape folders, envelopes and holders, bulk tape erasors and splicing patches / S 15 / E 1961 (div.)

Rotron Mfg. Co., Inc., Hasbrouck Lane, Woodstock, N.Y. 12498 / 914-679-2401 / *C 66
Cooling devices and high pressure/vacuum air sources specifically designed for the computer industry...Muffin Fan, Sprite, Skipper, Centrimax, Spiral, Duplex Spiral, Feather Fan, etc. / S 550 / E 1947

S

Sage Electronics Corp., 1212 Pittsford-Victor Rd., Pittsford, N.Y. 14534 / 716-LU6-8010 / *C 66
Resistors / S 170 / E 1948

Sanders Associates, Inc., 95 Canal St., Nashua, N.H. 03060 / 603-883-3321 / *C 65
Computer driven information displays, character generators, digital logic circuitry and special computers / S 3000 / E 1951

I. Savage Co., 1340 Commonwealth Ave., Boston, Mass. 02134 / 617-734-4569 / *C 66
Software and EDP consulting / S 1 / E 1964

The Scam Instrument Corp., 7401 N. Hamlin Ave., Skokie, Ill. 60076 / COrnelia 7-8300 / *C 65
Design and manufacture digital data scanners, loggers, digital controllers, recording annunciators, graphic control panels, special purpose digital computers. Also G.P. programming services / S 230 / E 1953

Schaevitz-Bytrex Corp., 223 Crescent St., Waltham, Mass. 02154 / 617-899-5600 / *C 65
Electronic weighing and measuring systems, strain gage devices; load, pressure and torque transducers and systems / S 70 / E 1957

Scientific Control Corp., 14008 Distribution Way, Dallas, Texas 75234 / 214-CHapel 1-2111 / *C 66
General purpose data processors / S 40 / E 1964

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / 213-871-0960 / *C 66
General-purpose digital computers and data processing systems; special-purpose digital computers; computer-controlled data systems; data-acquisition systems; analog and digital system components and modules; systems engineering services / S 2500 / E 1961

Scientific Educational Products Corp., 30 E. 42nd St., New York, N.Y. 10017 / 212-867-9480 / *C 66
Minivac and Nordac digital computer trainers for use in computer education programs in educational institutions and industrial concerns S ? / E 1962

Seismograph Service Corp., Box 1590, (6200 E. 41st St.), Tulsa, Okla. 74102 / 918-NA 7-3330 / *C 65
Optical analog computer / S 500 (Tulsa); 1600 (world-wide) / E 1931

Serendipity Associates, 9760 Cozycroft, Chatsworth, Calif. 91311 / 213-341-0033 / *C 66
Research development in computer application and technology as related to systems engineering and human factors. Specialized capabilities include problem definition, design of solution algorithms, programming, documentation, debugging and checkout for simulation models for stochastic systems, mathematical models for cost-effectiveness evaluation, management information systems and scientific application programming / S 55 / E 1961

The Service Bureau Corp., 425 Park Ave., New York, N.Y. 10022 / 212-PL 1-5600 / *C 66
Complete range of data processing and computer programming services for business, government, science and education. IBM 1401, 7094, System 360 / S 2200 / E 1957

Shepard Laboratories, Inc., 480 Morris Ave., Summit, N.J. / 201-CR 3-5255 / *C 65
Small and large high-speed typers for data processing field / S 40 / E 1940

S-I Electronics, Inc., 103 Park Ave., Nutley, N.J. 07110 / 201-667-0055 / *C 66
Digital magnetic tape transports, digital magnetic tape transport read and write heads / S 55 / E 1960

Sigma Instruments, Inc., 170 Pearl St., Braintree, Mass. / - / *C 65
Cyclonome, single phase, high torque, synchronous stepping motor / S ? / E ?

Simulators, Inc., 1856 Walters Ave., Northbrook, Ill. 60062 / 312-272-6310 / *C 66
General purpose analog computers / S 17 / E 1965

Société d'Electronique & D'Automatisme, 17-19, rue du Moulin des Bruyères, BP Noll1, 92 Courbevoie, France / 333-41.20 / *C 66
SEA 3900, SEA 4000, CINA, CAB 1500 (digital), NADAC 20, NADAC 100 (analog); peripheral equipment (highspeed printers, tape perforators, optical tape readers, magnetic units); analogical modules, various components / S 900 / E 1948

Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. / 364-2271 / *C 65
Line of solid state silicon digital logic modules; 10 megacycle speed, -55°C to +125°C; microminiature, Logic modules available include: J-K flip-flop (logic), flip-flop, counter/shift register, "and-or" gates, Schmitt Trigger, inverting amplifier, non-inverting amplifier, slave clock, clock oscillator, free running multivibrator, one-shot multivibrator / S 10 / E 1958

Soroban Engineering, Inc., Port Malabar Industrial Park-Palm Bay, P.O. Box 1690, Melbourne, Fla. 32902 / 305-723-7221 / *C 66
Paper tape equipments, punch card equipments, printers, keyboards / S 255 / E 1954

Southern Computer Service, 280 TV Rd., P.O. Box 100, Dothan, Ala. 36302 / 794-3166 / *C 65
EDP service bureau, commercial data processing / S 8 / E 1962

Spear, Inc., 335 Bear Hill Rd., Waltham, Mass. 02154 / 617-899-4800 / *C 66
Special and general purpose digital computers for general scientific and researcher laboratory processing with heavy emphasis on biomedical research and clinical applications / S 20 / E 1964

Sperry Farragut Co., Div. of Sperry Rand Corp., Bristol, Tenn. 37622 / 615-968-1151 / *C 65
Amplifiers; packaged computer circuits, plug-in circuits; printed circuits; computer type coils; analog computers; computer components; fire control equipment; systems engineering / S 1000 / E 1951

Sperry Gyroscope Co., Div. Sperry Rand Corp., Great Neck, N.Y. 11020 / 516-LR4-1270 / *C 66
Small microcircuited real-time general purpose computers, associated analog to digital and digital to analog converters; microcircuited CRT display consoles / S 8000 / E ?

Standard Products Corp., 856 Main St., New Rochelle, N.Y. / - / *C 66
100% nylon computer-printer uninked fabric ribbons / S ? / E ?

The Standard Register Co., Dayton, Ohio 45401 / 513-223-6181 / *C 66
Business forms, continuous; data collection equipment, electronic; auxiliary forms handling equipment, mechanical / S 3900 / E 1912

Statistical Tabulating Corp., 104 S. Michigan Ave., Chicago, Ill. 60603 / 312-DE2-2484 / *C 66
Nine data-processing and computer service centers containing IBM 1400 series card and tape systems, Systems/360, and Honeywell H200 tape systems. Plus peripheral equip. Administrative management, scientific management, engineering and general data-processing, programming, systems analysis, consultation and temporary personnel. Divisions: Data-processing, Task Force, CAM, Data-Mat./ S ? / E ?

Stellarmetrics, Inc., 210 E. Ortega St., Santa Barbara, Calif. 93101 / 805-963-3566 / *C 66
Airborne and ground telemetry systems and components, including solid state commutators, decommutators, A to D converters, space-borne programmers (intervalometers) / S 75 / E 1961

Straza Industries, 790 Greenfield Drive, El Cajon, Calif. 92021 / 714-442-3451 / *C 66
Microfilm printers/plotters, display/printers, display systems, symbol generators, line generators / S 110 / E 1963

Stromberg-Carlson Corp., Data Products Div., 1895 Hancock St., San Diego, Calif. 92112 / 714-298-8331 / *C 66
High speed microfilm recorders, electronic printers, direct view displays and computer inquiry and retrieval systems / S 310 / E 1955

Sunshine Scientific Instruments, 1810 Grant Ave., Philadelphia, Pa. 19115 / 215-OR chard 3-5600 / *C 65
Testing and measuring equipment, calibration, certification. Analog field plotter, prototypes, precision electromechanical assemblies, mechanical components / S 30 / E 1947

Sylvania Electronic Systems, 40 Sylvan Rd., Waltham, Mass. 02154 / 617-894-8444 / *C 65
Special purpose data processing system / S 10,000 / E 1905

System Development Corp., 2500 Colorado Ave., Santa Monica, Calif. 90406 / 213-393-9411 / *C 66
IBM 360/50; IBM 7094; Philco 2000-210; CDC 3600; specializing in the design and development of information management systems for military, governmental, scientific and educational applications / S 3000 / E 1957

Systemat, 1107 Spring St., Silver Spring, Md. / 301-587-4200 / *C 65
Professional placement of computer personnel / S 10 / E 1960

Systems Engineering Laboratories, Inc., P. O. Box 9148, 6901 W. Sunrise Blvd., Fort Lauderdale, Fla. 33310 / 305-587-2900 / *C 66
Low level, high level, slow speed, high speed digital data acquisition systems and computers / S 431 / E 1961

Systems Sales Co., a div. of Systems Mfg. Corp., 13 Broad St., Binghamton, N.Y. 13904 / 607-723-6344 / *C 65
Tabulating and computer accessories / S under 300 / E 1945

Systems Science Corp., 1104 Spring St., Silver Spring, Md., 400 E. Third St., Bloomington, Ind. 47403 / 301-779-5500 (Md.); 812-332-1720 (Ind.) / *C 66
Specialists in real time, on-line automation of police activities; perform feasibility studies; development of hardware specifications; systems and applications; software design and programming / S 15 / E 1961

Systron-Donner Corp., 888 Galindo St., Concord, Calif. 94520 / 415-682-6161 / *C 66
± 100 volt desk top analog computers, all solid state, with plug-in digital logic modules. SD 10/20 computer has 20 amplifier capacity; SD 40/80 computer has 84 amplifier capacity; both use same plug-in computing modules / S 450 / E 1957

T

TAB Products Co., 550 Montgomery St., San Francisco, Calif. 94126 / 415-981-6160 / *C 66
Data processing equipment including card files, open reference files, storaways, trucks, unit spacefinder card files, control panel cabinets. Computer room equipment including tape reel racks, tape cabinets, disc pack racks, disc pack cabinets, forms handling equipment / S 100 / E 1950

Tally Corp., 1310 Mercer St., Seattle, Wash. 98109 / 206-624-0760 / *C 66
Business digital data communication systems utilizing high speed paper tape readers and perforators at speeds from 60 to 120 char/sec with automatic error recovery routines; card and magnetic tape data terminals; paper tape readers and perforators / S 300 / E 1948

Tape Certifiers, Inc., 1604 W 139th St., Gardena, Calif. 90249 / 213-321-6846 / *C 65
Magnetic tape certification and re-certification for computer and telemetry applications and tape consulting / S 19 / E 1964

Tech Serv Inc., 5451 Holland Drive, Beltsville, Md. 20705 / 301-474-2900 / *C 65
Transistorized digital logic elements and digital systems / S 45 / E 1959

Technical Information Processing, 1503 N. Washington St., Wheaton, Ill. 60187 / 312-668-6131 / *C66
Technical programming in areas of engineering design, mathematics and statistics / S 2 / E 1965

Technical Measurement Corp., 441 Washington Ave., North Haven, Conn. 06473 / 203-239-2501 / *C 66
Signal averaging computers, correlation computers, pulse height analyzers / S 700 / E 1955

Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / 714-546-4500 / *C 66
Automatic telemetry processors, telemetry systems and equipment, input/output devices, buffers, synchronizers, simulators / S 240 / E 1959 (Telemetrics Div.)

Techni-rite Electronics, Inc., 65 Centerville Rd., Warwick, R.I. / 401-737-2000 / *C 65
Data recording equipment, oscillographs / S 85 / E 1959

Technitrol Inc., 1952 E. Allegheny Ave., Philadelphia, Pa. 19134 / 215-GA6-9105 / *C 66
Component parts - pulse transformers, electromagnetic delay lines, shift registers / S 1100 / E 1947

TELautograph Corp., 8700 Bellanca Ave., Los Angeles, Calif. 90045 / 213-OR 8-4756 / *C 65
Graphic communications systems/equipment for transmission of handwriting (instantaneous) or facsimile (page-a-minute) / S 250 / E 1888

Telecomputations, Inc., 1104 Spring St., Silver Spring, Md. / 301-779-5500 / *C 66
Teleprocessing services on IBM 360/40; packaged or specialized programs; 24-hour real time service. On order: IBM 360/67 with dual processors / S 25 / E 1964

Telecomputing Services, Inc. -- see Computing & Software, Inc., TSI Div.

Telemetrics Div., Technical Measurement Corp. -- see Technical Measurement Corp., Telemetrics Div.

Telemetrics, Inc., 2830 Fairview St., Santa Ana, Calif. 92704 / 714-546-4500 / *C 65
General and special purpose computers, telemetry data processors, signal conditioners, synchronizers / S 500 / E 1962

Teleregister Corp. -- name changed to The Bunker-Ramo Corp., which see

Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076 / 312-676-1000 / *C 66
Page printers; paper tape readers; paper tape punches; high-speed tape-to-tape equipment; automatic data switching systems / S 6000 / E 1930

M. Ten Bosch, Inc., 80 Wheeler Ave., Pleasantville, N.Y. / 914-RO 9-3000 / *C 65
Amplifiers, automatic controls, servo mechanisms / S 60 / E 1950

Texas Instruments, Inc., Industrial Products Group, 3609 Buffalo Speedway, Houston, Tex. 77006 / 713-JA 6-1411 / *C 66
A-D and D-A converters; multiplexers; pulse generators; tape transports for recording digital data; data collection, processing and display systems optimized for digital seismic data handling / S 1000+ / E 1930 (Parent company)

Texas Instruments, Inc., Semiconductor Components Div., P.O. Box 5012, Dallas, Tex. 75222 / 214-AD5-3111 / *C 66
Complete line of semiconductor devices including special computer diodes, transistor and integrated-circuit amplifiers, and military and industrial digital networks / S 25,000 / E 1930

Theta Instrument Corp., Saddle Brook, N. J. 07663 / 201-487-3508 / *C 65
Analog-digital converters / S 150 / E 1956

Merle Thomas Corp., State National Bank Bldg., Suite 410, 10400 Connecticut Ave., Kensington, Md. 20795 / 301-933-4410 / *C 66
ADP consulting services: consulting services to business, industry, government, in application of automatic data processing to business systems; engineering applications; feasibility studies; computer center / S 75 / E 1962

3 M Co., Instrument Dept., 12909 S. Cerise Ave., Hawthorne, Calif. / 213-772-5141 / *C 65
3 M-201 control computer systems, 3 M-110 data acquisition systems, 3 M-220 direct digital controls / S ? / E 1963

3 M Co., Revere-Mincom Div., 300 S. Lewis Rd., Camarillo, Calif. / 805-482-1911 / *C 65
Magnetic recorders for analog, frequency modulation, pulse code modulation as used in instrumenting missile ranges, etc. / S 500 / E ?

Torotel, Inc., 5512 E. 110th St., Kansas City, Mo. 64137 / 816-SOuth 1-6314 / *C 65
Magnetic amplifiers, delay lines, pulse transformers / S 100 / E 1956

Towson Laboratories, Inc., 3500 Parkdale Ave., Baltimore, Md. 21211 / 301-367-4001 / *C 66
A/D converters, multiplexers for modular data acquisition systems. Analog to teletypewriter converters. Telemetering systems. PCM encoders. Synchro to digital and digital to synchro converters / S 25 / E 1959

Trak Electronics Co., Inc., 59 Danbury Rd., Wilton, Conn. 06897 / 203-762-5521 / *C 66
Morse-to-teleprinter code converters; DIGI-STORE, asynchronous magnetic tape read/write unit / S 95 / E 1947

Transistor Electronics Corp., Box 6191, Minneapolis, Minn. 55424 / 612-941-1100 / *C 65
Digital readouts, indicators, switches and information display panels for computers, control, guidance and other solid state systems / S 280 / E 1957

Transitel International Corp., 615 Winters Ave., Paramus, N.J. 07642 / 201-262-8200 / *C 66
Solid state supervisory control and data acquisition systems / S 80 / E 1958

Transkrit Corp., 704 Broadway, New York, N.Y. 10003 / 212-OR3-2200 / *C 66
Continuous forms (spot carbonized), magnetic ink imprinting / S 100 / E 1938

Triad Distributor Div., Litton Industries -- see Litton Industries, Triad Distributor Div.

Triton Electronics, Inc., 62-05 30th Ave., Woodside 77, N.Y. / 212-721-7500 / *C 65
Computer and instrumentation tape / S 75 / E 1939

TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / 213-679-8711 / *C 66
General purpose computers, digital data processors, special purpose computers, memory systems, design code and checkout of real time digital computer programs, SE and ID for all data systems applications / S 11,000 / E 1954

U

Uarco Inc., W. County Line Rd., Barrington, Ill. / 381-4030 / *C 65
All types of business forms and forms handling equipment / S 2700 / E 1894

Ultronic Systems Corp., 7300 N. Crescent Blvd., Pennsauken, N.J. 08110 / - / *C 66
Data pumps, encoding keyboards, magnetic tape transmission terminals, character multiplex / S over 500 / E 1960

Unimation Inc., 16 Durant Ave., Bethel, Conn. / 203-744-1800 / *C 66
UNIMATE - industrial robot: teachable material transfer machine, performs manual labor. Weight handling capacity of 75 lbs / S 40 / E 1962

Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh, Pa. 15218 / 412-242-5000 / *C 65
"Readall" readout instruments, miniature and sub-miniature relays, remote control systems for railroads and pipelines; control and communication systems for industry; remote controls for locomotives and vehicles / S 1500 / E 1881

United Data Processing, 1001 S.W. 10th, Portland, Ore. / - / *C 65
Key punch trainer machine and program; service bureau with 2 tape 1401's, teleprocessing, punched tape, key punch, etc., providing general business computing / S 65 / E ?

U.S. Navy Marine Engineering Laboratory, Computer Div., Annapolis, Md. 21402 / 301-268-7711, Ext. 8514 / *C 66
Mathematical analysis and research; design, development, and validation of mathematical models simulating complex naval shipboard machinery systems and auxiliary systems;
design and development of management information systems; computer programming and data processing services / S 700 (lab), 25 (div.) / E 1903 (lab), 1964 (div.)

UNIVAC Div. of Sperry Rand Corp., 1290 Ave. of Americas, New York, N.Y. 10019 / 212-956-2121 / *C 65
Digital electronic computing systems, data processing services / S ? / E ?

UNIVAC Div. of Sperry Rand Corp., 10924 Ave. J East, Grand Prairie, Tex. / AN 2-3511 / *C 65
Complete MICR bank processor systems including high-speed document sorters, audit listers, and Central Processor with accumulating and dictionary look-up capabilities. MICR document encoding devices to print the amount, account number, and transit number fields. Optical character recognition systems for automation of accounts receivable and inventory control, including Readatron Card Punch and Charge Sales Recorders / S 150 / E 1957

Uptime Corp., 15910 West 5th Ave., Golden, Colo. 80401 / 303-279-3351 / *C 66
Punched card readers and punches / S 90 / E 1958

URS Corp., 1811 Trousdale Drive, Burlingame, Calif. 94011 / 415-697-1221 / *C 66
Data processing services, simulation and mathematical modeling, operations research, programming aids and languages, computer education, management information systems, command control systems, communications requirements, scientific and engineering computations, logistics research; service bureau with IBM 1440 and (2) 1311 disks / S 175 / E 1951

Useco Div., Litton Industries, 13536 Saticoy St., Van Nuys, Calif. / 213-ST 6-9381 or 213-TR 3-3520 / *C 65
Electronic hardware, terminals, terminal boards, molded products, headers, encapsulation cups, screw machine / S 125 / E 1943

V

Vector Electronic Co., Inc., 1100 Flower St., Glendale, Calif. 91201 / 213-245-8971 / *C 65
Pre-programming, patchboards, patch cords, plug-in cards, breadboard kits / S 85 / E 1947

Veeder-Root, 70 Sargeant St., Hartford, Conn. 06102 / 203-527-7201 / *C 66
Counting/recording/controlling devices / S 1200 / E 1866

Victor Comptometer Corp., Business Machines Group, 3900 North Rockwell St., Chicago, Ill. 60618 / 312-KE9-8210 / *C 66
Solenoid controlled digital printers, accumulators, listers, calculators, time-data printers / S 3800 / E 1918

Virginia Electronics Co., Inc., River Rd. & B and O Railroad, Washington, D.C. 20016 / 301-654-6680 / *C 65
Communication control systems, intercommunication systems, circuit programming systems (patch boards), etc. / S 90 / E 1951

W

Waber Electronics, Inc., 2000 N. Second St., Philadelphia, Pa. 19122 / 215-NEbraska 4-3200 / *C 66
Master power controls, electrical outlet boxes, instrument carts and lab mobile carriers / S 70 / E 1958

Paul G. Wagner Co., 1227 S. Shamrock Ave., Monrovia, Calif. 91016 / 213-357-1992 / *C 66
MICRO-PUNCH 461, a portable, printing key punch / S ? / E ?

The Walkirk Co., 10321 S. La Cienega, Los Angeles, Calif. 90045 / 213-776-0323 / *C 66
Design, assembly and functional testing of circuit modules using either 3D cordwood encapsulation techniques or open printed circuit boards; utilizing production or hand soldering and component preparation / S 50 / E 1948

Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. 01876 / 617-851-7311 / *C 66
LOCI desk-top digital computer for "on-line" and "off-line" use in scientific computations; data acquisition systems; universal, preset, and bidirectional counters; punched tape block readers / S 140 / E 1951

Warren Associates, 433 Putnam Ave., Cambridge, Mass. / OL 5-2097 (Natick, Mass.) / *C 65
Software, consulting service, correspondence courses / S 5 / E 1964

Washington Aluminum Co., Inc., Knecht Ave. and P.R. R., Baltimore, Md. 21229 / 301-242-1000 / *C 65
Computer flooring (raised, free access, steel) / S 250 / E 1947

F. S. Webster Co., Interchemical Corp., Copying Products Div., 1 Amherst St., Cambridge, Mass. 02142 / 617-KI 7-2300 / *C 65
Inked ribbons for all computers / S 225 / E 1889

West Eleven, Inc., 11836 San Vicente Blvd., Los Angeles, Calif. 90049 / 213-477-1039 / *C 66
Analog computers and analog computer components (distributor in USA and Canada for Hatachi) / S ? / E 1961

Westgate Laboratory, Inc., 506 S. High St., Yellow Springs, Ohio 45387 / ROckwell 7-7375 (Dayton, Ohio — VIctor 9-1330) / *C 65
Research, development, prototype, and small lot production in electronics, physics, optics and photography; X-Y plotters and vehicle position displays, controls, industrial instrumentation, eye movement cameras, X-Y recorders / S 58 / E 1956

Westinghouse Electric Corp., Advanced Data Systems, 700 Braddock Ave., East Pittsburgh, Pa. 15112 / — / *C 66
Consulting service: systems and operations research; data systems design and development; data retrieval systems and packages / S ? / E ?

Westinghouse Electric Corp., Electronic & Specialty Products Group, Gateway Bldg.#3, Pittsburgh, Pa. 15230 / 412-391-2800 / *C 66
Amplifiers, plug boards, computer packaged circuits, computing services, consulting services, analog to digital converters, digital to analog converters, electronic counters, indicator lights, diode and electronic multipliers, shift registers, research, scanners, telemetering systems, transformers, visual output devices / S 25,000 / E 1962 (Group)

Weston-Boonshaft and Fuchs, Hatboro Industrial Pk., Hatboro, Pa. / 215-OS 2-1240 / *C 65
Sine, transient and random computer analyzers, servo computers, control systems, statistical computers / S 100 / E 1959

Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N.J. 07114 / 201-243-4700 / *C 65
Instruments and components; indicating, display and controlling instruments; product resolvers, input-output devices, multipliers, calibrators, relays, and resistors / S 2000 / E 1888

Wheeldex, Inc., 1000 N. Division St., Peekskill, N.Y. 10567 / 914-737-6800 / *C 66
Continuous pinfeed card forms in single and multiple widths; record retrieval equipment associated with E.D.P. / S 150 / E 1931

Whittaker Corp., Technical Products Div., 9601 Canoga Ave., Chatsworth, Calif. 91311 / 213-341-0800 / *C 66
Electromechanical counter / S 950 / E 1939

John Wiley & Sons, Inc., 605 3rd Ave., New York 16, N.Y. / TN 7-9800 / *C 65
Technical books / S 500 / E 1807

G. C. Wilson & Co., 1035 26th St., Huntington, W. Va. 25703 / 304-523-5149 / *C 65
Timing controls and time delay relays / S 10 / E 1945

Winchester Electronics Div., Litton Industries, Main St. & Hillside Ave., Oakville, Conn. / 203-274-8891 / *C 65
Connectors, terminals, and accessories / S 375 / E 1941

Wittek Products Co., 14750 Keswick St., Van Nuys, Calif. 91405 / 213-ST 0-8265 / *C 65
Breadboard kits for electronic designers working on research and development in semiconductor circuitry, computers, and data processing systems / S 3 / E 1948

Wolf Research & Development Corp., P.O. Box 36, Baker Ave., West Concord, Mass. 01781 / 617-369-2111 / *C 66
Mathematical analysis and programming services; computer consulting in the fields of aerospace, information retrieval, geodesy, electronics and management systems / S 300 / E 1954

Wright Engineering Co., Inc. 180 E.California Blvd., Pasadena, Calif. 91101 / 213-MU 1-2651 / *C 65
Magnetic digital logic components and systems; buffers and storage systems; aerospace timers; magnetic tape transports / S 10 / E 1950

Wright Line Division, Barry Wright Corp., 160 Gold Star Blvd., Worcester, Mass. 01606 / 617-791-0933 / *C 66
Products for the handling, storage and filing of punched cards, magnetic tape, paper tape and disk packs / S 300 / E 1934

Wyle Laboratories, 128 Maryland St., El Segundo, Calif. 90245 / 213-678-4251 / *C 66
Computers, digital, desk-top and rack-mounted with expandable memories and expandable programmers. Punch card readers, keyboard-display units, other peripherals. Circuits, two complete lines of module cards, one utilizing germanium discrete components, the other principally silicon IC's / S 550 / E 1949

X

Xerox Corp., P.O. Box 1540, Rochester, N.Y. 14603 / 716-546-4500 / *C 65
Document copying and reproduction equipment / S 10,000 / E 1906

Y

Ed Younger & Assoc., 8 S. Michigan, Chicago, Ill. 60603 / — / *C 66
Recruit and select computer personnel for corporate clients on nationwide scale / S 5 / E 1962

Z

ZUSE KG, Wehneberger Str. 4, 643 Bad Hersfeld, Germany (West) / 2751 (06621) / Telex 04/93 329 / *C 65
Programmed controlled digital computers, automatic plotters, data handling equipment / S 1200 / E 1949

- END -

BUYERS' GUIDE FOR THE COMPUTER FIELD: PRODUCTS AND SERVICES FOR SALE OR RENT

Reprinted with permission from COMPUTERS AND AUTOMATION's "Computer Directory and Buyers' Guide", June, 1966, © 1966, published by Berkeley Enterprises, Inc., 815 Washington Street, Newtonville 60, Mass.

(Cumulative, information as of April 1, 1966)

The purpose of this roster "The Buyers' Guide for the Computer Field: Products and Services for Sale or Rent" is to give information about the existence and in many cases the properties of every product or service in the computer field that is offered for sale or rent and about which we have received information in 1966 — with certain exceptions as noted below. This is the tenth cumulative edition of this roster.

Kinds of Entries. There are three kinds of entries in this list: full entries; cross reference entries; and name entries. A full entry contains or should contain the following information:

Name of supplier and address / name or identification of product or service / DESCR: a brief description of the product in about 25 words or more / USE: how it is used / price range, and whether for sale or rent.

Every entry is subject to editing.

Cross-reference entries show that a product listed under one product heading is described more fully under another product heading.

Name entries consist of just the name of the organization, listed under the product class.

Corrections. We have tried to make each entry correct to the extent of information in our possession. But it is inevitable that at least some errors have occurred, and we shall be glad to publish corrections.

Exceptions. Certain products and services in the computer field and their descriptions are either not included or only partially included in this Buyers' Guide. For these, please see the following lists located elsewhere in this Directory:

Roster of Electronic Computing and Data Processing Services;
Survey of Consulting Services;
Survey of Software Suppliers;
Descriptions of General Purpose Digital Computers;
Characteristics of General Purpose Analog Computers;
Survey of Special Purpose Computers; and
Roster of School, College, and University Computer Centers.

Questionnaire. Many of the entries in this roster have been derived from answers to questionnaires which we sent out to over 800 suppliers. The entries have been mainly derived from answers given on the "Product Entry Form," which follows:

Product Entry Form for
THE COMPUTER DIRECTORY and BUYERS' GUIDE, 1966

1. Name or identification of product (or service)? ______
2. Brief description? ______
3. How is it used? ______
4. Price range? Between ______ and ______
5. Under what particular heading should it be listed? (See the list of 142 headings) ______

Note: Up to 25 words (subject to editing) will be published FREE. If you want more than 25 words published, the charge for up to 50 words (still subject to editing) is $15.
( ) Please give us 50 words. Enclosed is $15.

Organization ______
Address ______
This data supplied by ______
Title ______ Date ______

LIST OF HEADINGS

As a guide to the products and services offered in the computer field, please refer to the following list of headings under which products and services may be classified. There is some overlapping among these headings; it may be necessary or desirable to look under more than one heading.

A:	Adding Machines	___A1
	Amplifiers	___A2
	Analog Computers (SEE Computers, Analog)	
B:	Boards — Plotting	___B1
	— Plug	___B2
C:	Cameras. . . .	___C1
	— Data Recording	___C2
	Cards (SEE ALSO Punch Cards)	___C3
	— Magnetic	___C4
	Circuits. . . .	___C5
	— Computer, Packaged	___C6
	Communications Systems(Computer Types)	___C7

ROSTER

A1. ADDING MACHINES

Addo-X, Inc., 845 Third Ave., New York, N. Y. 10022 / Addo-X optical font adding machine / DESCR: type font to supply input data for IBM 1285 optical reader at speeds up to 3000 lines per min., list 12, total 13 / - / - / A1

Friden, Inc., a subsidiary of The Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / ADD-PUNCH® adding machine/tape punch / DESCR: performs same functions as adding machine plus punched paper tape containing all or part of printed information; tape may be converted to tab cards; tape processed by bureau or own computer / USE: sales analyses, inventory control and accounts receivable aging reports / $2000 to $3000 / A1

Friden, Inc., a subsidiary of The Singer Co., *a / AFY adding machine / DESCR: 10-key adding-multiplying; Natural Way keyboard; check dials show each entry before being printed; extra column totaling, plus regular 10 / - / $290 to $350 / A1

Friden, Inc., a subsidiary of The Singer Co., *a / 0105 Natural Way adding machine / DESCR: special type style compatible with IBM 1285 optical reader, Model I; reference numbers, amounts and totals appear on tape; check window prevents entry errors / USE: business reports such as payroll, inventory control and general accounting / $350 to $400 / A1

A2. AMPLIFIERS

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / ADI-BLOC modules / DESCR: operational amplifiers, sample-and-hold amplifiers, DAC switches, multiplexer switches, comparators, axis-crossing detectors. Offset stability, linearity, noise all .01% or better / - / $50 to $500 / A2

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / amplifiers / DESCR: broad line of all silicon DC operational amplifiers and instrumentation. Amplifiers featuring new FET input amplifiers and FET chopper stabilized units / USE: instrumentation, control, computing and measurement applications / $39 to $295/ stock units / A2

Cohu Electronics, Inc., Box 623, San Diego, Calif. 92112 / 114C differential DC amplifier / DESCR: provides high common mode rejection, stability and low drift and noise. Operates with balanced or unbalanced transducers and other input circuitry / USE: designed for thermocouple and strain gage measurements where transducer, amplifier and output device are grounded at different locations / $995 / A2

Cohu Electronics, Inc., *a / 112A wideband DC data amplifier / DESCR: provides accurate amplification of low level signals from DC to 40 kc--allowing simple, reliable measurement of strain, temperature, vibration, flow, displacement / USE: with strain gages, thermocouples and other transducers to test missiles, aircraft, bridges, buildings, ships, guns, heavy machinery / $530 to $680 / A2

COMCOR, Inc.

Engineered Electronics Co. -- see C5

General Computers, Inc., 5990 W. Pico Blvd., Los Angeles, Calif. 90035 / operational amplifier / DESCR: solid state operational amplifier provides ± 100 VDC output at 40 ma / - / $195 / A2

General Electric Co., Electronic Components Sales Operation

General Instrument Corp., Defense and Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N. Y. 11802 / amplifiers / DESCR: include IF, RF, pulse, video, distribution, isolation, limiting modulator, narrow band, wideband and general purpose / USE: Variety of applications / $1000 to $15,000 / A2

General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / amplifiers / DESCR: audio, DC, IF, power, RF, tuned / - / $95 to $1250 / A2

Genisco Technology Corp., Systems Div., 18435 Susana Rd., Compton, Calif. 90221 / tape recording and reproduce systems / DESCR: ruggedized systems for collecting information under adverse conditions / USE: high environment applications; adverse field conditions; laboratory environments / $4000 up / A2

F. B. MacLaren & Co., Inc., 15 Stepar Pl., Huntington Sta., L.I., N. Y. 11746 / packaged servo amplifiers / DESCR: vacuum tube and transistorized, plug-in units employing MS components for military and industrial applications requiring exceptional reliability, performance and life / USE: in precision custom designed servo mechanisms with AC or DC error signals / $100 to $3500 / A2

Melcor Electronics Corp., 1750 New Highway, Farmingdale, N. Y. 11735 / amplifiers / DESCR: solid state ac and dc amplifiers and power supply modules for analog and digital instrumentation / USE: power amplification, impedance matching, conversion / $20 to $1000 / A2

Nexus Research Laboratory, Inc.

Philbrick Researches, Inc., 34 Allied Drive at Route 128, Dedham, Mass. 02026 / operational amplifiers / DESCR: widest selection of performance and physical configuration / USE: computing, process control, instrumentation, simulation, active mathematics / $20 to $300 / A2

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / amplifiers; operational; analog input / DESCR: low- and high-level; accept analog inputs for subsequent conversion to digital form / USE: A/D conversion and analog computing devices / $60 to $500 / A2

Texas Instruments, Inc., Semiconductor-Components Div., P.O. Box 5012, Dallas, Tex. 75222 / integrated-circuit amplifiers / DESCR: operational/differential high-frequency, general-purpose, low-level audio, and thermal-feedback video amplifiers operate from -55° to +125° C.; packaged in standard TO-84 and TO-89 flat packages / USE: in high-reliability electronic systems / $25 to $145 / A2

B1. BOARDS, PLOTTING

Discon Corp. -- see P6

Methods Research Corp., 105 Willow Ave., Staten Island, N. Y. 10305 / magnetic visual control systems / DESCR: magnetic boards (plain or gridded) on which a wide variety of magnetic card holders, magnets, arrows, write-on strips is placed / USE: controlling production, personnel, sales, machine loading, trucking, etc. / $30 to $3000 / B1

B2. BOARDS, PLUG

AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / patchcord programming devices / DESCR: panel mount, rack mount, anti-vibration, fixed programming systems / USE: multiple switching / - / B2

Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / Digital Logic Laboratory / DESCR: training device and design tool built around a line of computer circuit packages with both integrated and discrete components / USE: desktop unit allows designers or students to build a complete operating digital system / $850 to $1000 / B2

Litton Industries, Triad Distributor Div. -- see C3

C1. CAMERAS

General Atronics Corp., 1200 E. Mermaid Lane, Philadelphia, Pa. 19118 / cameras, oscilloscopes / DESCR: automatic controls, sorting & counting; electronic counters; memory systems; photoelectric readers; systems engineering / USE: quality control inspections; automatic counting & sorting / - / C1

Giannini Scientific Corp., Flight Research Div., P. O. Box 1-F, Richmond, Va., 23201 / MULTI-DATA® camera / DESCR: photographic recorders electronically controlled for high resolution, high speed recording -- 16, 35 and 70 mm film sizes / USE: computer display recording, oscilloscope and television display recording / $1700 to $5000 / C1

Houston Fearless Corp., 11801 Olympic Blvd., Los Angeles, Calif. 90064 / filmcard camera-processor / DESCR: makes microfiche while you wait; finished 4 x 6" COSATI filmcards containing 60 microimages and full size typed title one minute after exposure / USE: microfiche production; libraries, archives, business and industry / price on request / C1

C2. CAMERAS, DATA RECORDING

Giannini Scientific Corp., Flight Research Div. -- see C1

Houston Fearless Corp. -- see C1

OPTOmechanisms Inc., 40 Skyline Drive, Plainview, N. Y. 11803 / Sentinel IV 35 mm recording instrumentation camera / DESCR: pulse or cine operated; capable recording data from cathode ray tube, may be synchronized, remote controlled between 2 or more cameras; single and double frame exposure / USE: in conjunction with cathode ray tube display / $1800 to $3500 / C2

C3. CARDS

DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / logic and control cards / DESCR: digital magnetic cards featuring low impedance circuitry, non-volatile storage, low power, high radiation resistance, small and lightweight packaging / USE: binary counters, shift registers, ring counters, digital delays, parallel to serial converters, sorters, pseudo-random code generators / $50 to $125 / C3

Jonker Corp. -- see D3, C15, P13

Litton Industries, Triad Distributor Div., 305 N. Briant St., Huntington, Ind. 46750 / circuit cards / DESCR: universal plated, extender, integrated, pre-punched, plug-in, card extractors / - / $1.40 to $12.50 / C3

Wheeldex, Inc. -- see F3

C5. CIRCUITS

The Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304 / hybrid thin-film microcircuits / DESCR: thin-film passive elements combined with active devices in chip form / USE: A/D converters; computer circuits; voltage regulators; active filters; resistor ladder networks; threshold logic circuits; etc. / quote on request / C5

Columbia Technical Corp., 50 St. at 25 Ave., Woodside, N. Y. 11377 / custom hybrid circuits / DESCR: flat packs or plug in configurations / USE: in both analog and digital systems / $10 to $150 / C5

Continental Connector Corp.

Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / digital system modules / DESCR: over 400 different types solid state digital circuit modules; 3 compatible frequencies -- 500 KC, 5MC, 10MC; specially packaged / USE: systems design, test, construction applications / $30 to $348 / C5

Digital Equipment Corp., *a / FLIP CHIP modules / DESCR: integrated and discrete components packaged on 5½ by 2½ inch printed circuit boards; low cost due to automated production facilities / USE: simple counters and adders to full scale digital computing systems / $5 to $100 / C5

Digital Equipment Corp., *a / laboratory and educational modules / DESCR: full coordinated series of transistorized digital computer circuits packaged in "building block" form; 3 compatible frequencies: 500 KC, 5MC, 10MC / USE: educational and industrial training; practical digital systems test and design work / $41 to $160 / C5

Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / digital logic modules and circuit cards / DESCR: complete line offers almost any desired circuit combination / USE: plug-in or permanent circuit modules for use in data processing and related equipment / $4/module to $150/module / C5

Litton Industries, Winchester Electronics Div.

Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles, Calif. / printed circuit boards / DESCR: etched, plated, plated through holes, flush commutators, multilayer / USE: all printed circuit applications / 50¢ to $500 ea. / C5

Philco Corp., Subsidiary of Ford Motor Co., Lansdale Div., Church Rd., Lansdale, Pa. 19446 / microelectronic integrated circuits; hybrid circuits / - / USE: broad range of digital and linear applications / $2.55 (100-999) quantity and $43.50 (100-999) quantity / C5

Texas Instruments, Inc., Semiconductor-Components Div., P.O. Box 5012, Dallas, Tex. 75222 / digital integrated circuits / DESCR: silicon monolithic circuits available in 0° to +70° and -55° to +125°C operating ranges. Packaged in TO-84 and TO-89 flat package. / USE: in high-reliability equipment ranging from guidance systems to hearing aids / $5 to $35 / C5

Wyle Laboratories, 128 Maryland St., El Segundo, Calif. 90245 / circuit cards / DESCR: two complete lines of module cards, one utilizing germanium discrete components, the other principal silicon IC's / USE: for assembling computers and other digital electronic systems $13 to $100 / C5

C6. CIRCUITS, COMPUTER, PACKAGED

Adage, Inc. -- see M5, A2

Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / circuits, computer, packaged / DESCR: single source capability for digital logic modules. Broad logic lines, 200 KC to 20 MC, from germanium to silicon, from discrete to comprehensive new integrated circuit packages / - / - / C6

Computer Logic Corp., 1528 20th St., Santa Monica, Calif. 90404 / digital logic cards / DESCR: discrete and integrated logic cards comprised of various logic function, (flip flops, gates, multivibrators); associated hardware and software / USE: build digital data systems / $23 to $315 per card / C6

Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / Series 600, 700, 800, 900 digital logic modules / DESCR: saturated circuits and clamped loads; high fan-out capability and high noise rejection; inputs diode-coupled and represent standard load; NAND and inverter logic available / - / $10 to $100 / C6

Control Logic, Inc., 3 Strathmore Rd., Natick, Mass. / digital circuit modules / DESCR: welded encapsulated; several with silicon and germanium semiconductors--operating ranges up to 50 MC. Each product family contains logic elements, level converters, lamp and indicator drivers / - / $10 per flip flop to $90 per flip flop / C6
Control Logic, Inc., *a / microcircuit digital circuit cards / DESCR: plug-in circuit cards utilizing microcircuits for logic operation and counting up to 20 MC. Over 30 different card types and standard mounting accessories. Complete systems readily constructed / - / $40 per card to $150 per card / C6
DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / core transistor logic modules / DESCR: perform logic functions; feature high logic power, maximum noise immunity, low power, non-volatile storage, high reliability, small-tough-light weight packaging / USE: primarily designed for space applications / $15 to $100 / C6
Digital Equipment Corp. -- see C5
Lockheed Electronics Co. -- see C5
MICRO SWITCH, a Div. of Honeywell, 11 W. Spring St., Freeport, Ill. 61032 / circuits, computer packaged / DESCR: 401 ED Series of Microsecond "one-shot" circuits -- produce single pulse voltage from 0.1 to 3.0 usec depending upon device; contain a resistor, capacitor, magnetic square loop core and diode / USE: in printed circuit boards or other applications in which circuit is at a remote location from controlling switch or load / - / C6
Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. 85008 / circuits, logical / DESCR: integrated circuits; MECL®, MRTL®, MDTL®, MVTL® types® / USE: gates, flip-flops, half-adder, bias regulator, gate expander / $2 to $45 / C6
Nexus Research Laboratory, Inc.
Philco Corp., Subsidiary of Ford Motor Co., Lansdale Div. -- see C5
Raytheon Computer, 2700 S. Fairview, Santa Ana, Calif. 92704 / digital circuit modules / DESCR: silicon and germanium for operation at 200KC, 1MC, 5MC, 20MC; module breadboard kit for digital system development / USE: digital data systems / $34 to $425 (in quantity of 1-10) / C6
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / circuits, computer, packaged / DESCR: all types of digital computer circuits and modules / USE: primarily for interface between analog processes and digital computers; also custom-built digital systems / $45 to $150 per module / C6
The Walkirt Co., 10321 S. La Cienega, Los Angeles, Calif. 90045 / electronic module manufacturing / DESCR: Mechanical design (including art work) 3D Cordwood encapsulated modules, and/or component assembly onto printed circuit boards using production flow and/or hand soldering, plus functional module testing / USE: assembling complex circuits into economical and/or small volume systems / bid basis / C6
The Walkirt Co. *a / Integrated Circuit Carriers and Breadboard / DESCR: carriers recessed for welding I.C.'s in place. 14 pins on carrier backside; welded I.C. becomes small plug-in module, mates with breadboard & allows plug-in of 6 carriers. / USE: prototype and/or limited production integrated circuit sub systems / $1.18 to $2.50 / C6
Wyle Labs -- see C5

C7. COMMUNICATIONS SYSTEMS

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / 770 hybrid-computer linkage system / DESCR: internal command set; 85 kc word rate; self-test frees digital computer during analog and linkage checkout / - / $30,000 to $150,000 / C7
The Bunker-Ramo Corp., 277 Park Ave., New York, N. Y. 10017 / Series 200 date display, updating and retrieval / DESCR: consoles contain CRT screen and alpha-numeric keyboards, many different configurations; usually connected to computer system through control unit and communication lines / USE: query and update a computer memory / $1100 to $14,000 / C7
CAE Industries Ltd., P.O. Box 6166, Montreal 3, Quebec, Canada / telepath auto-call / DESCR: on-line character generators automatically generate polling sequences for selecting outstation data and teleprinter equipment / USE: telegraph and data networks / $1000 to $3000 / C7
CAE Industries Ltd., *a / telepath selectors / DESCR: on-line out-station control and selection equipment to control teleprinters, tape reperforators, transmitter distributors, other on-line equipment / USE: telegraph and data networks operating with computer switching and automatic polling systems / $500 to $1500 / C7
Collins Radio Co., Dallas, Tex. 75207 / communication systems, computer type / DESCR: computer-controlled, store-and-forward digital message switching system for handling 32-1000 circuits / USE: control of high density message traffic and message processing / - / C7
Data Communications, Inc., Church Rd., P.O. Box 29, Moorestown, N. J. 08057 / DATABANK / DESCR: magnetic tape terminal designed to store data, transmit previously stored data or simultaneous storage and transmission / - / $2950 and up / C7
Data Communications, Inc., *a / DATAGUARD / DESCR: portable transmitting/receiving device which encrypts/decrypts data through a myriad of variations in the custom coding program / USE: in areas where security is of the utmost importance / $165/month rental / C7
Data Communications, Inc., *a / TELEMUX-I / DESCR: solid state, synchronous, full duplex, time division multiplexing terminal compatible with CCITT standards / - / $29,000 plus / C7
Data Systems Analysts, Inc.
Data Trends, Inc., 1259 Route 46, Parsippany, N.J. / TP-10 printer system / DESCR: compact, noiseless electronic strip printer / USE: in conjunction with touch-tone telephone; provides hard copy record of inquiries and responses / depends on configuration / C7
Digitronics Corp., 1 Albertson Ave., Albertson, L.I., N.Y. 11507 / Diato-verter data terminals / DESCR: transmits and receives magnetic tape, paper tape or punched card data over standard telephone lines / USE: centralized processing, inventory control, data collection / $7500 to $61,225 / C7
Electron Ohio, Inc., 1278 W. 9th St., Cleveland, Ohio 44113 / data collection system / DESCR: piece count, productive and down times electrically transmitted to control center; punched cards are produced / USE: central time keeping; production control / $100/machine connected to $500/machine connected / C7
Executone, Inc., 47-37 Austell Place, Long Island City, N. Y. 11101 / electronic communication systems / DESCR: intercom, sound, signalling, voice paging and pocket page systems / USE: instant internal communication to help speed work flow, increase productivity / - / C7
General Electric Co., / Process Computer Business Section -- see C10
G-E Communications Products Dept.
General Instrument Corp., Defense and Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N. Y. 11802 / communications systems / DESCR: wide variety of communications systems utilizing analog and/or digital information / USE: for any custom application / various / C7
General Instrument Corp., Magne-Head/Systematics Div., 13040 S. Cerise Ave., Hawthorne, Calif. 90250 / telepunch / DESCR: transmits and receives IBM cards via Model 33 or Model 28 teletypewriters; 10 characters/second; attaches to IBM 24 card punch / USE: data transmission systems / $3150 ($140/mo.) to $4250 ($175/mo.) / C7
General Instrument Corp., Radio Receptor Div. -- see S9
Hewlett-Packard Co., Datamec Div., 345 Middlefield Rd., Mountain View, Calif. 94041 / D-111 data entry system / DESCR: mark sense readers transmit via Data-Phone to editing, formatting buffer. Buffer output supplied as required / USE: capture small amounts of data from many sources / $700/mo. rental to $7000/mo. rental / C7
Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / data station / DESCR: remote communications terminal with paper tape, keyboard, printing, punch card, optical reading options / USE: data communications line terminal / $9000 to $30,000 / C7
Honeywell, Inc., Electronic Data Processing Div., *a / tape transmission terminal / DESCR: communications terminal for data transmission from or to magnetic tape / USE: remote terminal / $60,000 to $120,000 / C7
Lenkurt Electric Co., Inc., 1105 County Rd., San Carlos, Calif. 94070 / 26C data transmission system / DESCR: transistorized FSK system used to convert one 1200-bps or one 2400-bps data signal for transmission over a single voice channel / - / $2400 to $3900 / C7
Philco Corp., Communications & Electronics Div., 3900 Welsh Rd., Willow Grove, Pa. / Philco message and data switching systems / DESCR: communications processor and message switching system / USE: routing, storing and forwarding messages / $300,000 to $3,000,000 / C7
Quindar Electronics Inc., 60 Fadem Rd., Springfield, N. J. 07081 / solid state frequency multiplexing / DESCR: tone signalling for frequency multiplexing in supervisory control and telemetering systems; low speed and high speed; germanium and silicon types / USE: means of frequency or time division multiplexing for all types of supervisory control and data transmission / $300 to $600 / C7
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / communications systems (computer types) / DESCR: message-switching units / USE: with full-duplex, half-duplex, simplex telegraph or telephone lines / - / C7
Tally Corp., 1310 Mercer St., Seattle, Wash. 98109 / data communication systems / DESCR: paper tape, magnetic tape, card data communication terminals operating over dial-up telephone lines at 60-120 char/sec; automatic error correction routines, including typewriter I-O / USE: plugged into dataphone or equivalent / $20 per month to $300 per month / C7
Transitel International Corp., 615 Winters Ave., Paramus, N.J. 07642 / supervisory control systems / DESCR: solid state supervisory systems for conventional operation or use with a digital control computer; provides digital communication between remote devices and/or processes and a central point / USE: in the gas or water utilities or in any of the process industries / $5000 up / C7
Ultronic Systems Corp., 44 Wall St., New York, N.Y. / character multiplex / DESCR: up to 64 teletype lines on one voice grade line; various code levels and bit rates can be accommodated / - / quote from factory / C7
Ultronic Systems Corp., *a / DATA PUMP® / DESCR: transmission and reception of digital data up to 1200 bits/sec over conventional Schedule 4 telephone lines / - / under $500 / C7
Ultronics Systems Corp., *a / magnetic tape transmission terminal -- Model 3000 / DESCR: allows transmission and reception of magnetic tape data over conventional telephone lines / USE: with paper tape equipment, high speed printers, etc. / under $45,000 / C7
URS Corp. -- see I1

C8. COMPUTERS

Astrodata, Inc.
The Bunker-Ramo Corp., 277 Park Ave., New York, N.Y. 10017 / digital MIL spec. computer BR-133 / DESCR: general-purpose; extreme ruggedness and reliability / USE: shipboard; military uses - real-time control / - / C8
COMCOR, Inc.
Computer Co. of America, 121 Gill Rd., Haddonfield, N.J. 08033 / the "Compulator" series, desktop computers / DESCR: fully integrated group of desktop computers / USE: business, data or scientific problem solving / $650 to $2500 / C8
Computer International Sales Co.
Control Data Corp. -- see C10
DA-PEX Company, 334 Francis Bldg., Louisville, Ky. 40202 / used computer broker / DESCR: consult and advise with owners to help them obtain the best price when buying or selling used computers and punched card machines / - / - / C8
Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / LINC computer / DESCR: small, general purpose digital computer equipped with devices and logical circuits; programs in simplified symbolic language; built-in oscilloscope presents words, numbers, graphical displays of incoming or processed data / USE: biomedical research lab. / $42,000 up / C8
Digital Equipment Corp., *a / LINC-8 / DESCR: combining concepts and operating simplicity of LINC with speed, memory advantages, variety of peripheral devices of PDP-8; including multiplexed analog-to-digital inputs; relay register output provisions; dual digital LINtape transports; integral alphanumeric oscilloscope display / USE: biomedical and environment science research / $38,500 -- full range additional options available / C8
Digital Equipment Corp., *a / PDP-1 computer / DESCR: general purpose, solid state, digital computer; 100,000 additions per sec.; control simultaneously 1 large variety of peripheral devices; single address, single instruction, stored program, 18-bit word length / USE: from scientific on-line experimentation to real time process control / $120,000 up / C8
Digital Equipment Corp., *a / PDP-4 computer / DESCR: general purpose, single address, parallel, binary, 18-bit word length; random access magnetic core memory; cycle time 8 usecs; operates with variety of peripheral devices / USE: from scientific on-line experimentation to real time process control / $60,000 up / C8
Digital Equipment Corp., *a / PDP-5 computer / DESCR: small scale general purpose; one-address, fixed word length, parallel computer using 12 bit, two's complement arithmetic; magnetic core memorey with cycle time of 6 usecs / USE: in larger computer systems / $25,000 up / C8
Digital Equipment Corp., *a / PDP-6 computer / DESCR: medium-sized system; 16 accumulators; 15 index registers; provision for expansion; elements interconnected by busses and operate asynchronously; contains all hardware necessary for time-shared use / USE: very-high

capacity scientific data processing; time sharing / $250,000 up / C8
Digital Equipment Corp., *a / PDP-7 computer / DESCR: high-speed, solid state digital computer; single address, fixed 18-bit word length, binary machine; random access magnetic core memory; cycle time of 1.75 usec; 285,000 additions per sec. / USE: scientific lab; computing center; real-time process control system / $45,000 up / C8
Digital Equipment Corp., *a / PDP-8 computer / DESCR: compact, general-purpose digital computer; high speed, random access, magnetic core memory; binary operations on 12- or 24-bit 2's complement numbers; cycle time 1.6 usec; integrated solid state logic modules / USE: scientific computation, system and control applications, on line data collection and reduction / $18,000 / C8
Digital Equipment Corp. -- see C12
Ferranti Electric, Inc., East Bethpage Rd., Plainview, N.Y. 11803 / ARGUS 400 and 500 computers / DESCR: general purpose and process control, silicon integrated circuitry, full range process input/output devices / - / $45,000 to $60,000 / C8
Scientific Control Corp., 14008 Distribution Way, Dallas, Texas 75234 / computers, general purpose / DESCR: 5 computers ranging from 2 to 5 usec.; fully parallel, indexed operation / USE: scientific and data processing applications, independently or as integral part of data handling systems through adequate interfacing / $14,800 to $100,000 / C8
Société d'Electronique & D'Automatisme

C9. COMPUTERS, ANALOG

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / analog computer/simulator / DESCR: educational analog simulator and special purpose analog computers / USE: undergraduate instruction in physical sciences and engineering. Also, industrial control and computation / $3000 to $50,000 / C9
COMCOR, Inc.
GPS Instrument Co., Inc., 188 Needham St., Newton, Mass. 02164 / GPS 10,000 analog computer / DESCR: general purpose with hybrid capability, expandable to over 300 computing elements; high speed operation for iterative and statistical computation / USE: general purpose; hybrid / $50,000 up / C9
GPS Instrument Co., Inc., *a / GPS 200T analog computer / DESCR: compact solid state, real-time, compressed time and hybrid operation; based on full output band width to over 1 megacycle per second / USE: general purpose; hybrid / $20,000 to $70,000 / C9
F.B. MacLaren & Co., Inc., 15 Stepar Pl., Huntington Sta., L.I., N.Y., 11746 / analog computers / DESCR: custom designed precision electro-mechanical systems to perform specific mathematical operations in military and industrial computer applications / USE: data conversion - voltage to position, velocity, voltage, etc. / variable, depending on application / C9
Pastoriza Electronics, Inc., 385 Elliot St., Newton, Mass. 02164 / PAC (Personal Analog Computer) / DESCR: small analog computer for teaching applications; contains two integrators, two multiplexers, one adder, power and patch cords, read-out meter, controls / USE: simulate and solve differential equations / $350 / C9
Perspective, Inc.
Philbrick Researches, Inc., 34 Allied Drive at Route 128, Dedham, Mass. 02026 / analog computing components / DESCR: modular analog computing instruments; amplifiers, multipliers, dividers, integrators, differentiators / USE: research, process control, simulation, active mathematics / $300 up / C9
Reeves Instrument Co., 100 East Gate Blvd, Garden City, N. Y. 11532 / REAC 600 analog computer / DESCR: high speed, solid state, large scale computing system; expandable to powerful hybrid facility / USE: product analysis and systems simulation / varies / C9
Reeves Instrument Co. -- see C14
Simulators, Inc., 1856 Walters Ave., Northbrook, Ill. 60062 / simulation equipment / DESCR: small, medium and large general purpose analog and hybrid computers / USE: simulation, on-line data analysis / $5000 to $150,000 / C9
Systron-Donner Corp., 888 Galindo St., Concord, Calif. 94520 / SD 10/20 analog computer / DESCR: general purpose desk top computer; full ± 100 volt operating range, visual computer circuits on removable problem board, patchable electronic mode control and time scales, expandable to 20 operational amplifiers / USE: teaching and instructional use for engineering and mathematics students; also for simulation and optimization / $6000 to $13,000 / C9
Systron-Donner Corp., *a / SD 40/80 analog computer / DESCR: general purpose, desk top ± 100 volt; built-in digital logic, patchable electronic mode control and time scales, expandable up to 84 amplifiers / USE: in research for simulation and optimization of dynamic problems. Also at universities for teaching and instructional use / $14,000 to $75,000 / C9
West Eleven, Inc., 11836 San Vecente Blvd., Los Angeles, Calif. 90049 / Hitachi 303 analog computer / DESCR: low-cost desk-top; satellite for large analog computers / USE: high schools; colleges; research laboratories; aid in teaching mathematics, electronics and mechanics; engineering aid in solving small scale problems at high speed / $1400 to $5050 / C9
West Eleven, Inc., *a / Hitachi 505, analog computer / DESCR: low cost, advanced analog computer; highest quality standards; solid state (silicon) 100 V desk-top; modular, 10 amplifiers to 120 amplifiers / USE: high speed simulations and computations by engineer, researcher or scientist / $7300 to $60,000 / C9

C10. COMPUTERS, DIGITAL

American Bosch Arma Corp., ARMA Div., Roosevelt Field, Garden City, N. Y. 11532 / Micro D computer / DESCR: stored program 13 bit (expandable to 18 bits) serial binary microelectronic computer operating on fractional whole numbers at rates up to 80,000 operations per sec. / USE: aircraft inertial navigation; missile guidance applications / $10,000 to $14,000 ea. in quantity / C10
The Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304 / BR-130 (AN/UYK-1) digital computer / DESCR: medium scale; 6 usec read-write cycle; 8K core memory (expandable to 32K); interleaved I/O; real-time interrupts; NTDS compatible / USE: Polaris and Transit navigation systems; range tracking; photo recon interpretation; oceanographic data systems; communications intelligence processing systems / quote on request / C10
The Bunker-Ramo Corp., Defense Systems Div., *a / BR-133 (AN/UYK-3) digital computer / DESCR: general purpose; 1 usec read-write cycle; 16K core memory (expandable to 32K); multi-level priority interrupt; NTDS and mobil OPCON I/O devices compatible / USE: satellite tracking; fire control; simulation; reconnaissance; small ships data handling; air defense; oceanographic applications; automatic mapping / quote on request / C10
The Bunker-Ramo Corp. -- see C8
CAE, 17, Route de la Reine, Boulogne/Seine, France / CAE 90-10 / DESCR: basic cycle: 1.75 μs, large connection with peripheral equipments, integrated circuit / USE: process control and real time / $30,000 to $200,000 / C10
CAE, *a / CAE 90-40 / DESCR: four different possibilities for external connection / USE: real time and scientific applications / $200,000 to $400,000 / C10
CAE, *a / CAE 90-80 / DESCR: specially designed for external connection / USE: real time and scientific applications / $400,000 to $800,000 / C10
Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138 / digital computer systems / DESCR: designs, develops and manufactures / USE: industrial, commercial and military applications / - / C10
Celestron Associates, Inc. -- see C15
Cognitronics Corp., 549 Pleasantville Rd., Briarcliff Manor, N. Y. / computers / DESCR: full line designed to perform justification and hyphenation decisions and output completed tape for operation of hot and cold type machines / USE: accepts raw punched tape text and outputs tape complete with instructions / $30,000 to $75,000 / C10
Collins Radio Co., Dallas, Tex. 75207 / C-8500 electronic computing system / DESCR: intermediate scale, integrated circuit; 32-bit word, max. 262,000 bytes; 2 usec core storage; overlapped core banks; 32 high-speed I/O channels and 1 multiplex channel / USE: communication; industrial systems / - / C10
Computer Co. of America -- see C8
Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / computers, digital / DESCR: real-time, on-line computers featuring monolithic integrated digital logic circuit modules, General or special purpose / - / - / C10
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / 8090, 160A, 1700, 3000 Series, and 6000 Series computers / DESCR: small, medium, large-scale general purpose digital computer systems; some with time-sharing capabilities; world's largest digital computer; use with variety of peripherals; modular design for expansion / USE: general purpose computations; process control; total management information systems; scientific and engineering computations / $100,000 to $5,000,000 / C10
Control Logic, Inc., 3 Strathmore Rd., Natick, Mass. / special purpose systems / DESCR: special purpose digital data handling, measurement, control, data formatting systems designed to meet specific customer requirements / - / - / C10
Digital Electronics Inc., 2200 Shames Dr., Westbury, N. Y. 11590 / DIGIAC 3080 computer / DESCR: mobile, self contained; solid state machine with printed cards, requires no special maintenance / USE: in computer education / $19,500 / C10
Digital Equipment Corp. -- see C8
Electro-Mechanical Research, Inc., ASI Computer Div., 8001 Bloomington Freeway, Minneapolis, Minn. 55420 / ADVANCE series digital computer systems / DESCR: general purpose digital computers; series includes low-cost 6020, 6040, 6050, and 6070. Machines are program compatible and include full software package / USE: scientific and engineering computation and on-line systems applications / $80,000 to $225,000 / C10
Electro-Mechanical Research, Inc., ASI Computer Div., *a / digital computers / DESCR: small to medium scale, high speed, general purpose; associated peripheral equipment / USE: scientific, engineering, on-line systems application / $30,000 to $500,000 / C10
Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / custom digital systems / DESCR: will deliver a completely tested system according to customer's requirements / - / subject to negotiation / C10
Ferranti Electric, Inc. -- see C8
Ferranti-Packard Electric Ltd., Industry St., Toronto 15, Ontario, Canada / FP 6000 general purpose digital computer / DESCR: 24-bit; multi-processing memory protection by hardware; 1½ address order code with 7 accumulators to 3 index registers available to each program / USE: special purpose needs through special interfacing equipment / $120,000 to $1,000,000 / C10
Friden, Inc., a subsidiary of The Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / 6010 electronic computer / DESCR: fully transistorized, random access core storage; desk-sized; removable program panel; accepts input from punched tape, edge-punched cards, etc. Output: printed document, tape, cards / USE: billing, various accounting applications, statistical quality control, product analysis reports / $19,000 to $20,000 / C10
General Electric Co., Process Computer Business Section, 2255 W. Desert Cove Rd., Phoenix, Ariz. 85002 / computers, digital / DESCR: magnetic core; magnetic bulk memory backup; complete line of peripherals, including process and data communications / USE: real-time process applications for monitoring, logging, operator guide or control / $20,000 to $1,000,000 / C10
General Electric Co., Process Computer Business Section, *a / information processing systems; data communications systems / DESCR: 11 computers from small-scale (GE-115) punched-card processor, with capability for use as remote terminal, to a large-scale, time-sharing computer (GE-645); 12 different data-communications equipments / USE: business, banking, scientific/engineering, education, government / $1375 per month rental and $66,000 purchase to $150,000 per month rental and $7,000,000 purchase / C10
General Instrument Corp., Radio Receptor Div. -- see S9
General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / AN/ASN-24 (V) / DESCR: general purpose digital computer set including variety of input-output signal conversion and control-display modules. Fully qualified to MIL E 5400 Class II. Logistics complement established / USE: real time digital control and processing in manned aircraft (e.g., central navigation in USAF C-141) / - / C10
General Precision Inc., Kearfott Products Div., *a / GPK-10 / DESCR: general purpose micro-circuit digital computer; large, internally stored memory is NDRO, electrically alterable; up to 550,000 bits; extensive input-output and computing capacity / USE: real time airborne processing and control / - / C10
General Precision, Inc., Kearfott Products Div., *a / L 90-1 / DESCR: microcircuit digital computer with 5 megahertz serial bit processing; 28 bit data word, up to 16,000 words of memory; large input-output capability; compiler, simulator developed / USE: airborne data processing and control / - / C10
Honeywell Electronic Data Processing, 60 Walnut St., Wellesley Hills, Mass. 02181 / Series 200 computers / DESCR: six models of business data processing systems ranging from small card system to super-powered multi-programming models, including complete array of peripheral equipment / USE: business and scientific data processing applications / $150,000 to $2,500,000 / C10

Honeywell Inc., Industrial Div., 100 Virginia Drive, Fort Washington, Pa. 19034 / H20 digital control system / DESCR: low cost, real-time system with 18-bit word; 1.75 usec. cycle time; parallel I/O channels; 16 priority hardware interrupts; memory protect; parity checking / USE: on line industrial control, laboratory data acquisition, off-line scientific computations / $21,000 to $200,000 / C10

Information Processing Systems, Inc., 200 W. 57th St., New York, N. Y. 10019 / sale of used computer systems / DESCR: brokerage of used computer systems for organizations having purchased equipment and now upgrading to newer machines / - / - / C10

Litton Industries, Data Systems Div., 8000 Woodley Ave., Van Nuys, Calif. 91406 / microelectronic general purpose computer / DESCR: family of micromodular, high speed, militarized, off the shelf general purpose machines; multiprogramming and multiprocessing; user options / USE: general purpose computer applications / $100,000 up / C10

Monroe Computer Systems Division, 550 Central Ave., Orange, N. J. / Monrobot XI / DESCR: desk-size general purpose electronic computer; 2000 word drum memory (optional high capacity storage system provided by magnetic Monro-Card); needs no air-conditioning or special installation / USE: general business accounting; packaged programs for commercial and engineering applications; educational tool in secondary schools and colleges / $24,500 basic operating system / C10

The National Cash Register Co., Main & K Sts., Dayton, Ohio 45409 / NCR 315 RMC computer / DESCR: first commercially available computer to employ all thin film memory; new high speed peripheral units plus floating point logic have been added / USE: for random, sequential, real-time or remote inquiry processing / $300,000 up / C10

The National Cash Register Co., *a / NCR 500 computer / DESCR: ability to communicate in one or a combination of five data processing languages; offers over 20 different types of supporting units / USE: variety of applications, including payroll accounting, bill and charge, sales and inventory analysis / $25,000 to $30,000 / C10

Northrop Corp., Nortronics Div., 2301 W. 120th St., Hawthorne, Calif. / NDC 1050-A militarized airborne digital computer / DESCR: 2048 20-bit word memory, add time 89.5 microseconds, mult. time 835 microseconds, conductively cooled, designed to meet MIL-E-5400 (G) environment / USE: aircraft navigation / C10

Northrop Corp., Nortronics Div., *a / NDC 1051 militarized airborne digital computer / DESCR: 2048 24-bit words (expandable to 8192), add time 8 microseconds, mult. time 72 microseconds, conductively cooled, designed to meet MIL-E-5400 (G) environment / USE: aircraft, space navigation / C10

N.V. Electrologica, 4 Bordewijkstraat, Rijswijk (ZH), The Netherlands / EL X2, EL X4 digital computers and peripherals / DESCR: magnetic core memory 4,096 - 32,768 words of 27 bits excl. one parity-bit; cycle-time 5 mms; time-sharing and interrupt features; floating point arithmetic; backing store possibilities (drums and discs) / USE: general purpose machine / fl 240,000 to max. dependent on desired peripheral equipment / C10

N.V. Electrologica, *a / EL X8 digital computer and peripherals / DESCR: magnetic core memory 16,384 - 262,144 words of 27 bits, excl. one parity bit; cycle-time 2.5 mms; backing store; magnetic drum (524,288 words), disc-storage (23,000,000 words), disc-storage (interchangeable disc-packs, 2,100,000 words/pack); extensive interrupt and time-sharing features; memory protection; floating point arithmetic / USE: general purpose machine / min. fl 1.2 million and up dependent on desired peripheral equipment / C10

Pacific Data Systems, Inc., 1058 E. First St., Santa Ana, Calif. 92107 / PDS 1020 computer / DESCR: general purpose, serial, decimal, internally stored program computer / USE: direct access by engineer or other operator / $21,500 to $25,050 / C10

Philco Corp., Communications & Electronics Div., 3900 Welsh Rd., Willow Grove, Pa. / Philco 2000 / DESCR: general purpose large scale computer series / USE: scientific and business data processing / $250,000 to $2,500,000 / C10

Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. 92704 / 520 computer system / DESCR: solid state digital computer; 1 usec main memory; peripheral equipment includes keyboard/CRT display station, disc file, disc pack, drum memory / USE: real-time, hybrid and general purpose scientific and engineering computing / $100,000 to $200,000 / C10

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / computers, digital / DESCR: 8 general-purpose digital computers: Sigma 7, designed for time-sharing in real-time environments; and the SDS 92, 910, 920, 925, 930, 940, 9300 / USE: scientific and business data processing (real-time; on-line; and interactive time-sharing); digital system control / $30,500 (SDS 92 in minimum useful configuration) to $1 million (large-scale Sigma 7 system) / C10

Spear, Inc., 335 Bear Hill Rd., Waltham, Mass. 02154 / micro-LINC computer / DESCR: general purpose stored program digital computer and data acquisition system; accepts direct analog or digital input, stores data on integral digital tape units; provides analog or digital output / USE: on-line operation in laboratory by those unskilled in computer usage; bio-medical research; clinical applications / $40,000 to $50,000 / C10

Sperry Gyroscope Co., Div. Sperry Rand Corp., Great Neck, N. Y. 11020 / MARK XIV microcircuited computer / DESCR: small, lightweight general purpose computer meeting both MIL-E-5400 and MIL-E-16400 specs. Offers 21 bit word length; 4096 to 8192 word memory; speed of 16,700 multiplies/second/ USE: navigation, fire control and other control applications / under $50,000 / C10

Systems Engineering Laboratories, Inc., P. O. Box 9140, ~~6901 W.~~ Sunrise Blvd., Fort Lauderdale, Fla. 33310 / digital computers / DESCR: 1.75 usec cycle time, 16 and 24 bit word size, memory expandable from 4K to 32K words / USE: simulators and process controllers / - / C10

Systems Engineering Laboratories, Inc., *a / digital systems / DESCR: low level, high level, slow and high speed digital data acquisition and processing systems / - / $25,000 up / C10

TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / MARCO 4418 / DESCR: general purpose digital computer; volume 0.3 ft^3, weight 32 lbs., power 75 watts; MTBF, greater than 20,000 hrs / - / - / C10

Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. 01876 / LOCI-2, LOgarithmic computing instrument / DESCR: desk-top digital computer computes complex expressions using unique principle of digitally generating logarithms. Programmable. Loops, branches, makes decisions. Results are displayed and/or recorded at electronic speeds / USE: scientific computations / $2750 to $8450 / C10

Wang Labs, Inc. -- see C36, D6

Wyle Laboratories, 128 Maryland St., El Segundo, Calif. 90245 / computers / DESCR: digital, desk-top and rack-mounted, with expandable memories and expandable programmers. Punch card readers, keyboard-display units, other peripherals / USE: scientific and engineering computations. General purpose / $4000 to $15,000 / C10

C11. COMPUTERS, SPECIAL PURPOSE

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / AMBILOG 200 signal-processing computer / DESCR: analog and digital signal processing under stored-program control via hybrid-arithmetic and logic modules / USE: simulation; on-line data processing / $125,000 to $350,000 / C11

American Bosch Arma Corp., ARMA Div. -- see C10

The Bristol Co., Waterbury, Conn. 06720 / special purpose computers / DESCR: gas flow computers, solid-state and mechanical units; converts volumetric rate of flow measurements to standard conditions / USE: recording or telemetering / $1800 to $6000 / C11

The Bunker-Ramo Corp. -- see C8

Cambridge Thermionic Corp.

Celestron Associates, Inc. -- see C15

Control Data Corp., Government Systems Div., 3101 E. 80th St., Minneapolis, Minn. 55440 / special purpose digital computers / DESCR: design, development and production (including microminiature computers); related equipment for military, aerospace and government applications / USE: fire control; system checkout (automatic); navigation; advanced weapons development and testing / varies / C11

Control Logic, Inc. -- see C10

DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / computer keyboard / DESCR: special-purpose digital computer and high-speed keyboard produce clear justified 6-level tape for operating line casters and photo composing machines / USE: newspapers, book publishers, commercial type setting houses / $16,480 to $25,000 / C11

Ferranti Electric, Inc. -- see C8

General Instrument Corp., Radio Receptor Div. -- see C12

General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / DYDAN / DESCR: microcircuit incremental computer with reprogrammable NDRO memory; delay line working storage contains up to 110 dual digital integrators of (nominally) 20-bits each; variable word length / USE: doppler or inertial navigation of aircraft / - / C11

General Precision, Inc., Kearfott Products Div., *a / MINAC (Miniature Navigational Computers) Series / DESCR: navigational computers combining analog and digital computing techniques; compatible with existing Doppler sensors; modular design with built-in self-test feature / USE: real time navigational computation in aircraft / - / C11

HRB-Singer, Inc. -- see I1

George Kelk Ltd., 48 Lesmill Rd., Don Mills, Ontario, Canada / special purpose digital computers / DESCR: produces complete measuring system in connection with an optical scanner / USE: size measurement of steel slabs / $30,000 to $70,000 / C11

Nash and Harrison Ltd., 1355 Wellington St., Ottawa 3, Ont., Canada / digital, process control computers / DESCR: designed around standard modular components; used in conjunction with electronic inspection equipment. Special designs and consulting services quoted on request / USE: wide variety of control applications / $2000 to $10,000 / C11

Philbrick Researches, Inc. -- see C9

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / computers, special purpose / DESCR: engineering services to adapt SDS general-purpose computers to special-purpose configurations and to integrate SDS computers into custom-designed data systems / USE: spacecraft simulation via analog/digital hybrid system; telemetry data processing; gas pipe line monitoring and on-line control / no charge for system engineering when 80% or more of system price consists of SDS standard products, including SDS computer / C11

Scientific Data Systems, Inc. -- see S9

Spear, Inc., 335 Bear Hill Rd., Waltham, Mass. 02154 / statistical analysis systems or data processing systems / DESCR: special purpose front end designs in combination with micro-LINC general purpose computer to gather and process analog or digital signals for analysis or control / USE: unique scientific research applications / $50,000 to $200,000 / C11

Sperry Gyroscope Co. -- see C10

Technical Measurement Corp., 441 Washington Ave., North Haven, Conn. 06473 / CAT 1000 (Computer of Average Transients) / DESCR: on-line digital computer for statistical analysis / USE: scientific and engineering data -- signal averaging (for signal-to-noise ratio improvement), histogram computations, correlation / $8000 to $15,000 / C11

Technical Measurement Corp., *a / Model 258 correlation computer / DESCR: hybrid for on-line determination of auto- and cross-correlation functions. Used with TMC CAT 1000 / USE: medical research, geophysics, structural analysis, acoustic research, wave propogation studies / $8000 to $15,000 / C11

Technical Measurement Corp., *a / Model 1001 pulse height analyzer / DESCR: 1024-address computer for determining energy, velocity and time distribution spectra through analysis of input pulse amplitudes / USE: primarily nuclear physics and radiochemistry research / $8000 to $15,000 / C11

Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / Model 670 automatic telemetry processor / DESCR: telemetry decommutator operating with computer techniques and having computer capabilities / USE: receives, decommutates and distributes data to many different devices / $120,000 to $190,000 / C11

Texas Instruments Inc., Industrial Products Group, 3609 Buffalo Speedway, Houston, Tex. 77006 / TIAC® system / DESCR: high speed data processing system optimized for processing of field digital data for signal-to-noise improvement / USE: firms engaged in seismic exploration; service firms renting computation services / - / C11

TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / special purpose computers / DESCR: complete capability for design, development, manufacture of all types; several in early development / - / - / C11

Wyle Labs -- see C10

C12. COMPUTERS, TEST EQUIPMENT

Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / computers, test equipment / DESCR: magnetic and digital test instruments. Generators: pulse current, pulse voltage, digital program (20MC and 5MC). Memory exerciser with 150 n sec cycle time. 65,536 addresses / - / - / C12

Control Data Corp., Government Systems Div., 3101 E. 80th St., Minneapolis, Minn. 55440 / ACE-SC / DESCR: computerized automatic checkout system for Apollo spacecraft systems; design, development, production of checkout systems / USE: identical systems check various subsystems at production sites and after assembled together on launch pad / varies / C12

Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / memory test systems / DESCR: single core to automatic testers; memory exercisers to plane testers for coincident current memories or word address memories; other special purpose systems / USE: testing magnetic memory cores, planes, stacks for lab evaluations and production line applications / depends on system / C12

Exact Electronics Inc., 455 S.E. 2nd Ave., Hillsboro, Ore. 97123 / waveform generators / DESCR: electronic instruments of vacuum tube or solid-state design, producing a variety of standard and complex low frequency waveforms / USE: as operational and measuring devices in military, industrial and medical application / $400 to $3000 / C12

General Instrument Corp., Radio Receptor Div., 100 Andrews Rd., Hicksville, N. Y. 11802 / custom designed general support equipment / DESCR: automated test equipment utilizing general purpose or special purpose computer and data gathering devices. Hardware and/or software designed to customer specifications / - / C12

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio 44108 / DMS-3200 digital measuring system / DESCR: digital display of electrical parameters as determined by plug-in selection -- DC voltage, Imc. counter, ohmmeter, capacity meter / USE: circuit testing of potentials, components, and timing circuits / $400 to $520 / C12

Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / memory tester / DESCR: automatic testing of computer memories, as planes or stacks / USE: quality assurance testing / $80,000 to $100,000 / C12

George Kelk Ltd. -- see C11

TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / computer test equipment / DESCR: present equipment available for standard line computers; capabilities for building test equipment for all computer systems / - / - / C12

Wyle Labs -- see C10

C13. COMPUTER COMPONENTS (SEE ALSO SPECIFIC TYPES)

Astrodata, Inc.

The Bunker-Ramo Corp., 277 Park Ave., New York, N. Y. 10017 / thin-film circuits / DESCR: integrated; packaged to customer's specs. by a proprietary process / USE: military; aerospace; commercial products / on application / C13

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138 / digital logic modules / DESCR: 100 KC germanium lines and 2MC silicon line, both have same pin configuration. A 10MC integrated circuit logic module line also available / USE: industrial, commercial and military applications / $2.50 to $40.00 / C13

COMCOR, Inc.

Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / computers, components / DESCR: wide variety digital circuit modules, magnetic core memories, magnetic and digital test instruments / - / - / C13

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. 91109 / analog computer function modules / DESCR: encapsulated modules / USE: computers constructed from these modules solve arithmetic and algebraic problems, control and simulate processes, and perform many other functions / - / C 13

Control Logic, Inc. -- see C6 and C10

DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / aerospace systems / DESCR: aerospace qualified digital magnetic control systems include: memories, clocks, timers, velocity meter counters, intervalometers, logic modules, telemetry counters / USE: data storage and control aboard satellites and space vehicles / $1000 - $20,000 / C13

General Electric Co., Electronic Components Sales Operation

General Instrument Corp., Radio Receptor Div. -- see S9

Honeywell, Inc., Electronic Data Processing Div. -- see P9, P15, R9, S5, T1

International Diode Corp., 90 Forrest St., Jersey City, N. J. 07304 / alloy junction switching diodes / DESCR: hermetically sealed glass package D07 and smaller; super-speed switching combined with high forward current / USE: digital computers, voltmeters, coupling with tunnel diodes in coincidence circuits / $.45 to $2.65 / C13

International Rectifier, 233 Kansas St., El Segundo, Calif. 90246 / silicon controlled rectifiers / DESCR: 3 terminal, 4-layer solid-state devices for control amplification of a-c power or a-c to d-c conversion / USE: controlling firing point on a-c phase cycle / $1.50 to $500 / C13

International Resistance Co., Inc. (IRC), 401 N. Broad St., Philadelphia, Pa. 19108 / computer components / DESCR: resistors, precision potentiometer and trimmers, zener diodes / - / - / C13

Litton Industries, Data Systems Div., 8000 Woodley Ave., Van Nuys, Calif. 91406 / display / DESCR: modular display consoles with microminiatured electronics for ultra reliability: militarized; user options / USE: computer output display / $75,000 up / C13

Litton Industries, Data Systems Div., "a / microelectronic power supply / DESCR: various voltage and power ratings: militarized off the shelf ultra high reliability / USE: avionic; computers and related input/output equipment / $1000 to $1500 / C13

Litton Industries, Triad Distributor Div. -- see T14

Litton Industries, Winchester Electronics Div.

Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles, Calif. / position transducer / DESCR: standard units measure displacement from 1" to 150"; designed around an infinite resolution potentiometer which is actuated through a precision spring motor / USE: measurement of position or displacement / $200 to $350 / C13

Lockheed Electronics Co. -- see C5

Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. 85008 / computer components / DESCR: semiconductor devices: germanium and silicon transistors; silicon rectifiers and diodes; thyristors; rectifier assemblies; integrated circuits / USE: electronic circuits / 20 ¢ to $75 / C13

Nexus Research Laboratory, Inc.

PAKTRON Div. Illinois Tool Works Inc., 1321 Leslie Ave., Alexandria, Va. 22301 / capacitors / DESCR: MYLAR, polycarbonate, metalized mylar, miniature capacitors / USE: circuit component / variable / C13

Rotron Mfg. Co., Inc., Hasbrouck Lane, Woodstock, N. Y. 12498 / cooling devices and air sources / DESCR: cooling devices and high pressure/vacuum air sources specifically designed for the computer industry / USE: cooling electronic circuits and provide air sources for tape control, fluidic power supplies, tape air bearings, etc. / $3.95 to $185 / C13

Sage Electronics Corp., Box 3926, Rochester, N. Y. 14610 / Resistors / DESCR: miniature precision wirewound power resistors / - / - / C13

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / computer components / DESCR: complete range of peripheral devices, memories, analog/digital instrumentation / USE: digital computer systems / - / C13

Scientific Data Systems, Inc., "a / multiplexers, analog / DESCR: models with from 2 to 256 channels / USE: to switch a number of analog inputs into a single output, generally under digital control / $400 to $4000 / C13

Lear Siegler, Inc., Power Equipment Div., P. O. Box 6719, Cleveland, Ohio 44101 / clutch and/or brake / DESCR: stationary coil magnetic particle module. Can be used as either a clutch or brake. Models with torque range up to 80 lb. in. Time to reach rated torque as low as 2 milliseconds. Smooth, noise-free engagement. Maintenance-free, long-life with consistant performance independent of normal environmental range / USE: clutch or brake mounted directly on actuated shaft / $40 to $70 / C13

Société d'Electronique & D'Automatisme

Westinghouse Electric Corp., Electronic & Specialty Products Group

Wyle Labs -- see C5

C14. COMPUTING SERVICES

Automated Data Processing Services, Inc.

Booz, Allen Applied Research, Inc., 135 S. LaSalle St., Chicago, Ill. / scientific and technical services / DESCR: computer and hardware systems design, installation management, computer feasibility, applications, systems analysis, software design, information retrieval systems, scientific computation / - / - / C14

The Bunker-Ramo Corp., 277 Park Ave., New York, N. Y. 10017 / TeleCenter services / DESCR: on-line, off-line data processing; processor, data storage, communications, input/output equipment on customer's premises tailored to his requirements / USE: storage, updating, retrieval of any data subject to continuous change and frequent inquiry / $100 per mo. to $35,000 per mo. / C14

Computer Advisors to Management (CAM), Div. of Statistical Tabulating Corp., 104 S. Michigan Ave., Chicago, Ill. 60603 / Professional counseling in economic evaluation and application of data-processing and computer systems / DESCR: provides full line of advisory services from feasibility studies to systems design, equipment selection and personnel indoctrination / - / C14

Computer Applications Inc., 555 Madison Ave., New York, N. Y. 10022 / computer services, consulting / DESCR: programming systems, data processing applications, scientific and engineering applications, systems engineering, real-time applications, project management, data processing service centers / USE: business, institutional, government, military / - / C14

Computer Associates, Inc.

Computer Fulfillment, 225 East St., Winchester, Mass. 01890 / computing services / DESCR: subscription fulfillment; circulation; file maintenance and analyses; reader inquiry processing; consulting / USE: publishing industry / - / C14

Computing & Software, TSI Div., 8155 Van Nuys Blvd., Panorama City, Calif. 91402 / computing services / DESCR: complete data processing and data reduction services including electronic equipment operation and maintenance, data analysis, facilities planning, and associated software and program development services / USE: at data centers in Los Angeles and at Government locations / C14

Control Data Corp., Data Centers Div., 8100 34th Ave. So., Minneapolis, Minn. 55440 / digital computing service / DESCR: programming and processing services; Nationwide chain of data centers; computers ranging from small digital systems to large-scale systems; dataphone and remote services / - / on request / C14

Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. 90804 / computing services / DESCR: digital, analog and hybrid; software, machine rental; simulation studies / - / - / C14

Cybertype Corp. -- see C15

DA-PEX Company -- see C8

Data-Mat, Div. of Statistical Tabulating Corp., 104 S. Michigan Ave., Chicago, Ill. 60603 / eight data-processing and computer service centers / DESCR: "come-in-and-do-it-yourself" service; customer selects equipment and operates it himself / hourly rates or on contract basis / C14

Decision Systems Inc.

Design Automation, Inc., 4 Tyler Rd., Lexington, Mass. 02173 / computer analysis of electronic circuit performance / DESCR: computer calculation of non-linear DC, nonlinear transient and linear sinusoidal frequency response of any electronic circuit, with any parts values, and any signals applied / USE: design review analysis / $150 and up / C14

Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / computing services / DESCR: specializing in the design, analysis, programming and implementation of computer-based systems / USE: government and industry / - / C14

Information International Inc., 200 Sixth St., Cambridge, Mass. 02142 / automatic film reading service / DESCR: accept customer film for reading; magnetic tape output. Will develop program if required; system rental available (special rates for universities) / USE: service center for automatic film reading / $200/hour, rental / C14

ITT Data Services, a division of International Telephone and Telegraph Corp., P. O. Box 402, Paramus, N. J. / data processing services / DESCR: full range of scientific and commercial data processing services, including programming, computational services and data center management / - / - / C14

Keystone Computer Associates, Inc. -- see P12

Litton Systems, Inc., Mellonics Systems Development Div., 1001 W. Maude Ave., Sunnyvale, Calif. 94086 / system design tools / DESCR: general-purpose digital computer programs used to simulate and evaluate complex satellite, command and control, transportation, information management and industrial process control systems / USE: optimization of system design prior to procurement / $5000 to $50,000 / C14

Management Systems Corp., 209 Griffin St., Dallas, Tex. 75202 / computing services / DESCR: turn-key computing from problem definition to system and report design and preparation; facilities for client programming, testing and processing on hourly computer usage / - / - / C14

McDonnell Automation Center, Box 516, St. Louis, Mo. 63166 / computing services / DESCR: over $25 million worth of data processing and computing equipment allows efficient handling of one time or continuous large or small jobs / - / - / C14

Monroe Data Processing Inc., 550 Central Ave., Orange, N. J. / data processing computing service / DESCR: process all paperwork for business accounting; comparative analyses for management; also, DATATAX, a computerized income tax service; raw or coded information processed and returned within a week / USE: accountants, or firms who have a staff accountant; management / variable / C14

National Computer Analysts, U. S. Highway 1, Lynwood Drive, Princeton, N. J. 08540 / computing services / DESCR: processing of clients data for banks; book composition of directories and dictionaries; payroll; hospital packages / - / - / C14

National Physical Laboratory, Mathematics Div., Teddington, Middx, England / digital computing service / DESCR: specialists in numerical analysis, including problems in applied mathematics and theoretical physics; data processing / - / - / C14

Philbrick Researches, Inc., 34 Allied Drive at Route 128, Dedham, Mass. 02026 / computing services / DESCR: large scale, high-speed repetitive analog computer with experienced operator / USE: available by the hour / $25 to $50 per hour / C14

Programming & Systems, Inc., 33 W. 42nd St., New York, N. Y. 10036 / consulting and computer service / DESCR: specializing in total applications from daily invoicing on / USE: all areas involved in EDP / - / C14

Randolph Computer Corp., 200 Park Ave., New York, N. Y. 10017 / short term leasing of IBM's System/360 equipment / DESCR: acquiring and leasing EDP equipment; rental charges lower than manufacturer; initial terms usually fall between 2 to 4 years; service on equipment performed by manufacturer; no charge for overtime usage / USE: alternative to user purchasing his equipment or renting directly from IBM / rental reduction 10%-15% and in many cases higher / C14

Reeves Instrument Co., 100 East Gate Blvd., Garden City, N. Y. 11532 / computation center / DESCR: complete hybrid facility for scientific computation / USE: for product analysis and systems simulation interfaced with a digital computer / depends on application / C14

Reeves Instrument Co. -- see C9

The Service Bureau Corp.

Statistical Tabulating Corp., 104 S. Michigan Ave., Chicago, Ill. 60603 / independent data-processing and computer service with nine centers located in principal cities / DESCR: IBM 1400 series card and tape; Systems/360 and Honeywell H200 tape; peripheral equipment. All phases of management control and reporting for industry, business, science and government / - / C14

Task Force, Div. of Statistical Tabulating Corp., 104 S. Michigan Ave., Chicago, Ill. 60603 / temporary personnel service; (nineteen offices in principal cities) / DESCR: offers specialized data-processing and computer personnel for temporary service -- key-punch, computer and data-processing operators; programmers; methods engineers; systems analysts and mathematicians / - / C14

Telecomputations, Inc.

Merle Thomas Corp. -- see C15

U. S. Navy Marine Engineering Lab., Computer Div., Annapolis, Md. 21402 / computing services / DESCR: Equipment: IBM 360/G40; computer-oriented mathematical systems studies related to the development of advanced naval shipboard machinery, consultation, programming and data processing services / - / - / C14

URS Corp., 1811 Trousdale Drive, Burlingame, Calif. 94011 / computing services / DESCR: any system or application involving utilization and programming of electronic digital computer systems / - / - / C14

Westinghouse Electric Corp., Advanced Data Systems

Wolf Research & Development Corp., P. O. Box 36, Baker Ave., West Concord, Mass. 91781 / computing services / DESCR: digital computer operations, business and scientific programming, engineering analysis; applications in data reduction, data storage, retrieval, computer displays, computer communications; in-house H-200, CDC-G-15D, Whirlwind I / - / - / C14

C15. CONSULTING SERVICES

Advance Data Systems, 9261 W. Third St., Beverly Hills, Calif. 90213 / revenue control systems / DESCR: computer based systems for automatic collection of money and tickets involving computers, ticket readers, gates, fare vendors, money handling equipment / USE: automatic revenue collection in public transportation, distribution and entertainment fields, / varies / C15

Applied Data Research, Inc., Route 206 Center, Princeton, N. J. 08540 / management information controls / DESCR: evaluation of data processing system needs and equipment selection; review evaluation of existing installations / USE: computer users / - / C15

Auerbach Corp., 121 N. Broad St., Philadelphia, Pa. 19107 / EDP consulting services / DESCR: design, implementation of integrated data processing systems; computer system effectiveness evaluation; reliability studies; installation evaluation, recommendation; feasibility studies; programming; scientific, technical information studies / USE: management / - / C15

Booz, Allen Applied Research, Inc. -- see C14

Booz, Allen & Hamilton, Inc., 135 S. LaSalle St., Chicago, Ill. / management consulting / DESCR: feasibility studies, system design, equipment selection, implementation, systems conversion, EDP audit and review / USE: industry; commerce; banking; government; institutions / - / C15

Brandon Applied Systems, Inc., 30 E. 42nd St., 10017 / consulting services / DESCR: complete range of consulting services in data processing, including systems design, o.r. audits of installations, computer selection, feasibility analysis and implementation guidance / USE: by organizations desiring temporary highly experienced technical assistance / $80 to $275 per day / C15

Celestron Associates, Inc., 4 Broadway, Valhalla, N. Y. 10595 / EDP software scientific & business / DESCR: consulting; programming/analysis services; software; applications; design automation; automatic program translation (X-ACT System); debugging aids; automatic segmentation for multi programming / - / C15

Computer Advisors to Management (CAM), Div. of Statistical Tabulating Corp. -- see C14

Computer Applications Inc. -- see C14

Computer Associates, Inc.

Computer Fulfillment -- see C14

Computer Sciences Corp.

Control Data Corp., Control Systems Div., 4455 Miramar Rd., La Jolla, Calif. 92037 / consulting services / DESCR: electronic data processing and systems design consulting services of all kinds / - / request / C15

Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. 90804 / consulting services / DESCR: on-line control systems; hybrid simulation; digital computer software / - / $10 per hr. to $30 per hr. / C15

Cybertype Corp., 80 Fifth Ave., New York, N. Y. 10011 / consultants and engineers / DESCR: supplying computer systems, applications, programs and data processing / - / - / C15

DA-PEX Company -- see C8

Data Systems Analysts, Inc.

Design Automation, Inc., 4 Tyler Rd., Lexington, Mass. 02173 / electronics consulting / DESCR: design review of electronic equipment and circuits; consulting on design of electronic circuits and equipment / USE: to assure design will meet requirements / $15/hr. to $30/ hr. / C15

Ebasco Services, Inc., 2 Rector St., New York, N. Y. 10006 / consulting and engineering services / DESCR: systems analysis and design; commercial, scientific, engineering, EDP applications; data communications; feasability studies; plant automation; data processing and computing services / - / - / C15

Electronic Administrative Services, Inc.

Electronic Management, Computerology Corp. (EMC^2), 6900 Wisconsin Ave., Washington, D. C. 20015 / military and civilian command and control / DESCR: long range planning and prediction of functionally encompassing systems / USE: decision making for implementation and systems designs / - / C15

Entelek, Inc. -- see E2

Floating Floors, Inc., (subsidiary of National Lead Co.) -- see F2

H. J. Gruy & Associates, Inc., 2501 Cedar Springs Rd., Dallas, Tex. 75201 / petroleum engineering consulting / DESCR: methematical reservoir model simulation and computer application to all types of petroleum engineering problems, including geophysical mapping with X-Y plotter / USE: petroleum exploration, development, refining, producing / C15

HRB-Singer, Inc. -- see I1

Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / consulting services / DESCR: specialists in design, analysis, documentation and implementation of: System 360, on-line systems, message switching, PERT, PL/1, file management, command/control, synthetic intelligence / - / - / C15

Information International Inc. -- see P12

Information Processing Systems, Inc., 200 W. 57th St., New York, N. Y. 10019 / consulting services / DESCR: purchases and sales of computer systems; appraisals of value of systems owned by users / - / - / C15

Infotran, Inc., 860 Fifth Ave., New York, N. Y. 10021 / consulting services / DESCR: special purpose computers, data communications, control systems; planning, design and development of total information systems; new product development; educational services / - / - / C15

Innovation Consultants, Inc., 4 E. State St., Doylestown, Pa. 18901 / management consulting / DESCR: assistance in planning enlarged or new computer applications; cost effectiveness studies on alternatives; network scheduling / - / per diem / C15

Jonker Corp. -- see D3, P13

Jonker Corp., 26 N. Summit Ave., Gaithersburg, Md. 20760 / information retrieval systems consulting / DESCR: design of information and data retrieval systems including forms design, vocabulary development, input/ output procedures and index training / USE: to setup a total information/data retrieval program / $200 per day, travel and living expenses / C15

Keystone Computer Associates, Inc. -- see P12

Kyros Corp., P. O. 406, Madison, Wis. / consulting services / DESCR: plastics; chemical photography, high speed recording, optical computer tapes; ball point inks, marking fluids; specialty solvents, paint-removers; encapsulation of inks, adhesives, etc.; visual developers for computer tape; sensing and alarm systems for natural gas, etc. / USE: computer industry / $10 to $15/hr. / C15

Liskey Aluminum, Inc., Box 580, Glen Burnie, Md. 21061 / computer facilities design / DESCR: design and engineering services for planning and supplying computer room flooring, air conditioning and partitioning / - / - / C15

Management Systems Corp., 209 Griffin St., Dallas, Tex. 75202 / consulting services / DESCR: installation evaluation and management; feasibility studies; equipment selection; systems design; software development; personnel evaluation and selection / - / $15 and $35/per net hr. / C15

McDonnell Automation Center, Box 516, St. Louis, Mo. 63166 / consulting services / DESCR: complete automation service center, offering consulting and systems analysis for administrative and scientific applications / USE: data processing problem solving for industry, science and government / - / C15

Ray Myers Corp., 1302 E. Main St., Endicott, N. Y. 13760 / consulting services / DESCR: systems development and production programs / - / - / C15

Nash and Harrison Ltd. -- see C11

National Computer Analysts, U. S. Highway 1, Lynwood Dr., Princeton, N. J. 08540 / consulting services / DESCR: software planning (assemblers, compilers), message switching systems, commercial systems (payroll, inventory, management information), print composition systems (newspaper, books) / - / - / C15

Simon M. Newman, 1411 Hopkins St., N. W., Washington, D. C. 20036 / consulting service, documentation / DESCR: indexing and information retrieval, including application of automation to retrieval problems / - / $250 per day + expenses / C15

Profimatics, Inc.

Programmatics Inc., 12011 San Vicente Blvd., Los Angeles, Calif. 90049 / consulting services / DESCR: systems analysis and design, feasibility studies, management control systems, software design / - / - / C15

Programming Services, Inc.

Programming & Systems, Inc. -- see C14

Randolph Computer Corp. -- see C14

B. I. Savage Co., 1340 Commonwealth Ave., Boston, Mass. 02134 / consultant / DESCR: consulting services: programming --scientific and commercial; software systems development; real-time and control systems; displays and graphics; systems analysis / USE: help client with expertise or reduce his overload / - / C15

Systems Science Corp., 1104 Spring St., Silver Spring, Md.; 400 E. Third St., Bloomington, Ind. 47403 / consulting services / DESCR: specialists in real time, on-line automation of police activities; perform feasibility studies; development of hardware specifications; systems and applications; software design and programming / - / - / C15

Merle Thomas Corp., State National Bank Bldg., Suite 410, 10400 Connecticut Ave., Kensington, Md.

20795 / ADP management consultants / DESCR: application of automatic data processing to business systems; engineering applications; feasibility studies; computer center / USE: business; industry; government / - / C15

URS Corp. -- see C14, I1, O2

Westinghouse Electric Corp., Advanced Data Systems

Westinghouse Electric Corp., Electronic & Specialty Products Group

Wolf Research & Development Corp., P. O. Box 36, Baker Ave., West Concord, Mass. 91781 / consulting services / DESCR: computer and programming specialists; management analysts; applied mathematicians; physical scientists; engineers. Computer systems and applications; information systems; technical and business management; operational analysis; telemetry; data processing; scientific and engineering analysis / - / - / C15

C16. CONTROLS

General Atronics Corp. -- see C1

General Electric Co., Electronic Components Sales Operation

MICRO SWITCH, a Div. of Honeywell, 11 W. Spring St., Freeport, Ill. 61032 / controls / DESCR: Coordinated Manual Controls (CMC) multi-light, multi-circuit control devices comprised of 2¼" sq. indicator, pushbutton, selector, and selector-push units / USE: provide remote control of process operations and illuminated status feedback in data processing / - / C16

Robertshaw Controls Co., Aeronautical & Instrument Div., Santa Ana Freeway @ Euclid St., Anaheim, Calif. 92603 / automatic controls / DESCR: complete control systems; systems engineering available for one or a thousand process loops; direct digital devices offered / USE: complete automation of industrial processes / varies / C16

Scientific Data Systems, Inc. -- see C13

Waber Electronics, Inc.

C17. CONTROLS, AUTOMATIC

API Instruments Co., 7100 Wilson Mills Rd., Chesterland, Ohio 44026 / self-contained controllers, indicating panel meters / DESCR: actuated by direct unamplified signals, act as stable reference points for electronic circuitry that tends to drift / USE: to signal a deviation in computing equipment from a scheduled method of operation and to rigger corrective action when necessary / $25 to $200 / C17

Bendix Corp., Industrial Controls Div., 8880 Hubbell Ave., Detroit, Mich. / Dynapath / DESCR: a numerical control system providing continuous path control of machine tools from a punched tape input / USE: with machine tools / $35,000 to $90,000 / C17

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. 91109 / automatic control equipment / DESCR: includes chromatographs, moisture monitors, mass spectrometers, residual gas analyzers, recorders, and other instruments / USE: for controlling various chemical and petrochemical processes / - / C17

Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / electronic memory wheel / DESCR: "turns" in synchronism with p[illegible]essive assembly machines and conveyor systems / - / $3000 to $6000 / C17

General Atronics Corp. -- see C1

Hagan Controls Corp., 250 Mt. Lebanon Blvd., Pittsburgh, Pa. 15228 / automatic controls / DESCR: systems for all types of boilers, furnaces, and industrial processes; transistorized and magnetic amplifier type components are used / USE: control systems engineered for specific applications / varies with system / C17

Leeds & Northrup Co., Sumneytown Pike, North Wales, Pa. 19454 / LN 4200 computer control system / DESCR: system includes I/O, peripheral equipment, computer mainframe, auxiliary memory, control programs, as well as human engineered man/machine and man/process interface / USE: digitally directed analog control of all industrial processes and supervisory control / $200,000 to $300,000 / C17

Leeds & Northrup Co., *a / LN 4200 direct digital control / DESCR: system includes I/O, peripheral equipment, computer mainframe, auxiliary memory, control programs and human engineered man/machine and man/process interface / USE: direct digital control of all industrial processes / $150,000 to $250,000 / C17

Magnetics Inc., Butler, Pa. 16001 / 412-285-4711 / isolation amplifier / DESCR: linear, push-pull magnetic amplifier, reversible dc voltage output, powered by 3 KC square wave inverter. Fast response, excellent stability and sensitivity. Signal input isolated from output / USE: provide isolation for mv or voltage signals at high potential or remotely located to be fed into computers or other instruments / $150 to $250 / C17

Philco Corp., Communications & Electronics Div., 3900 Welsh Rd., Willow Grove, Pa. / Philco industrial control systems / DESCR: monitors production lines, records production counts, downtime, rejects, alarms and displays in case of deviation from standards / USE: on-line production control / $20,000 to $1,200,000 / C17

Robertshaw Controls Co., Aeronautical & Instrument Div. -- see C16

Transitel International Corp. -- see C7

Waber Electronics, Inc.

C18. CONTROLS, SORTING AND COUNTING

Control Equipment Corp. -- see C17

Davidson Electronic Development Co., 2211 Peninsula Dr., Erie, Pa. 16505 / component parameter controllers/testers / DESCR: over 4,000/hour automation for testing various electronic components. Also high speed (40,000/Hr.) for resistors / USE: manufacturing and testing / $2000 to $50,000 / C18

General Atronics Corp. -- see C1

Nash and Harrison Ltd. -- see C11

C19. CONVERTERS, INFORMATION

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / sample and hold units / DESCR: track analog signal and at command, hold or store the instantaneous value of an analog signal for sufficient time to record or convert the data to digital form / USE: interface between analog and digital circuits / $3000 to $50,000 / C19

Data Products Corp. -- see P8

Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / binary to decimal converter / DESCR: rack mounted solid state unit converts 19 bit binary or gray code to decimal display in degrees, minutes, seconds / USE: readout for shaft angle encoders / $8000 to $12,000 / C19

Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 751 format control buffer / DESCR: provides conversion buffering and format control to prepare blocked computer tapes from analog and asynchronous digital data / - / $20,000 to $40,000 / C19

General Electric Co., Process Computer Business Section

Giannini Scientific Corp., Flight Research Div., P. O. Box 1-F, Richmond, Va., 23201 / Mem-O-Tizer (shaft encoder) / DESCR: contains memory and high power output (200 watt) to allow direct recording of numerical data; low breakaway torque .003 inch/ounces allows installation directly to weighing systems / USE: weighing systems to provide electrical data as to automatic and computer controlled systems / $500 to $700 / C19

Straza Industries, 790 Greenfield Drive, El Cajon, Calif. 92021 / Mod. 11-64 symbol generator / DESCR: solid state character generator; 240 points resolution/char., 64 characters; 100,000 char/sec., 16 dots/char. on 15 x 16 matrix; handwired, programmed character modules / USE: input from computer; output to display / $8860 / C19

Straza Industries, *a / Mod. 14-64 symbol generator / DESCR: solid state character generator; 1000 points resolution/char., 63 characters; 200,000 characters/sec., stroke characters; 2 sizes, interchangeable character modules / USE: input from computer; output to display / $6150 / C19

Texas Instruments Inc., Industrial Products Group, 3609 Buffalo Speedway, Houston, Tex. 77006 / data acquisition equipment / DESCR: A-D, D-A converters and multiplexers for high-speed, high-accuracy data processing / USE: industrial, military data processing applications / - / C19

Trak Electronics Co., Inc., 59 Danbury Rd., Wilton, Conn. 06897 / DIGI-STORE asynchronous magnetic tape read-write unit / DESCR: bi-directional, read/write mode, asynchronous speeds to 333 char/sec. (3330 wpm); functional replacement for paper tape punch and tape reader; parallel-to-serial or serial-to-parallel logic; modular construction permits variety of configurations / USE: input/output; data recorder; message storage; editing system / $3300 up / C19

C20. CONVERTERS, INFORMATION, ANALOG TO DIGITAL

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / VOLDICON voltage digitizers / DESCR: analog-to-digital converters; 10khz to 1 mhz word rate, 11- to 15-bit resolution, binary or BCD output, 1 to 100 volt input / - / $3500 to $7000 / C20

Burr-Brown Research Corp. -- see C19

CAE Industries Ltd., P. O. Box 6166, Montreal 3, Quebec, Canada / telepath A/D converters / DESCR: convert low and high level analog input to a digital equivalent in binary or telegraph codes; scanner available to sample multiple inputs / USE: interface between analog input to digital input for on-line or direct read-out / $1500 to $2500 / C20

Clifton Precision Products, Div. of Litton Industries

Control Data Corp.

Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / Series 3030 A/D converters / DESCR: solid-state; ± 0.1% accuracy and stability; conversion rates to 40Kc; automatic bipolar operation; 1-volt, 10-volt, 100-volt ranges; 10 binary bits plus sign, or 3 decimal digits plus sign / - / $1500 to $3000 / C20

Digital Electronics Inc., 2200 Shames Drive, Westbury, N. Y. 11590 / analog to digital converters / DESCR: all solid state circuitry; internal power supply / USE: general laboratory, on line data processing and educational applications / $225 to $995 / C20

Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / digital scanner and converter / DESCR: photo-electrically senses readout of dial pointer instrument and translates into digital format for computer or control system input / USE: functions in combination with precision dial-pointer instrument as a digital transducer / $2000 to $3000 / C20

Electronic Development Corp., 423 West Broadway, So. Boston, Mass. 02127 / voltage digitizers / DESCR: voltage to digital converters (decimal and binary); 20,000 complete measurements per second. Digital comparitor function (limit testing), serializer function and verification built in / USE: data acquisition, alarm scanning to computer, or magnetic tape, or paper tape, etc. / $3485 to $4485 / C20

Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 760 analog to digital converter / DESCR: up to 14 bits binary or 4 BCD digits and sign at conversion speeds of 33,000 per second / - / $2500 to $3700 / C20

Electronic Engineering Co. of Calif., *a / EECO 761 analog to digital converter / DESCR: up to 11 bits binary or 3 BCD digits at conversion speeds of 12,000 per second. Sample and hold - 100 megohm input / - / $1500 to $2000 / C20

Electronic Engineering Co. of Calif., *a / EECO 762 multichannel ADC / DESCR: up to 100 analog channels input and 4 decimal digits output in a single chassis / - / $3300 to $4600 / C20

Encoder Div., Litton Precision Products, Inc., 7942 Woodley Ave., Van Nuys, Calif. 91406 / shaft to digital encoders / DESCR: optical, magnetic and contact encoders for digitizing a shaft position; output codes include self-decoded, binary, BCD, gray and V-Scan binary / USE: converting shaft position to digital format for transmission, recording or computer operation / $300 to $10,000 / C20

General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / ADAC® / DESCR: size 11 and 18 direct-drive analog to digital code converters in binary, Gray, binary decimal, cyclic binary decimal or excess 3 codes; with or without logic diodes / USE: A-D conversion in computer servos and system modules / - / C20

Giannini Scientific Corp., Flight Research Div. -- see C19

International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91502 / digital voltmeter / DESCR: analog-to-digital voltmeter using as reference source with inductive digital potentiometer / USE: digital display or programmer reading of a DC voltage level of 10 uvolt to 1000 volts / - / C20

George Kelk Ltd., 48 Lesmill Rd., Don Mills, Ontario, Canada / pulse tachometer / DESCR: Moire fringe optical system to give any number of pulses up to 5000 per revolution / USE: in connection with counting type circuits / $1000 to $1500 / C20

George Kelk Ltd., *a / shaft encoder / DESCR: input is a shaft rotation, 10-100 turns for full scale output (0-999 or 0-999. at substantial power level) / USE: sensing machine settings, such as rolling mill screw downs / $2000 to $4000 / C20

North Atlantic Industries, Inc., 200 Terminal Drive, Plainview, N. Y. 11803 / resolver or synchro to digital converter / DESCR: automatically converts resolver or synchro data to digital data with resolution and accuracy to 19 bits / USE: for age, for closed loop systems / $6000 to $50,000 / C20

Pastoriza Electronics, Inc., 385 Elliot St., Newton, Mass. 02164 / ADC 10 IC / DESCR: analog to

digital converter contained on single card using integrated circuits; converts in 1/8 usec. per bit; ten bit resolution; ± 5 volts input / USE: convert voltage to binary code / $1000 to $2000 / C20
Pastoriza Electronics, Inc., *a / analog data formatter / DESCR: formats analog inputs for digital magnetic tape in IBM format; sample rates up to 100 KC; data gapped with aux-man data input / USE: prepare computer compatible tapes / $5000 to $25,000 / C20
Pastoriza Electronics, Inc., *a / sample-hold multiplexer / DESCR: analog storage device, for sampling one or many analog signals and multiplexing them; 100 KC rates, 1/10 usec operature / USE: input to analog-digital converters / $300 to $3000 / C20
Raytheon Computer, 2700 S. Fairview, Santa Ana, Calif. 92704 / multiverter / DESCR: integrated circuit multiplexer, sample and hold unit, analog-to-digital converter in single chassis; up to 96 channels of multiplexing provided; accuracy is 0.01% / USE: scientific, engineering, bio-medical, industrial data acquisition systems / $5000 to $10,000 / C20
Reeves Instrument Co. -- see C9
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / converters, analog to digital / DESCR: complete range of speeds; 11-bit to 16-bit conversion / USE: data processing or control systems / $2000 to $6000 / C20
Stellarmetrics, Inc., 210 E. Ortega St., Santa Barbara, Calif. 93101 / ADC-1 A to D converter / DESCR: solid state rack-mounted converter featuring internal sampling rates up to 25 Kc/sec., output resolution of one part in 1024, front panel digital readout / - / approximately $4000 / C20
Towson Laboratories, Inc., 3500 Parkdale Ave., Baltimore, Md. 21211 / A/D converters and multiplexers / DESCR: A/D converters, multiplexers for modular data acquisition systems. Analog to teletypewriter converters. Telemetering systems. PCM encoders. Synchro to digital and digital to synchro converters / - / $650 up / C20
Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. 01876 / special purpose digital systems / DESCR: shaft-to-digital or voltage-to-digital systems tailored to user's functional requirements. Accuracies to .05%. Output to any standard peripheral equipment / USE: for "on-line" or "off-line" recording of information which can be measured either by a rotary shaft or a voltage transducer / $6000 to $20,000 / C20
Wang Laboratories, Inc. -- see C36, D6
Wyle Labs. -- see C5

C21. CONVERTERS, INFORMATION, CARD TO MAGNETIC TAPE

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / Card-Tape System / DESCR: Models 400, 800, and 1500 (cards read per minute), converts data at twice the speed and one third the cost of previous methods; four versions available / - / $28,900 to $39,850 / C21
Ampex Corp., Computer Products Div., *a / Model MCS-2500 Combination Media-Conversion System / DESCR: converts from punched cards or paper tape to magnetic tape; 1500 cards per minute and 1000 cps from paper tape. Both systems operate completely off-line / purchase or lease / C21
Control Data Corp.
Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / TCP converters, Series 4100 / DESCR: instruments for transferring digital data between punched tape, punched cards, magnetic tape and printers; code-changing and reformatting / - / $3000 to $16,000 / C21
Cook Electric Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / converters / DESCR: card to magnetic tape; paper tape to magnetic tape; magnetic tape to magnetic tape / USE: produce computer compatible tapes / $15,000 to $19,000 / C21
Tally Corp., 1310 Mercer St., Seattle, Wash. 98109 / converters / DESCR: paper tape to magnetic tape, magnetic tape to paper tape, cards to paper or magnetic tape utilizing error checking logic to insure error free conversion / - / $5000 to $15,000 / C21

C22. CONVERTERS, INFORMATION, CARD TO PAPER TAPE

CAE Industries Ltd., P. O. Box 6166, Montreal 3, Quebec, Canada / telepath translators / DESCR: on-line--1 and 2-way code translation devices to convert 5, 8, 12 level, 2 out of 8 touch-tone codes directly from line to tape on cards / USE: interface between teleprinters, business machines, other input equipment to on-line computers / $1000 to $3000 / C22
Control Data Corp.
Control Equipment Corp. -- see C21
Digital Electronic Machines, Inc., 2130 Jefferson, Kansas City, Mo. 64108 / CTU, card to tape unit / DESCR: photoelectrically reads tab cards and transfers data to punched paper tape; interchangeability of code boards / USE: data processing / $2395 up / C22
Dura Business Machines, 32200 Stephenson Highway, Madison Heights, Mich. / Dura converters / DESCR: paper tape-to-card, card-to-paper tape and paper tape-to-paper tape / USE: converts any 5, 6, 7, 8-channel paper tape to card and vice-versa / $3250 to $7000 / C22
General Instrument Corp., Magne-Head/Systematics Div., 13040 S. Cerise Ave., Hawthorne, Calif. 90250 / K177 card to tape converter / DESCR: converts IBM cards to 5, 6, 7, or 8-channel punched tape; 20 char/sec; attaches to IBM 24 card punch / USE: card to tape conversion / $4150 (160/mo.) to $4400 ($169/mo.) / C22
Tally Corp. -- see C21

C23. CONVERTERS, INFORMATION, CODE

CAE Industries Ltd. -- see C22
Control Equipment Corp. -- see C21
Trak Electronics Co., Inc., 59 Danbury Rd., Wilton, Conn. 06897 / Morse-to-teleprinter code converter / DESCR: electronic, completely transistorized digital computer for converting Morse-code transmissions into electrical impulses that drive standard teleprinter; copies 10 to 110 wpm / USE: message handling; remote data recording / $20,000 to $40,000 / C23

C24. CONVERTERS, INFORMATION, DIGITAL TO ANALOG

The Bendix Corp., Bendix-Pacific Div., 11600 Sherman Way, Hollywood, Calif. 91605 / digital to analog converter / DESCR: 8 bit parallel binary format; word rate up to 200,000 wps provided in panel height of 8-3/4" / USE: data handling and processing systems / $4000 to $8000 / C24
CAE Industries Ltd. -- see C20
Cognitronics Corp., 549 Pleasantville Rd., Briarcliff Manor, N. Y. / "Speechmaker" systems / DESCR: digital to audio devices, operated by switch closure or binary input to select prerecorded vocabulary and compose variable messages / USE: audio alarms or audio computer output / $1000 to $25,000 / C24
Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / DA-101 D/A converter / DESCR: resistor matrix and 10 voltage-switching circuits designed to perform digital-to-analog output / - / $60 to $130 / C24
Digital Electronics Inc., 2200 Shames Dr., Westbury, N. Y. 11590 / digital to analog converter / DESCR: self powered; designed to accept up to 8 bit parallel binary input and convert to analog at a rate of up to 50kc. Compatible with other units of its kind / USE: industrial and educational applications / $149 / C24
Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 764 multi-channel D/A converter / DESCR: converts up to 36 digital signals in parallel form to analog values / - / $1500 to $5000 / C24
Engineered Electronics Co. -- see C5
General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / digital-to-analog converter / DESCR: digital output from counter is translated into dc for analog recording; storage circuits permit intermittent and continuous BCD input; converter selects any 3 consecutive columns / - / $755 to $900 / C24
North Atlantic Industries, Inc., 200 Terminal Drive, Plainview, N. Y. 11803 / digital to resolver or synchro converter / DESCR: available in 10-16 bit, binary angle or binary sin/cos input, multi-speed options, with or w/o storage registers / USE: compatible with standard general purpose computers / $2500 to $5000 / C24
Pastoriza Electronics, Inc., 385 Elliot St., Newton, Mass. 02164 / DAC 10 IC / DESCR: digital to analog converter converting 10 parallel binary bits to ± 5 volts; 1 usec settling time. Includes digital word storage / USE: display digital information / $300 to $700 / C 24
Reeves Instrument Co. -- see C9
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / converters, digital-to-analog / DESCR: 4-bit to 15-bit conversion / USE: output from digital system to analog indicating or control devices / $200 to $3500 / C24
Wang Labs. Inc. -- see C20, C36, D6
Wyle Labs. -- see C5

C25. CONVERTERS, INFORMATION, DIGITAL TO GRAPHIC

CAE Industries Ltd. -- see C20
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / Digigraphic 270 System / DESCR: converts digital information to graphic form and vice versa. Latter application involves use of special "light pen" and CRT. / USE: for advanced automated design applications / on request / C25
Data Products Corp. -- see P8
Discon Corp. -- see C19, P6
General Precision Inc., Link Group, -- see D3
LFE Electronics, 1075 Commonwealth Ave., Boston, Mass. 02215 / SM-2A / DESCR: CRT computer display; alpha-numeric and vector material; character generator generates 500,000 char. per sec. for flicker-free display / USE: display computer-stored or hot-line information for easy reference / - / C25
Stromberg-Carlson Corp., Data Products Div. -- see D3

C26. CONVERTERS, INFORMATION, GRAPHIC TO DIGITAL

Auto-trol Corp., 5566 Harlan, Arvada, Colo. 80002 / Auto-trol model 3700 digitizer / DESCR: all solid state digitizers for two and three coordinate measuring and recording. Outputs to cards, paper tape, and magnetic tape / USE: photogrammetry, geophysics, strip charts, general purpose (clothing patterns, rug patterns), prepare data for plotters and machine tool directors / $10,000 to $20,000 / C26
CALMA Co., 346 Mathew St., Santa Clara, Calif. 95050 / Model 302 analog data digitizer / DESCR: a new device for reducing analog graphical data to digital form on 7-channel, 556bpi computer-compatible magnetic tape for digital computer processing and analysis. To digitize analog graphical data directly on magnetic tape, operator simply traces the data with a movable stylus, at speeds up to 125 inches per minute / USE: to reduce such analog graphical data as oscillographic traces, oil-well logs, and instrument data films to digital form / $20,000 to $40,000 / C26
Control Data Corp., -- see C25
Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / digital coordinate reader / DESCR: photo-electric readers and linear encoder scales for accurate translation of map and chart data to magnetic tape / USE: computer processing / $120,000 to $150,000 / C26
Discon Corp. -- see C19
General Precision Inc., Link Group -- see D3
The Gerber Scientific Instrument Co., 83 Gerber Rd., South Windsor, Conn. (P. O. Box 305, Hartford, Conn.) / large area coordinate digitizer / DESCR: flat bed digitizing table; movable crosshair reticle; console with digital circuitry to output coded coordinate information / USE: convert drawings or graphical data to a coded digital output / $12,000 to $30,000 / C26

C27. CONVERTERS, INFORMATION, MAGNETIC TAPE TO CARD

Control Equipment Corp. -- see C21

C28. CONVERTERS, INFORMATION, MAGNETIC TAPE TO PAPER TAPE

Control Equipment Corp. -- see C21
General Devices, Inc., Box 253, Princeton, N. J. 08540 / "DAT" tape to tape translator / DESCR: bi-directional magnetic tape to paper tape converter to handle differing input/output media and codes / USE: interchange of data by translating different codes / $17,500 to $24,750 / C28
Tally Corp. -- see C21

C29. CONVERTERS, INFORMATION, MAGNETIC TAPE TO MAGNETIC TAPE

Control Equipment Corp. -- see C21
Cook Electric Co., Data Stor Div. -- see C21
Lufkin Research Laboratories, 210 W. 131st St., Los Angeles, Calif. 90061 / tape-to-tape converter / DESCR: prepares computer compatible tapes from tape cartridges / - / - / C29
Marksmen, Inc., 21 West 10th St., Kansas City, Mo. 64105 / Electric Information Company's data collection/conversion systems / DESCR: incremental, block and digital recorders interfaced with typewriter, adding machine, badge reader and time recorder; data recorded on ¼" magnetic tape cartridges / USE: off-line data collection, alpha/numeric / $1000 hand recorder to $15,000 most sophisticated conversion unit / C29
Trak Electronics Co., Inc. -- see C19
Ultronic Systems Corp. -- see C7

C30. CONVERTERS, INFORMATION, PAPER TAPE TO CARD

CAE Industries Ltd. -- see C22
Control Equipment Corp. -- see C21
Dura Business Machines -- see C22

General Instrument Corp., Magne-Head/Systematics Div., 13040 S. Cerise Ave., Hawthorne, Calif. 90250 / C750 tape to card converter / DESCR: converts 5, 6, 7, or 8-channel punched tape to IBM cards; 20 chars/sec; attaches to IBM 24 card punch / USE: tape to card conversion / $3750 ($140/mo.) to $4000 ($149/mo.) / C30

C31. CONVERTERS, INFORMATION, PAPER TAPE TO MAGNETIC TAPE

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / Model PTS-1000 System / DESCR: converts data at half the cost of previous methods; reads 1000 char/sec from paper tape; operates completely off-line / approximately $26,800 (may be purchased or leased / C31
Control Equipment Corp. -- see C21
Cook Electric Co., Data Stor Div. -- see C21
Marksmen, Inc. -- see C29
Tally Corp. -- see C21
Trak Electronics Co., Inc. -- see C19

C32. CORES

Ferroxcube Corp., Saugerties, N. Y. 12477 / cores, planes and stacks / DESCR: cores in all sizes from 80 mils to 20 mils; wide variety of plane and stack arrays including coincident current, word select and special / USE: data storage for digital data process systems / custom design / C32
Haddonfield Research & Mfg. Co., 121 Gill Rd., Haddonfield, N. J. 08033 / cores / DESCR: 80, 50, 30, and 20 mil ferrite cores produced under controlled conditions to produce optimum parts for system application. Available in various configurations / USE: memory planes and logic applications / $5/M to $75/M / C32
Magnetics Inc., Butler, Pa. 16001 / 412-285-4711 / powder cores / DESCR: moly-permalloy powder cores manufactured in toroidal shapes ranging from .25" to 2.25" in diameter, available in permeabilities from 14 to 550 / USE: inductors requiring high Q and good temperature stability over wide temperature range / $ .25 to $8 / C32

C33. CORES, FERRITE

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / ferrite cores / DESCR: ferromagnetic memory cores / USE: computer memories and memory stacks / - / C33
Burroughs Corp., Electronic Components Div., P. O. Box 1226, Plainfield, N. J. 07061 / Ferrite cores, planes and stacks / DESCR: ferrite cores -- 20, 30, 50 and 80 mil. diameters, wide temperature and standard. Stacks and planes assembled to specification / USE: as main memory in data processing equipment / - / C33
Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif. 90250 / ferrite cores / DESCR: coincident current, word select, lithium, Isodrive(R) cores and Shmoo transfluxors in 20, 30, 50, 80, 100, 140 mil sizes / USE: commercial and military memory stacks and arrays / - / C33
Ferroxcube Corp. -- see C32
Haddonfield Research & Mfg. Co. -- see C32
Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles, Calif. / computer ferrite memory products / DESCR: core to stacks and complete memory systems; high-speed (less than one usec cycle time) systems; integrated circuit systems / USE: random-access digital data storage for data processing systems, both commercial and military applications / dependent on customer's requirements / C33

Magnetics Inc., Butler, Pa. 16001 / 412-285-4711 / ferrite cores / DESCR: ferrite pot cores, toroids, E's, I's, U's. Initial permeabilities from 100 to 2000 for operation up to 20mc / USE: inductors, pulse transformers, magnetic amplifiers / $.05 to $5.00 / C33

C34. CORES, MAGNETIC

Ampex Corp., Computer Products Div. -- see C33
Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass. / cores, magnetic / DESCR: TCM32, 5 usec, front access, 128 to 4096 word capacity, 8 to 48 bits; TCM35, silicon, 1.4 to 2 usec (coincident current, general purpose); ICM40, monolithic integrated circuitry, 1 usec full cycle / - / - / C34
Ferroxcube Corp. -- see C32
Haddonfield Research & Mfg. Co. -- see C32
Lockheed Electronics Co. -- see C33
Magnetics Inc., Butler, Pa. 16001 / 412-285-4711 / tape wound cores / DESCR: strip wound toroidal cores made with high permeability nickle-iron alloys .014" to .000125" thickness / USE: transformers, magnetic amplifiers, inductors, memory elements / $.50 to $20 / C34

C35. COUNTERS

Veeder-Root, 70 Sargeant St., Hartford, Conn. 06102 / series 1770 electric counter / DESCR: miniature, rear or panel mounting, low power requirements, high count speed (1000 cpm), reset or non-reset models / USE: count accumulation in data processing equipment / $8.61 to $20.70 / C35
Veeder-Root, *a / series 1951 high speed electric counter / DESCR: high speed (ac or dc, 3000 cpm), compact, long service life (100 million counts). Reset options: pushbutton, electrical, electrical/manual, non-reset / USE: high speed count accumulation in data processing systems / $22.19 to $51.70 / C35
Veeder-Root, *a / series 1969 Veeder DECADE / DESCR: electro-magnetic single wheel counting device with electric reset, readout and transfer / USE: high speed count accumulation, storage and transfer in data processing systems / $13 to $22.25 / C 35

C36. COUNTERS, ELECTRONIC

Burroughs Corp., Electronic Components Div., P. O. Box 1226, Plainfield, N. J. 07061 / uni- and bi-directional counters / DESCR: ten position ring counters with NIXIE® tube readout, 10 electrical outputs and counters are presettable and resettable / USE: as visual indication of an accumulated count / $70 / C36
Components Corp., 106 Main St., Denville, N. J. 07834 / DCU-100 solid state decade counter / DESCR: counter with inexpensive D'Arsonval readout; counts at rates up to 200 kc.; power requirements approximately 6V at 10 milliamps per decade -- none for readout / - / $50 (quantity discounts available) / C36
Electron Ohio, Inc., 1278 W. 9th St., Cleveland, Ohio 44113 / counters, mechanical and electronic / DESCR: reset, predetermining, length measuring; high speed electro-mechanical / USE: record motion, impulses, length / $10 to $50 / C36
Engineered Electronics Co. -- see C5
General Atronics Corp. -- see C1
General Electric Co., Electronic Components Sales Operation
General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / DELSIN Ⓣ C70 8753 Series / DESCR: digital electroluminescent solid state indicator modules: numeric and alpha-numeric readouts. Multi-digit displays use multiplexed logic input. Accepts BCD data directly from computer / USE: matched computer digital interface for mapping, cockpit, or plotting board displays, remote readouts / - / C36
General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / electronic counters / DESCR: cumulative count, frequency, period, or ratio measurements can be made from dc to radio frequencies / - / $995 to $3145 / C36
Janus Control Corp., 296 Newton St., Waltham, Mass. 02154 / electronic decade and instrument counters and counter-related products; numerical displays with and without latching / DESCR: high-speed, low-cost, integrated circuit and discrete component counters available as modules and complete functional instruments / USE: industrial and military applications / $40 to $2000 / C36
Texas Instruments, Inc., SemiConductor-Components Div., P. O. Box 5012, Dallas, Tex. 75222 / series 51/51R counters / DESCR: RCTL digital semiconductor networks featuring low power drain (2mW at 3V), 300 ns propagation delay, and fanout from 4 to 20; operating at temperatures from -55° to +125° C. / USE: missile and space applications where size weight and reliability are critical / $28 to $36 / C36
Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. 01876 / transistorized electronic counters / DESCR: universal, preset, and bidirectional; measure speed, frequency, ratio, draw, period, time interval, batch control, machine tool position, etc. / USE: tailored to requirements for industrial applications / $750 to $2000 / C36
Wang Laboratories, Inc. -- see D6
Wyle Labs. -- see C5

C37. COUNTERS, MECHANICAL

Electron Ohio, Inc. -- see C36
West Eleven, Inc., 11836 San Vecente Blvd., Los Angeles, Calif. 90049 / SARCEM, elapsed time indicator / DESCR: small, low-cost in-line electrical time; continuous elapsed/in-operation time check of any 100 volt 50-60 cycle equipment / - / $5 to $7.50 / C37
Whittaker Corp., Technical Products Div., 9601 Canoga Ave., Chatsworth, Calif. 91311 / electromechanical counter / DESCR: bi-directional and accurately record 15,000 counts per minute. Visual or switch readout available with either mechanical or electrical reset / - / - / C37

C38. COURSES BY MAIL (COMPUTER FIELD)

Bonner & Moore Associates, Inc. -- see I1, P12
Entelek, Inc., 42 Pleasant St., Newburyport, Mass. 01950 / programmed instruction / DESCR: 4 programmed instruction courses in computer-based planning (PERT), inventory control and forecasting / - / $27.50 to $47.50 / C38
Entelek, Inc. -- see E2
Institute for Computing Sciences -- see E2
International Accountants Society, Inc., Business Electronics Div., 209 W. Jackson Blvd., Chicago, Ill. 60606 / home study courses on programming business computers / DESCR: study of computer programming with particular attention to business application / USE: by individuals and companies in training computer programming personnel / $285 (10% discount allowed companies enrolling 5 or more at one time) / C38

D1 DATA PROCESSING ACCESSORY EQUIPMENT

The Bunker-Ramo Corp., 277 Park Ave., New York, N.Y. 10017 / bank teller machine, Teleregister Mark I / DESCR: direct--connected to any modern computer; transaction processed and recorded by central processor; records continually updated and instantly retrievable; on-line operation / USE: banks; savings, mortgage and loan transactions / $8200 plus / D1
The Bunker-Ramo Corp., *a / BR-90 visual analysis console / DESCR: displays visual data on CRT screen: computer input; operator input from keyboard, from light pencil; projected image from rear port in CRT / USE: superimpose and update digital data on maps and charts / $100,000 plus / D1
The Bunker-Ramo Corp. -- see C7
CAE Industries Ltd. -- see C7
California Computer Products, Inc., 305 N. Muller St., Anaheim, Calif. 92803 / digital plotters / DESCR: 8 basic models for computer controlled preparation of quality ink-on-paper graphic presentations; suitable for on-line or off-line operation / USE: to present digital computer output in pictorial or graphic form / $5000 to $50,000 / D1
California Computer Products, Inc., *a / digital plotting systems / DESCR: off-line digital plotting capability and can drive both 500 and 700 series plotters / USE: for low-speed reading of standard format tape to operate the digital plotters / $15,000 to $35,000 / D1
Camwil, Inc., 11821 Pico Blvd., Los Angeles, Calif. 90064 / special type heads for IBM selectric mechanisms / DESCR: computer and teletype codes; foreign languages; mathematical, chemical and electronic symbols. Type heads prepared to suit customer requirements / USE: in all equipment which incorporates the IBM selectric typing mechanism / $35 to $3000 / D1
Cohu Electronics, Inc., Box 623, San Diego, Calif. 92112 / 490 series digital coupler / DESCR: recording device for use with DVM/ratiometer. Actuates adding machine to record completed voltmeter readings; operates most 10-key office adding machines to produce permanent printed record of voltmeter readings / USE: on the production line, in the repair shop, general laboratory and industrial data logging / $795 / D1
Cohu Electronics, Inc., *a / 510 series DVM/ratiometer / DESCR: 4-digit, lightweight unit, 1 control for range and function; bidirectional tracking logic; high input resistance / USE: reads voltages or ratios: laboratory, bench or assembly line / $995 to $1385 / D1
Control Data Corp. -- see D4
Cook Electric Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / recorder / DESCR: data processing accessory equipment and data recording equipment / USE: data systems / $4000 to $20,000 / D1
DA-PEX Company -- see C8
Data Trends, Inc.
Digital Devices -- see D5
Digital Electronic Machines, Inc., 2130 Jefferson, Kansas City, Mo. 64108 / TPU, tape preparation unit / DESCR: keyboard input converted to punched paper tape and/or printed tape listing / USE: data gathering for computer input / $1850 up / D1
Digitronics Corp., 1 Albertson Ave., Albertson, L.I., N.Y. 11507 / DATA-VERTER / DESCR: a source data acquisition and transmission system / USE: to collect information for inventory control, data collection, warehousing, stocking, etc. / $1495 to $1875 / D1
Digitronics Corp., *a / paper tape readers and handlers / DESCR: reads and transports all levels

of paper or mylar punched tape / USE: input to computer or automated control systems / $295 to $5890 / D1
Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / data minimizer / DESCR: data processing unit approximates any input function by a series of linear functions or straight line segments / USE: pre-processing analog or digital data to conserve computer time and storage requirements / $40,000 to $50,000 / D1
Dresser Products, Inc., 112-114 Baker St., Providence, R.I. 02905 / #5110 splicer / DESCR: portable splicer, weight 5 lbs. Once placed on splicer, tapes can be joined, looped or repaired without being touched by hand until splice is complete / USE: splicing punched paper tapes / $148 / D1
Electron Ohio, Inc., 1278 W. 9th St., Cleveland, Ohio 44113 / magnetic drum / DESCR: medium speed delays from users to several hours; used as program storage; flux responsive heads read out at rest; solid state electronics; "out-of-contact" recording / USE: industrial control purposes; sorting, inspection, control systems / $1000 to $20,000 / D1
Electron Ohio, Inc. -- see C7
General Devices, Inc., Box 253, Princeton, N.J. 08540 / "DAN" data acquisition system / DESCR: PCM programmers and multiplexing systems; up to 90 channels into digital words of 10 data bits plus sign, etc. / USE: time division multiplexes / $9500 to $14,790 / D1
General Electric Co., Process Computer Business Section
General Instrument Corp., Defense & Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N.Y. 11802 / data processing equipment / DESCR: data acquisition processing, storage and display; overall system design and programming for on and off line computers, sensors and output devices / USE: variety of information handling systems involving analog and digital processes / various / D1
Allen Hollander Co., Inc.
Houston Fearless Corp. -- See I2
Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / Model TTR-200 typewriter transmitter/receiver / DESCR: adapted for use as an I/O device; 15.5 char/sec; machine function plus optional functional switches / USE: entry and receiving device for data processing / $1840 unit price / D1
Invac Corp. -- see T9, T10, T7, K1
Kyros Corp., P.O. 406, Madison, Wis. / Kysolve solvents / DESCR: to "strip" computer tape coatings and to combine visual with magnetic bits on the same tape / USE: can be tailored to specific problems / $1.50 per pt. to $4.50 per gal. / D1
Liskey Aluminum, Inc., Box 580, Glen Burnie, Md. 21061 / Data-Aire / DESCR: modular, air conditioning, packaged units; engineering and installation specialist services provided / USE: controlling special computer room environmental conditions / - / D1
Liskey Aluminum, Inc., *a / Spacemaker / DESCR: moveable office partitions, sound and dust proof / USE: computer room and general offices / - / D1
Missouri Research Laboratories, Inc., 2109 Locust St., St. Louis, Mo. 63103 / Model 131 digital address selector / DESCR: selects and decodes addresses to provide read commands; features thumbwheel selection of binary or BCD addresses up to 22 bits / USE: PCM telemetry address and data pickoff, ground station selection computer testing, selection of discrete data for readout / $1500 / D1
Missouri Research Laboratories, Inc., *a / Model 160A universal logic translator / DESCR: provides logic level translation and/or inversion with driven outputs available. Capable of translating up to 30 channels and inverting up to 15 channels / USE: interface for incompatible digital equipments / $550 to $1050 / D1
Monarch Metal Products, Inc., MacArthur Ave., New Windsor, N.Y. 12550 / data processing accessory equipment / DESCR: items for the filing, sorting, storage and moving of punched cards, control panels, disk packs and magnetic tape reels / USE: filing, storage and transportation of punch cards, control panels, disk packs and magnetic tape reels / - / D1
Ray Myers Corp., 1302 E. Main St., Endicott, N. Y. 13760 / data processing accessory equipment / DESCR: mobile and fixed equipment / USE: storage and processing / - / D1
National Blank Book Co., Water St., Holyoke, Mass. 01040 / data binders / DESCR: binders for housing data processing forms with unbreakable cable flexible posts; six styles / USE: loose leaf binding of tabulating forms / 50¢ to $7.50 / D1
National Blank Book Co., *a / perforator tape / DESCR: paper tape for communications, readers and perforators, data collection, control equipment and converters; available in 5, 6 or 7 and 8 channels, oiled and unoiled / USE: transmitting information and converting tapes to cards / priced per roll / D1
Ohio Envelope Co., Box 19086, Cincinnati, Ohio 45219 / file folders and filing supplies / DESCR: file folders and filing supplies for storage of paper, tape and other EDT information / - / custom made / D1
Photon, Inc., 355 Middlesex Ave., Wilmington, Mass. 01887 / phototypesetting machines / DESCR: computer-driven off-line, print-out and phototypesetting machines using either paper or magnetic tape input / USE: as computer printout system; as automated typesetting / $15,000 to $295,000 / D1
Potter Instrument Co., Inc.
Robbins Data Devices, Inc., 15-58 127th St., Flushing, N.Y. / data processing accessories / DESCR: splicers, encoders, winders, reels, centerfeed unwinders, unwind cans, data tape holders, punched tape folders and envelopes, mailing boxes, bulk tape erasors, splicing patches / USE: editing, storing, winding and unwinding of tape / $15 to $400 / D1
Scientific Data Systems, Inc. -- see C13
Lear Siegler, Inc., Power Equipment Div. -- see C13
TAB Products Co., 550 Montgomery St., San Francisco, Calif. 94216 / data processing auxiliary equipment; computer room equipment / DESCR: card files, open reference files, storaways, trucks, unit spacefinder card files, control panel cabinets; tape reel racks, tape cabinets, disc pack racks, disc pack cabinets, trucks, forms handling equipment/ USE: storage and handling of data processing and computer room materials / wide / D1
Trak Electronics Co., Inc. -- see C19
Weber Electronics, Inc.
Wheeldex, Inc. -- See F4, P14, Te, T8
Wright Line Division Barry Wright Corp., 160 Gold Star Blvd., Worcester, Mass. 01606 / disk pack storage / DESCR: 4" and 6" thickness can be stored in any of 6 available models; four have work surface tops; all equipment has full-suspension drawers / USE: storage of disk packs / varies / D1
Wyle Labs -- See C10

D2. DATA PROCESSING MACHINERY (SEE ALSO SPECIFIC TYPES)

Ampex Corp., Computer Products Div. -- see C21, C31
Bell Telephone Mfg. Co., Automation Systems Div., Berkenrodelei 33, Hoboken, Belgium / "Jacketing System" document handling system / DESCR: based on the use of a mylar jacket which is a reusable document and information carrier / - / - / D2
Bell Telephone Mfg. Co., Automation Systems Div., *a / mailhandling equipment and postal automation systems / DESCR: automatic and semi-automatic letter sorters as well as indexing desks destined to automate mail handling / - / - / D2
The Bunker-Ramo Corp. -- see C7, D1
Control Data Corp. -- see D4
Dura Business Machines, 32200 Stephenson Highway, Madison Heights, Mich. / Dura MACH 10 automatic typewriters / DESCR: punched paper tape/edge card, "selectric" or binary code, special code models available, speed 15.4 c.p.s. Auxiliary equipment including punches/ readers edit control / USE: repetitive writing applications, data preparation for input, systems applications / $2810 to $5000 / D2
Dymec Div. of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. 94306 / digital data plotting systems / DESCR: systems accept digital data on magnetic tape, punched card or tape and reduce to X-Y smooth curve or point plot / USE: data plotting applications / $7000 to $14,000 / D2
Friden, Inc., a subsidiary of the Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / 5010 Computyper* electronic billing accounting machine / DESCR: produces completed invoices at electronic speeds; stores numbers; performs calculations in milliseconds; equipped with a removable program panel. *trademark / USE: for billing and accounting / $6000 to $7000 / D2
Friden, Inc., a subsidiary of The Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / FLEXOWRITER(TM) automatic writing machine / DESCR: produces business documents and simultaneously punches tape or cards. With some models, changing program panels, means changing machine functions. Up to 145 words per minute / USE: purchase orders, letter writing, personnel records, sales and production orders, legal documents, etc. / $2400 to $4600 / D2
General Electric Co., Process Computer Business Section
Geo Space Corp., 5803 Glenmont Drive, Houston, Tex. / ADA-200 seismic data conversion system / DESCR: analog to digital to analog magnetic tape; operates in real time; digitizes up to 29 channels of analog data simultaneously / USE: convert and playback seismic data / - / D2
Honeywell, Inc., Electronic Data Processing Div. -- see P9, P15, R9, S5, T1
International Computers and Tabulators Ltd., I.C.T. House, Putney, London S.W. 15, U.K. / computer systems and O.E.M. products / DESCR: I.C.T. 1900 series of digital computers and O.E.M. peripheral and ancillary equipment / - / - / D2
Omni-Data, Div. of Borg-Warner Corp. -- see P10
Potter Instrument Co., Inc.
Recognition Equipment Inc., 4703 Ross Ave., Dallas Tex. 75204 / electronic retina computing reader / DESCR: general purpose optical character recognition system; reads printed or typewritten information, eliminates need for data conversion methods such as keypunching / USE: automates input to computers / $600,000 to $750,000 / D2
Societe d'Electronique D'Automatisme
Teletype Corp.

D3. DATA RECORDING EQUIPMENT

Addo-X, Inc., 845 Third Ave., New York, N.Y. 10022 / Addo-X data capture & control / DESCR: 10-key shuttle carriage adding-bookkeeping machines linked to Addo-X program controlled tape punches and IBM card punches; digit verifier Mod. 7-11 / - / - / D3
Addo-X, Inc., *a / Addo-X 990 key data collection system / DESCR: high speed key operated. Each key encoded with discrete number. Numbers are transmitted from remote stations to central data collection station / USE: attendance recording; job recording; production control / - / D3
Addo-X, Inc. -- see A1
Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / Model ATM-13 digital tape recorder / DESCR: airborne and portable; produces recorded data blocks immediately compatible with computers, needing no intermediate processing / USE: reconnaissance, geophysical and similar applications / - / D3
Ampex Corp., Instrumentation Div., 401 Broadway, Redwood City, Calif. 94063 / Model CDR tape recorder / DESCR: digital cartridge tape recorder / USE: commercial and industrial / - / D3
Ampex Corp., Instrumentation Div., *a / Models DAS-100 and SP-300 instrumentation tape recorders / - / USE: medical and industrial data / - / D3
Ampex Corp., Instrumentation Div., *a / Model FR-900 tape recorder / DESCR: rotary head, 5.0 MHz instrumentation tape recorder / USE: for radar recording / - / D3
Ampex Corp., Instrumentation Div., *a / Models FR-1800 (1.5 MHz) and FR-1600 (2.0 MHz) tape recorders / DESCR: instrumentation tape recorders / USE: telemetry and laboratory test data / - / D3
Ampex Corp., Research Div., Redwood City, Calif. 94063 / recording systems / DESCR: electron beam recording systems development / - / - / D3
Ampex Corp. -- see I2 and T1
The Bristol Co., Waterbury, Conn. 06720 / data recording / DESCR: electronic, electrical and mechanical equipment for analog and digital data; chart recorders, logging and printout / USE: process, utility and pipeline applications / $150 to $2000 / D3
Connecticut Technical Corp., 3000 Main St., Hartford, Conn., 06120 / digital printers / DESCR: tape listing (numeric) printers, data logging typewriters; single line or coded input / USE: instrumentation, data logging and process control printout / $250 to $1000 / D3
Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. 91109 / data recorders / DESCR: include several types of recording oscillographs, strip-chart recorders, magnetic tape recorder/ reproducers, indicating controllers, vibration monitors, and other instruments / USE: for recording data / - / D3
Control Logic, Inc. -- see C10
Cook Electric Co., Data Stor Div. -- see D1
Dennison Manufacturing Co., Framingham, Mass. / print-punch marking machines / DESCR: prints and punches simultaneously up to 320 control tickets per minute; may be converted into punch-cards, paper tape and/or magnetic tape / USE:

inventory control, retail price ticket, production control / $69 (monthly rental) to $115 (monthly rental) / D3

DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / series "N" and "DL" lister/printers / DESCR: high speed lister/printer handles numeric printout (2400 lines/min.) and alphanumeric printout (1200 lines/min.); expandable in 4 column increments to 16 columns (series "DL") and 32 columns (series "N") / USE: listing, data logging, DVM printout, addressing, computer output printing / $3000 to $10,000 / D3

Electron Ohio, Inc. -- see C7

Electronic Development Corp., 423 West Broadway, So. Boston, Mass. 02127 / 423 data logging systems / DESCR: data acquisition and alarm scanning systems accepting up to 1200 inputs and producing typewriter and punched tape outputs / USE: will record and limit test temperatures, flows, pressure, etc. / $14,500 to $25,000 / D3

Electronic Engineering Co. of Calif., P.O. Box 58, Santa Ana, Calif. 92702 / EECO 755 data recording system / DESCR: digitizes up to 200 analog inputs and records on magnetic tape in IBM format / - / $8500 to $25,000 / D3

General Precision Inc., Link Group, Colesville Rd., Binghamton, N.Y. 13902 / waveform display analyzer / DESCR: computer aided film scanning and recording display device / USE: digital to graphic and graphic to digital conversion, data recording and film readout / varies / D3

Giannini Scientific Corp., Flight Research Div. -- see C1

Hagan Controls Corp., 250 Mt. Lebanon Blvd., Pittsburgh, Pa. 15228 / marine data logger / DESCR: digital data recording system consisting of operators console, two printers and one modular constructed floor cabinet; solid state circuits and printed circuit boards / USE: continuous monitoring of pressures, temperatures, etc. / $50,000 and up / D3

Hagan Controls Corp., *a / Optimac recorder / DESCR: measures up to four electrical inputs, records them on vertical moving strip chart; use cartridge type capillary inking systems, transistorized circuit amplifiers, easily removable chassis / USE: to record process variables which have been converted into analog dc currents and voltages / $315 to $820 / D3

Jonker Corp., 26 N. Summit Ave., Gaithersburg, Md. 20760 / Termatrex / DESCR: information and/or data retrieval system; uses optical coincidence cards to store data/information / USE: retrieval of documents, engineering drawings and data, personnel, chemical compounds, etc. / $5000 to $35,000 / D3

Jonker Corp. -- see C15, P13

Marksmen, Inc. -- see C29

Potter Instrument Co., Inc.

The Standard Register Co., Dayton, Ohio 45401 / source record punch / DESCR: desk-size electronic data collecting unit for recording information both printed form and key-punched code simultaneously on ZIP-CARDS (tab card unit sets); several models available / USE: recording hospital charges at source; production and inventory control in industry / - / D3

Straza Industries, 790 Greenfield Drive, El Cajon, Calif. / Mod. 1201 microfilm printer/plotter / DESCR: converts computer output to alphanumeric and graphic information; 62,500 char/sec - 10,000 vectors/sec 64 or 128 characters; 35 mm or 16 mm camera - hard copy camera, forms projector / USE: on-line or off-line, BCD or binary / $120,000 to $160,000 / D3

Straza Industries, *a / Mod. 1311 display/printer / DESCR: converts computer output to alpha-numeric and graphic information; 30,000 char/sec., 10,000 vectors/sec.; 35 or 16 mm camera; 16" display tube; light pen; keyboard / USE: on line, BCD or binary / $45,000 to $65,000 / D3

Stromberg-Carlson Corp., Data Products Div., P.O. Box 2449, San Diego, Calif. 92112 / S-C 4020 computer recorder / DESCR: operates on-line with a computer or accepts digital magnetic tape signals and converts binary or BCD codes into combinations of alphanumeric printing, curve plotting and line drawings / USE: converting computer data to graphs, plots, charts, maps on microfilm, movie film, hard copy / $150,000 to $200,000 / D3

Stromberg-Carlson Corp., Data Products Div., *a / S-C 4400 computer document recorder / DESCR: records alphanumeric output directly from computer or computer-generated tapes onto 16mm microfilm. Option permits production of 35mm film for aperture card filing systems / USE: automated and semi-automated storage and retrieval systems / $80,000 to $100,000 / D3

Trak Electronics Co., Inc. -- see C19

Paul G. Wagner Co. -- see P15

Wang Labs, Inc. -- see C20, C36, D6

D4. DATA REDUCTION EQUIPMENT

Adage, Inc. -- see C11

Control Data Corp., 8100 34th Ave., So., Minneapolis, Minn. 55440 / data reduction equipment / DESCR: a complete line of peripheral equipment for use with digital and hybrid computer systems / - / - / D4

Control Logic, Inc. -- see C10

The Gerber Scientific Instrument Co., 83 Gerber Rd., South Windsor, Conn. (P.O. Box 305, Hartford, Conn.) / data reduction equipment / DESCR: X and Y reading heads; back-lighted work surfaces; chart spooling equipment / USE: converts graphical analog data to a printed or coded form / $3000 to $25,000 / D4

Stromberg-Carlson Corp., Data Products Div. -- see D3

D5. DELAY LINES (COMPUTER TAPE)

Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn. / delay memories / DESCR: magnetostrictive delay memories; digital glass memories / USE: buffer memories / $75 to $500 / D5

Columbia Technical Corp., 50 St. at 25 Ave., Woodside, N.Y. 11377 / delay lines (computer types) / DESCR: electromagnetic networks of lumped constant and distributed constant types, of fixed or variable delays / USE: as information storage / $10 to $100 / D5

Cornell-Dubilier Electronics Div. Federal Pacific Electric Co., 50 Paris St., Newark, N.J. 07101 / delay lines / DESCR: custom designed delay lines -- engineered lumped constant to meet requirements of computers / USE: in pulse equipment / - / D5

Digital Devices, Inc., 200 Michael Dr., Syosset, L.I., N.Y. / delay lines / DESCR: magnetostrictive delay lines and computer memory systems / USE: computer memories, data storage / $30 to $30,000 (systems) / D5

EL-RAD Manufacturing Co., 4300 N. California Ave., Chicago, Ill. 60618 / delay lines / DESCR: units for both conventional wiring and printed circuit applications. Hermetically sealed or epoxy encapsulated construction / USE: in timing and sync circuits, and phase shifting of sine waves / $1.50 to $250 / D5

General Instrument Corp., Defense and Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N.Y. 11802 / delay lines / DESCR: magnetostrictive, longitudinal and torsional delay lines for digital and analog computers / USE: computers, coders and decoders, simulators, missiles and aircraft / $100 to $3000 / D5

Technitrol Inc., 1952 E. Allegheny Ave., Philadelphia, Pa. 19134 / electro-magnetic delay lines / DESCR: lumped and distributed constant; 5ms to 10 ms delay. Impedance 50 to 2000 ohms. Tapped and programmable / - / $1 to $15 / D5

D6. DESK CALCULATORS

Friden, Inc., a subsidiary of The Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / 132 electronic calculator / DESCR: same as 130 electronic calculator with addition of automatic square root / USE: scientific and engineering calculations / $1950 / D6

Friden, Inc., a subsidiary of The Singer Co., *a / rotary desk calculators / DESCR: complete line featuring models with short-cut multiplication, automatic squaring and square root, separate multiplier keyboard, tough-one-key division and fast chain multiplication / USE: scientific, business and engineering calculations / $300 to $1400 / D6

Friden, Inc., a subsidiary of The Singer Co., *a / 130 electronic calculator / DESCR: desk size; gives answers in milliseconds; entries and answers on cathode ray tube screen; automatic transfer of intermediate answers / USE: business, scientific and engineering calculations / $2150 / D6

Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. 01876 / Wang 300 series electronic desk calculators / DESCR: feature single electronics packages with up to four satellite keyboards. Large numerals, duplex operations, exclusive "phantom touch" keys, square, square root, e^x and lnx. / USE: business, statistical, and scientific calculations / $1690 to $5130 / D6

Wang Laboratories, Inc. -- see C10, C36

Wyle Laboratories, Inc. -- see C10

D7. DIFFERENTIAL ANALYZERS

Philbrock Researches, Inc. -- see C9

D8. DISCS, MAGNETIC

Bryant Computer Products, Div. of Ex-Cell-O Corp. -- see S4

Control Data Corp.

Data Products Corp., 8535 Warner Dr., Culver City, Calif. 90321 / DISCfILES ® / DESCR: large-scale random access DISCfILES. Capacities from 200 million to 1 billion bits / USE: as part of data processing system / $50,000 to $100,000 / D8

Data Products Corp., *a / on-line DISCfILES® / DESCR: large-scale random access DISCfILES directly connected to computer systems to augment memory capacity / USE: part of a data processing system / $75,000 to $125,000 / D8

Digital Development Corp., 5575 Kearny Villa Rd., San Diego, Calif. 92123 / magnetic discs / DESCR: capacity to 250 million bits at 3600 RPM; read-write selection electronics. System capabilities--operate with standard computers. Sealed units provide maximum reliability for continuous operation and extreme environments / USE: computer memory / $10,000 to $250,000 / D8

Electron Ohio, Inc. -- see D1

Friden, Inc., a subsidiary of the Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / 6010 magnetic disc file / DESCR: operates on-line with the 6010 electronic computer; stores 122,880 alphanumeric characters; features automatic address verification and variable length data capability / USE: with 6010; storage of payroll, invoice, inventory, accounting, etc. data / $7000 to $8000 / D8

General Electric Co., Process Computer Business Section

General Instrument Corp., Magne-Head Div., 13040 S. Cerise, Hawthorne, Calif. 90250 / magnetic memory discs / DESCR: records and plays back data up to 10 million bits with median access times from 5 to 20 milliseconds / USE: inventory control, process control, communications, multiplexing, data logging, data buffer / $1500 to $13,000 / D8

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / discs, magnetic / DESCR: Rapid-Access Data (RAD) Storage System, 17-msec average access time, capacity 2.097 million char/unit. Mass Memory Disc Storage System, 162 msec average access time, capacity 67 million char/controller (up to 2 controllers) / - / $30,000 (RAD system) to $200,000 / D8

Scientific Data Systems, Inc. -- see M2

D9. DRUMS, MAGNETIC

Bryant Computer Products, Div. of Ex-Cell-O Corp. -- see S4

The Bunker-Ramo Corp. -- see C7

Control Data Corp.

Digital Development Corp., 5575 Kearny Villa Rd., San Diego, Calif. 92123 / magnetic drums / DESCR: capacity to 1024 tracks at 3600 RPM; read-write selection electronics. Sealed units. / USE: computer memory / $1000 to $40,000 / D9

Electron Ohio, Inc. -- see D1

General Electric Co., Process Computer Business Section

General Instrument Corp., Magne-Head Div., 13040 S. Cerise, Hawthorne, Calif. 90250 / magnetic memory drum / DESCR: records and plays back data up to 50 million bits with median access times from 5 to 20 milliseconds / USE: inventory control, communications, multiplexing, data logging, data buffer / $3000 to $60,000 / D9

E1. ECONOMIC RESEARCH

Bonner & Moore Associates, Inc. -- see O2

URS Corp.

E2. EDUCATION (SEE ALSO COURSES)

Aries Corp., Westgate Research Park, McLean, Va. 22101 / education / DESCR: fundamentals of data processing and programming courses in JOVIAL and other languages. Specially designed courses in programming, computer communications, and information retrieval / USE: computer training / determined by course requirements / E2

Automation Institute of America, Inc., Suite 600, 760 Market St., San Francisco, Calif. 94102 / data processing training / DESCR: courses ranging from Card Punch Operator training through Computer Programming and Systems Design -- entry skill and advancement courses / USE: individual enrollment and company sponsored programs / - / E2

Brandon Applied Systems, Inc., 30 E. 42nd St., New York, N.Y. 10017 / technical training courses / DESCR: series of 7 technical

training courses / DESCR: series of 7 technical training courses in computer field on a seminar basis, publicly and on an in-house basis. Public courses given where firm has offices / - / $75 to $175 / E2
Computer Systems Institute, Inc., 300 Sixth Ave., Suite 275, Pittsburgh, Pa. 15222 / computer programming training / DESCR: train computer programmers; graduates are capable of writing programs for RCA 301, IBM 1401 and 1410 systems; also training the visually handicapped for programming positions / USE: data processing field / $750 to $1500 / E2
Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. 90804 / education / DESCR: courses in advanced programming; combined analog-digital simulation; advanced hybrid simulation; advanced analog computation; digital simulation / - / $250 to $350 / E2
Digital Equipment Corp. -- see B2, C5
Entelek, Inc., 42 Pleasant St., Newburyport, Mass. 01950 / computer-assisted instruction / DESCR: computer-based management games / USE: remote use of time-shared computer in simulation of management decision-making / - / E2
Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / education / DESCR: System 360 training, on-line systems, executive training; presented Symposiums on Disc Files (1964), On-Line Systems (1965), and Computers/Graphic Arts, with UCLA (1966) / - / - / E2
Innovation Consultants, Inc., 4 E. State St., Doylestown, Pa. 18901 / education / DESCR: in-house and some public courses on computer applications / USE: for technically untrained top mangement / per diem / E2
Institute for Computing Sciences, Preston Forest Tower, P.O. Box 30245, Dallas, Tex. 75230 / computer programming / DESCR: comprehensive programming training (including actual computer run practice programs) designed to provide technical qualification for entry in the computer field as a programmer or system analyst / USE: initial career training / $725 to $895 / E2
Institute for Computing Sciences, *a / electronic computing for management / DESCR: management training program in the potential of electronic computing systems; course offered in resident and correspondence form / USE: management training / $325 to $360 / E2
Programming & Systems, Inc., 33 W. 42nd St., New York, N.Y. 10036 / EDP education / DESCR: complete range of EDP courses from key punching through programming of IBM 1401 and System 360 / - / $90 to $650 / E2
Scientific Educational Products, 30 E. 42nd St., New York, N.Y. 10017 / Minivac 6010 / DESCR: self instructional digital computer trainer / USE: in laboratory or classroom to teach basic concepts of digital computers, including basic logic, Boolean algebra, binary arithmetic, basic computer operations and basic switching circuitry / $285 / E2
Scientific Educational Products, *a / Nordac II / DESCR: solid state digital logic trainer / USE: to teach basic logic, Boolean algebra, and basic digital computer functions / $485 / E2
URS Corp.

F2. FLOORS

Fabri-Tek Inc., 5901 S. County Rd. 18, Box 24035, Minneapolis, Minn. 55424 / Information storage devices and related equipment / DESCR: memory systems, planes and stacks for use in electronic data processing equipment / USE: information storage devices / - / E2
Floating Floors, Inc., (subsidiary of National Lead Co.), 22 E. 42nd St., New York, N.Y. 10017 / floating floors / DESCR: steel die formed panels -- extra strong design eliminates need of stringers for support. Treated with rust prevention paint, also electrically conductive / USE: computer room floors, general construction / $3 to $4 one sq. ft. installed / F2
Floating Floors, Inc., (subsidiary of National Lead Co.), *a / floating floors / DESCR: aluminum die cast panels, lightweight, stronger than steel, specially designed pedestal prevents any lateral movement of panels. No danger of rust, easily grounded electrically / USE: computer room floors, general construction / $4 to $5 one sq. ft. installed / F2
Liskey Aluminum, Inc., Box 580, Glen Burnie, Md. 21061 / Elaflor / DESCR: raised flooring / USE: computer and general purpose office spaces / - / F2

F3. FORMS, CONTINUOUS

Allied/Egry Business Systems, Inc., 429 East Monument Ave., Dayton, Ohio 45402 / continuous forms / DESCR: continuous, marginally-punched, carbon interleaved forms, stock, imprinted and custom / - / - / F3
Automated Business Forms Corp., 24 Forge St., Jamesburg, N.J. / continuous tabulating forms / DESCR: stock, imprinted and custom made continuous forms / USE: tabulators and computers / competitively priced / F3
Baltimore Business Forms, Inc.
Columbia Ribbon & Carbon Mfg. Co., Herb Hill Rd., Glen Cove, N.Y. / Colitho continuous offset forms / DESCR: offset duplicating plates in continuous form / USE: on tabulators, high speed printers where extra copies are required / - / F3
Columbia Ribbon & Carbon Mfg. Co., *a / ready master forms / DESCR: spirit duplicating masters in continuous form / USE: on tabulators, high speed printers where extra copies are required / - / F3
Essex Systems Co., Inc., 40 E. 49th St., New York, N.Y. 10017 / continuous tabulating forms / DESCR: stock, imprinted and custom made continuous forms / USE: tabulators and computers / competitively priced / F3
Philip Hano Co., Inc., 85 Sargeant St., Holyoke, Mass. 01040 / continuous forms marginally punched / DESCR: custom, standard, stock tab, tab imprints; production lithographed; stapled, pasted and crimped fastening / USE: typewriters, bookkeeping machines, electronic computers, data processing machines / - / F3
The Standard Register Co., Dayton, Ohio 45401 / business forms, continuous / DESCR: tailor-made and stock forms, continuous, marginally punched, various sizes, piles, with one-time carbons and carbonless papers / - / variable / F3
Transkrit Corp., 704 Broadway, New York, N.Y. 10003 / "Transkrit" forms / DESCR: continuous forms or unit sets using "Transkrit" hot wax spot carbonizing / - / available thru business forms dealers or printers only / F3
Wheeldex, Inc., 1000 No. Division St., Peekskill, N.Y. 10567 / continuous pinfeed forms / DESCR: single or multiple width pinfeed card forms, plain, printed, corners rounded or square or other special edge or interior punching / - / - / F3

F4. FORMS HANDLING EQUIPMENT

The Acratod Co. -- see T3A
The Standard Register Co., Dayton, Ohio 45401 / forms handling equipment / DESCR: forms bursters, burster-imprinters, rotary imprinters, decollators (horizontal and A-frame), linefinder attachments for key-driven office machines, forms feeding devices / USE: whenever processed continuous forms require automatic handling to remove carbons, obtain individual documents, etc. / - / F4
TAB Products Co. -- see D1
Wheeldex, Inc., 1000 N. Division St., Peekskill, N.Y. 10567 / mechanized files and continuous pinfeed forms / DESCR: automatic pushbutton filing and storage equipment for all size records / - / - / F4

G1. GENERATORS, FUNCTION

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / function generator 1662 / DESCR: compact solid-state units offering high reliability and accuracy for a variety of signal conditioning or computing applications / USE: simulate transfer functions which cannot be handily described mathematically / $625 / G1
Datapulse Inc., Datapulse Div., 509 Hindry Ave., Inglewood, Calif. 90306 / pulse generators / DESCR: fast pulse generators with wide range repetition rates and output powers; programmed models also available / USE: design and test of pulse circuitry and systems / $345 to $1980 / G1
Elgenco, Inc.
General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / electronic function generators / DESCR: producing sine and square waves, staircase or ramp wave-forms, pulse bursts, sync signals, pedestals, doubtlets, binary digits, etc. / USE: testing electronic equipment including data handling equipment / $215 to $2500 / G1
Philbrook Researches, Inc. -- see C9

G2. GENERATORS, FUNCTION, ELECTRONIC

Adage, Inc. -- see C11
CAE Industries Ltd. -- see C7
Datapulse Inc., Datapulse Div., 509 Hindry Ave., Inglewood, Calif. 90306 / digital data generators / DESCR: off-the-shelf digital test instruments for high speed simulated serial data, serial words, and pulse programs / USE: general logic and systems development, magnetic memory and tape equipment design and test / $1720 to $6680 / G2
Elgenco, Inc.
General Computers, Inc., 5990 W. Pico Blvd., Los Angeles, Calif. 90035 / card programmed diode function generator / DESCR: any function of an independent variable, Y = f (X), is set up by inserting a prepunched card into the integral card reader of this unique DFG / USE: in analog computer or control system to generate any desired function of an independent variable / $1500 to $4000/ G2
General Radio Co. -- see G1
Texas Instruments Inc., Industrial Products Group, 3609 Buffalo Speedway, Houston, Tex. 77006 / pulse generators / DESCR: wide variety; made-to-order versatility without delivery time or price penalties/ USE: testing and design functions in many areas of science, industry, military / - / G2

G3. GENERATORS, FUNCTION, MECHANICAL

George Kelk Ltd. -- see C20

H1. INFORMATION ENGINEERING

Ampex Corp. -- see H3
Applied Magnetics Corp., 749 Ward Drive, Santa Barbara, Calif. 93105 / magnetic heads / DESCR: precision magnetic recording heads custom designed. Analog, digital, interlaced and redundant assemblies. Research, prototype development and production quantities / USE: computer and instrumentation applications / $150 to $1500 / H1
Ferroxcube Corp., Saugerties, N.Y. 12477 / recording heads / DESCR: complete multiple track recording head assemblies for drum, disc and contact recording applications to standard or customers' specifications with precisely controlled dimensional and finished tolerance / USE: recording of digital data storage on drum, disc or tape / custom design / H1
General Instrument Corp., Magne-Head Div., 13040 S. Cerise, Hawthorne, Calif. 90250 / digital tape heads / DESCR: input-output transducer for magnetic tape / USE: on any digital tape deck / $50 to $2000 / H1
Lipps, Inc., 1630 Euclid St., Santa Monica, Calif. 90404 / magnetic recording heads / DESCR: complete line of instrumentation and audio heads for professional equipment / USE: with all kinds of tape and drum recording equipment / $50 to $2000 / H1
Midwestern Instruments, Inc., Subsidiary of Tele Corp.
Norton Associates, Inc. 240 Old Country Rd., Hicksville, N.Y. 11801 / magnetic heads / DESCR: standard and special magnetic record, playback and erase heads in single and multi-track arrangements / USE: magnetic tape, film, drum, magnetic ink character recognition / wide range / H1
Pickering & Co., Inc., Sunnyside Blvd., Plainview, N.Y. 11803 / magnetic drum heads / DESCR: non-contracting for computer & data acquisition systems. Stereophonic/monophonic tape heads for OEM & commercial applcns / - / $11.95 to $34 / H1
S-I Electronics, Inc., 103 Park Ave., Nutley, N.J. 07110 / read and write heads, digital magnetic tape transport / DESCR: various head configurations for transports which can be computer compatible, IBM, UNIVAC, etc.; from 7 to 21 tracks / USE: mounted to digital magnetic tape transports for eading from or writing on digital magnetic tape / varies / H1

H2. HEADS, MAGNETIC

Applied Magnetics Corp. -- see H1
Ferroxcube Corp. -- See H1
General Instrument Corp., Magne-Head Div. -- see H1
Lipps, Inc. -- see H1
Norton Associates, Inc. -- see H1
Pickering & Co., Inc. -- see H1
S-I Electronics, Inc. -- see H1

H3. HEADS, RECORDING

Ampex Corp., Audio and Video Communications Div., Instrumentation Div., 401 Broadway, Redwood City, Calif., 94063 / recording heads / DESCR: longitudinal and rotary / USE: for Ampex videotape, instrumentation, professional audio, and digital tape recorders / - / H3
Applied Magnetics Corp. -- see H1
Ferroxcube Corp. -- see H1
General Instrument Corp., Magne-Head Div. -- see H1
Lipps, Inc. -- see H1
Norton Associates, Inc. -- see H1
Pickering & Co., Inc. -- see H1
S-I Electronics, Inc. -- See H1

I1. INFORMATION ENGINEERING

Aries Corp., Westgate Research Park, McLean, Va. 22101 / communications based management information systems / DESCR: design and implementation of financial and management information systems, which utilize communications for input and query response to remote locations on a real-time basis / USE: computerized organization management and reporting system

determined by job requirements / I1
Aries Corp., *a / information retrieval / DESCR: information retrieval analysis and programming. Development of specialized file structure design and advanced file search techniques. Thesaurus construction / USE: development of information retrieval systems / determined by job requirements / I1
Aires Corp., *a / message switching systems / DESCR: development of specialized executive programs for receipt, storage, forwarding and processing of communications message data from multiple remote locations, on a real-time basis. / USE: computer controlled communications systems / determined by job requirement / I1
Aries Corp. -- see P12
Bonner & Moore Associates, Inc., 500 Jefferson Bldg., Houston, Tex. 77002 / information systems / DESCR: general accounting; data processing; operations accounting and control; process control; inventory control; maintenance systems / USE: management / consulting or contractual basis / I1
Bonner & Moore Associates, Inc. -- see P12
Booz, Allen Applied Reserach, Inc. -- see C14, C15
The Bunker-Ramo Corp., 277 Park Ave., New York, N. Y. 10017 / electronic systems study, research, development / DESCR: real-time systems; on-line operation / USE: business; industry; government (both military and non-military) / subject to requirements / I1
The Bunker-Ramo Corp. -- see D1
Celestron Associates, Inc. -- see C15
Documentation Inc., 4833 Rugby Ave., Bethesda, Md. 20014 / information systems engineering / DESCR: consulting, systems design and engineering, indexing, abstracting, cataloging, microfilming, mechanized publishing, microfilm and microfiche readers and reader-printers / USE: management information and selective dissemination of information / $500 to $1,000,000 / I1
HRB-Singer, Inc., Box 60, Science Park, State College, Pa. 16801 / information systems / DESCR: research, development, and production of information systems and components including operations research, systems analysis and system measurement and evaluation / USE: feasibility study, system design and development, and system production and operation / I1
Jonker Corp. -- see C15, D3, P13
Keystone Computer Associates, Inc. -- see P12
System Development Corp.
Merle Thomas Corp. -- see C15
URS Corp., 1811 Trousdale Drive, Burlingame, Calif. 94011 / information engineering / DESCR: management, command and control, logistics, transportation, inventory management, maintenance, production control, personnel, administrative support, communications, operations research / - / - / I1
Wolf Research & Development Corp., P.O. Box 36, Baker Ave., W. Concord, Mass. 01781 / information engineering / DESCR: requirements analysis for storage, retrieval of large-colume data files, including information flow, display; programming systems design; library science and communications / - / - / I1

I2. INFORMATION RETRIEVAL DEVICES

Ampex Corp., Videofile Dept., 401 Broadway, Redwood City, Calif. 94063 / Videofile System / DESCR: videotape recording methods can provide hard copies of file page, even at remote monitor locations; push-button filing and retrieval by television possible in ten seconds or less / USE: information recording, storing, display and retrieval / - / I2
The Bunker-Ramo Corp. -- see D1
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / Control Data 210 System / DESCR: information retrieval (and man-machine communications) system employing visual input-output units for record keeping; automatic updating applications; as part of total management information systems / USE: with digital computer / - / I2
Data Trends, Inc.
General Precision, Inc., GPL Div., Bedford Rd., Pleasantville, N.Y. 10570 / PARD (precision annotation and retrieval display system) / DESCR: microfilm source, GPL microtelevisor, GPL CCTV cameras and display monitors. 250X magnification and complete annotation capability / - / - / I2
Honeywell, Inc., Electronic Data Processing Div. -- see S5
Houston Fearless Corp., 11801 Olympic Blvd., Los Angeles, Calif. 90064 / filmCARD reader / DESCR: compact, automatic, retrieval-display reader provides 4-second random access to 67,500 microfilmed pages; easily adaptable as computer peripheral equipment / USE: offline and online for fact, document or image retrieval / price on request / I2
Jonker Corp. -- see C15, D3, P13
Kyros Corp., P. O. 406, Madison, Wis. / Kyread computer tape developer / DESCR: visual reading better than 10-3 inches; continuous spray type; metered-spray type; non-toxic; non-flammable; zero readback error / USE: computer industry / various prices according to size / I2
Photon, Inc. -- see D1
Potter Instrument Co., Inc.
Programming Services, Inc.
Stromberg-Carlson Corp., Data Products Div., P.O. Box 2449, San Diego, Calif. 92112 / S-C 1100 inquiry display system / DESCR: instantaneous two-way communication from multiple stations to centralized computer memory; high-speed queuing with 25,000 per sec. maximum character rate; works with any present random access computer / USE: inventory scheduling, financial reporting, freight and traffic scheduling, management reporting, order processing, transportation reservations / approx. $4000 per station / I2

I3. INTEGRATORS

Robertshaw Controls Co., Aeronautical & Instrument Div., Santa Ana Freeway @ Euclid St., Anaheim, Calif. 92603 / flow integrator-totalizer / DESCR: solid state integrator offered as a linear or optionally as a square root extracted unit with direct reading totalizer. Converts input current signal into proportional pulse-rate count / USE: with flowmeters where output is linear with flow / $375 to $425 / I3

I4. INTEGRATORS, ELECTRONIC

Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / integrators, electronic models 1663, 1666 / DESCR: dual function modules: sample and hold amplifiers or switched integrators employing epoxy encapsulated submodules and all silicon construction / USE: to integrate incoming analog signal so that the voltage at output is proportional to the integral of input / $295 to $395 / I4
Digital Devices -- see D5
Philbrook Researches, Inc. -- see C9
Robertshaw Controls Co., Aeronautical & Instrument Div. -- see I3
Wang Labs, Inc. -- see C20, C36

I6. INVENTORY SYSTEMS

Automated Systems International Ltd., P.O. Box 5201, Seven Oaks Station, Detroit, Mich. 48235 / ASI parts inventory control / DESCR: card oriented system; produces weekly replenishing stock order, sales and stock analysis and an updated card file. Field installation, service and consultation provided / USE: installed principally in automobile dealers / $150 and $1000 per month / I6
Bonner & Moore Associates, Inc. -- see I1
The Bunker-Ramo Corp. -- see C7, C14
Electron Ohio, Inc. -- see C7
Management System Corp., 209 Griffin St., Dallas, Tex. 75202 / inventory systems / DESCR: design merchandise control and material accounting; consideration of minimum order points, activity analysis, projected requirements and material cost accounting / USE: commercial manufacturing; retail industries / - / I6
Marksmen, Inc. -- see C29
URS Corp. -- see I1

K1. KEYBOARDS

The Bunker-Ramo Corp. -- see C7, D1
Connecticut Technical Corp., 3000 Main St., Hartford, Conn. 06120 / keyboards / DESCR: alphanumeric and numeric coded and uncoded, any code, power assisted or manual, interlocked or free, high data rates, single character memory / USE: graphic arts, data display systems, computer input, information retrieval, process control / $150 to $1500 / K1
DI/AN Controls, Inc. -- see C11
Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / Model PK-144 and PK-164 photoelectric encoders generate any binary code up to 8 level, 10 to 75 key alphanumeric keyboard, keyboard interlock plus optional function switches / USE: entry device for data processing / $300 to $1200 / K1
Invac Corp. -- see D1
MICRO SWITCH, a Div. of Honeywell, 11 W. Spring St., Freeport, Ill. 61032 / KB Switch/Display Matrix / DESCR: lighted display in pushbutton switch modules and indicators. "Auto Coding" in monetary and alternate action switch modules with sliding contacts; coding by wiring; provide direct output to logic circuits / USE: on control panels and keyboards in data and other input applications / - / K1
Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / Model 8096 photoelectric keyboard / DESCR: low price; one moving part per station long MTBF; versatile; compact; light weight; deleting electro-mechanical contacts / USE: loading programs into computers and data processors; preparing punched tapes; input to cathode ray tube data display systems / $725 (1 ea.) to $225 (1000 unit) / K1
Ultronic Systems Corp., 44 Wall St., New York, N.Y. / encoding keyboards / DESCR: allows the input of digital information by manual insertion; electro-mechanical and electrical models; various code output / - / $1.50 to $8 per key / K1
Wang Labs, Inc. -- see C20, C36, D6

L1. LIGHTS, INDICATOR

AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / AMPILLUME indicator lights / DESCR: neon and incandescent indicator lights / USE: panel, pilot, indicator lights / - / L1
Drake Mfg. Co., 4626 N. Olcott, Harwood, Ill. 60656 / indicator lights, lampholders and accessories / DESCR: miniature lighting specialists -- indicator, instrument, read-out lights, lenses and lampholders / USE: commercial; military equipment / 20¢ to $4.50 / L1
Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / transistorized indicators / DESCR: sensitive device to provide an off-on indication where power is too small for direct operation of neon or incandescent lamps / USE: indicate state of a flip flop, storage, element, etc. / $5 to $18 / L1
General Electric Co., Electronic Components Sales Operation

M1. MAGNETIC INK IMPRINTING

Transkrit Corp., 704 Broadway, N.Y. 10003 / "Transkoding" / DESCR: magnetic ink printing of checks and other documents. Also consecutive MICR numbering including Modulus-9 system / - / available through business forms dealers or printers exclusively / M1

M2. MEMORY SYSTEMS

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / INCA core memory stack / DESCR: one array functions as stack in itself; each double-sided array provides to 8 bits in word sizes 128 through 1024, or to 18 bits in word sizes 2048 and 4096 / USE: memory systems / 3½ to 4 cents per bit for 4096-word stack / M2
Ampex Corp., Computer Products Div., *a / Rf-1, RF-2, RF-3 family of coincident current core memories / DESCR: capacities: from 512 to 16,834 words by 4 to 72 bits; expandable by modules, individually and from one Model RF to next larger RF; 600 nsec word access time / USE: general storage, buffer, off-line or main-frame applications with small to medium-large computers / $2600 to $42,000 / M2
Ampex Corp., Computer Products Div., *a / RS coincident current, large capacity memory / 1 usec cycle time. Capacities: 4096, 8192, 12,228 and 16,384 words by 8 to 56 bits / USE: large capacity computers / - / M2
Ampex Corp., Computer Products Div., *a / RZ coincident current, large capacity memory / DESCR: 1.8 usec cycle time. Capacities: 4096, 8192, 12,228, 16,384 words by 8 to 56 bits / USE: large capacity computer / - / M2
Ampex Corp., Computer Products Div. -- see T2
Anelex Corp., Anelex Bldg., 150 Causeway St., Boston, Mass. 02114 / disk files / DESCR: Series 80 and 81 provide unlimited capacity, fast access time through interchangeable six-disk disk kits, each has capacity of 60 million (81) or 24 million (80) bits / USE: medium and small scale date processing systems / - / M2
Bryant Computer Products, Div. of Ex-Cell-O Corp. -- see S4
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / memory systems / DESCR: complete line of computer-controlled electronic memory devices and systems / - / - / M2
Data Products Corp. -- see D8
DI/AN Controls, Inc., 944 Dorchester Ave., Boston, Mass. 02125 / magnetic core memories / DESCR: aerospace memories, memory core planes, buffer storage units of coincident current random access or specialized access organization, panel or rack mounted modular memory series / USE: computer and data acquisition oriented storage and buffering / $500 to $100,000 / M2
Digital Development Corp., 5575 Kearny Villa Rd., San Diego, Calif. 92123 / memory systems / DESCR: up to 13 commands; 8.5 ms average access; 6 modular capacities; 7.5 to 250 million bits per unit. Up to 8 disc units per system; simultaneous multiple access I/O channels / - / $15,000 to $2,000,000 / M2

Digital Devices, Inc., 200 Michael Dr., Syosset, L.I., N.Y. / memory systems / DESCR: random, sequential, interlaced memory and buffer systems; deltic correlators / USE: computers, data systems, signal processors / $500 to $50,000 / M2
Digital Devices, Inc. -- see D5
Electron Ohio, Inc. -- see D1
Electronic Engineering Co. of Calif., P.O. Box 58, Santa Ana, Calif. 92702 / EECO 781 magnetic core memory / DESCR: random access, sequential access, and sequential interlace. Capacities from 8 x 256 to 18 x 4096; 5 microsecond cycle time / - / $3800 to $7800 / M2
Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif. 90250 / MIL-SPEC core memory stacks / DESCR: low weight; high speed; 30- and 20-mil stacks; high systems tolerance; integral heat sink to 1/3 more bits per inch; shock and vibration resistant matrix / USE: military; space / - / M2
Electronic Memories, Inc., *a / NANOMEMORY 650 and NANOMEMORY 900 memory systems / DESCR: high speed, large capacity; 650 and 900 nanosecond cycle time; 300 and 350 nanosecond access time, respectively; capacity to 16,384, 84-bit words / USE: high-speed digital storage / - / M2
Electronic Memories, Inc., *a / (2) 1/2D NANOSTAK memory stacks / DESCR: high speed; large capacity to 16,384 words of up to 84 bits; 2 1/2D organization / USE: memory systems / - / M2
Electronic Memories, Inc. *a / SEMS® series of military and aerospace memory systems / DESCR: low weight and volume, minimum power, high reliability / USE: satellites, aircraft, ship, GSE equipment / - / M2
Fabri-Tek, Inc., 5901 S. County Rd. 18, Minneapolis, Minn. / core memory systems / DESCR: range in speed from 10 usec to 375 nsec and up to 20 million bits or more / USE: computer main memory; instrumentation and computer peripheral equipment / - / M2
Fabri-Tek, Inc. *a / thin film memory systems / DESCR: range in speed from 375 nsec to 150 nsec / USE: computer "scratch pad" memory, etc. / - / M2
Fabri-Tek, Inc. -- see E2, S4
Ferroxcube Corp., Saugerties, N.Y. 12477 / memory systems / DESCR: low cost, covering all sizes from 128 words x 8 bits to 16K x 32 bits in speeds ranging from 10 microseconds down to 1 microsecond / USE: data storage for digital data processing systems / custom design / M2
General Atronics Corp. -- see C1
General Precision, Inc., Librascope Group, 808 Western Ave., Glendale, Calif. 91201 / L-400 disc memories / DESCR: series of high-capacity disc memories, featuring a storage capacity up to 36 million bits / USE: peripheral memory or as mainframe memory / - / M2
General Precision, Inc., Librascope Group, *a / L-4800 and 3800 mass memory disc files / DESCR: large-scale, random-access, high-capacity disc-file mass memories / USE: as data base in on-line, real-time computer systems, or other large data processing systems / - / M2
General Precision, Inc., Librascope Group, *a / woven plated-wire memories / DESCR: machine-woven memories; operate in nanosecond speed, are light weight, have low power consumption / USE: as scratchpad or main memory in aerospace, military, and commercial computers / - / M2
LFE Electronics, 1075 Commonwealth Ave., Boston, Mass. 02215 / batch-fabricated core memories / DESCR: low-cost, light-weight, low-power, medium speed coincident circuit core memories, batch-fabricated by photo-etching techniques from permalloy / USE: computer memories, including airborne applications / - / M2
Lockheed Electronics Co. -- see C33
Potter Instrument Co., Inc.
Raytheon Computer, 2700 S. Fairview, Santa Ana, Calif. 92704 / BIAX memory products / DESCR: memory systems using BIAX nondestructive readout ferro-magnetic element; provide up to 2000 bits per cubic inch storage and readout rates up to 20MC / USE: airborne, spaceborne and ground computer; data processing systems / 10¢ a bit and upward / M2
Rese Engineering Inc., A and Courtland Sts., Philadelphia, Pa. 19120 / magnetic core memories / DESCR: speeds from 1.5 usec full cycle to 10 usec full cycle; low cost units and highly sophisticated units / USE: - / $1000 up / M2
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / memory systems / DESCR: modular integrated-circuit memories (256 bits) / - / $400 per module / M2
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / memory systems / DESCR: complete systems from existing product lines; capability to design and develop new ones for any mission requirements / - / - / M2

M4. MULTIPLIERS, DIODE

Philbrock Researches, Inc. -- see C9

M5. MULTIPLIERS, ELECTRONIC

Adage, Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 / hybrid multiplying DAC / DESCR: multiplies analog voltage by digital number directly: eliminates motor-driven pots. 15-bit resolution, 100 usec settling to 0.01% final value / - / $930 to $1350 / M5
Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / multiplier/divider Model 1661 / DESCR: a quarter-square for quadrant electronic multiplier or a two quadrant electronic divider at high operational accuracy / USE: a variety of specialized functions in industrial analog applications / $595 / M5
Philbrock Researches, Inc. -- see C9

O1. OFFICE MACHINES

The National Cash Register Co., Main & K Sts., Dayton, Ohio 45409 / NCR 395 electronic accounting machine / DESCR: transistorized, electronic, accounting and computing system; performs initial processing or serves as a satellite where initial processing requires by-product machineable media / USE: for varied data processing applications in all types and sizes of business / $10,000 to $24,000 / O1
Wheeldex, Inc. -- see F4, P14, T3, T8
Wyle Labs -- see C10

O2. OPERATIONS RESEARCH

Bonner & Moore Associates, Inc., 500 Jefferson Bldg., Houston, Tex. 77002 / operations research / DESCR: forecasting and econometrics; corporate simulations through investment allocation, planning and scheduling models and general mathematical model developments / USE: industrial fields / consulting or contractual basis / O2
Booz, Allen Applied Research, Inc. -- see C14, C15
HRB-Singer, Inc. -- see I1
Keystone Computer Associates, Inc. -- see P12
McDonnell Automation Center, Box 516, St. Louis, Mo. 63166 / operations research / DESCR: simulation and optimization of tactical and strategic operating, manufacturing and distribution functions for industry and government - complete engineering analysis of structures, networks and equipment / - / - / O2
URS Corp., 1811 Trousdale Drive, Burlingame, Calif. 94011 / operations research / DESCR: mathematical modeling and simulation in inventory, production, traffic control; communications, combat, management and administrative operations; command and control systems / - / - / O2
Wolf Research & Development Corp., P.O. Box 36, Baker Ave., W. Concord, Mass. 01781 / operations research / DESCR: computer applications of regression analysis to system data analysis; mathematical modeling, simulation in inventory, traffic control, communications, management and administrative operations / - / - / O2

P1. PANELS

DA-PEK Company -- see C8
General Electric Co., Process Computer Business Section
Hammond Manufacturing Co. Ltd., 394 Edinburgh Rd. North, Guelph, Ont., Canada / panels / DESCR: aluminum or steel, natural or baked enamel finish, flat or formed; can be custom made to specs / USE: for mounting, protecting, ventilating, computer components and sub assemblies / $1 to $10 / P1

P3. PANELS, RELAY RACK

Hammond Manufacturing Co. Ltd., 394 Edinburgh Rd. North, Guelph, Ont., Canada / relay rack / DESCR: steel, baked enamel, open floor and enclosed floor table models and cabinet racks; special racks to customer specifications / USE: supporting panel mounted computer systems and sub assemblies / $15 to $250 / P3

P4. PAPER TAPE

Addo-X, Inc. -- see D3
Invac Corp. -- see T9
Paper Manufacturers Co., 9800 Bustleton Ave., Phila., Pa. 19115 / PERFECTION® perforator tape / DESCR: in rolls or fan-folded; available in wide variety of colors, diameters, widths and compositions / USE: for communications, data processing and programming / varies / P4

P6. PLOTTERS (SEE ALSO BOARDS -- PLOTTING)

Auto-trol Corp., 5566 Harlan, Arvada, Colo. 80002 / Auto-trol model 6000 data plotter / DESCR: all digital solid state incremental plotter featuring .001" steps, complete line drawing at any angle with one command capabilities, speeds up to sixty inches per second, 384 character printer, internally programmed for varying input formats, and drawing of up to a four inch diameter circle with one command / USE: automatic drafting, maps, electronic schematics, scribing, sketching, art work, graphs, etc. / $25,000 to $75,000 / P6
California Computer Products, Inc. -- see D1
Discon Corp., 4250 NW 10th Ave., Fort Lauderdale, Fla. 33309 / digital plotter / DESCR: high resolution photo-electric readers traversing 19 track linear encoder scales provides absolute position sensing plotter; extreme accuracy and repeatability / USE: off line and on line plotting and drafting / $95,000 to $130,000 / P6
Geo Space Corp., 5803 Glenmont Drive, Houston, Tex. / DP-203 digital photographic plotter / DESCR: on-line computer generated infinitely variable and flexible; alphameric character and curvi-lineal function; displays at extremely fast plotting rates on either paper or film / USE: to produce pictorial and graphic displays / - / P6
The Gerber Scientific Instrument Co., 83 Gerber Rd., South Windsor, Conn. (P.O. Box 305, Hartford, Conn.) / automatic drafting systems / DESCR: numerically controlled; operate from punched tape, magnetic, or tape on-line; 4 control series with table sizes to 5'x20'; accuracies to .0009"; also specialized models / USE: generating drawings, charts, maps, etc. / $25,000 to $150,000 / P6
Stromberg-Carlson Corp., Data Products Div. -- see D3

P7. PLUGBOARDS

AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / pinboards / DESCR: matrix and universal pinboards / USE: switching operations / - / P7
Litton Industries, Triad Distributor Div. -- see C3

P8. PRINTERS

The Bunker-Ramo Corp. -- see D1
Data Communications, Inc., Church Rd., P.O. Box 29, Moorestown, N. J. 08057 / DCI 150 teleprinter / DESCR: high speed on- or off-line printer capable of operating directly with a CX paper tape reader at 1,500 wpm producing an original and 6 copies / - / $6700 to $9600 / P8
Data Products Corp., 8535 Warner Dr., Culver City, Calif. 90321 / off-line print stations / DESCR: high-speed LINE/PRINTERS ® driven from magnetic tape or paper tape / USE: to handle requirements for output printing in date processing and data communications systems / $30,000 to $50,000 / P8
Data Products Corp. *a / on-line printers / DESCR: high-speed LINE/PRINTERS ® directly connected to computer systems to provide printed output / USE: as part of data processing system / $25,000 to $50,000 / P8
Holley Computer Products Co., Subsidiary of Control Data Corp., 1408 N. Rochester Rd., Rochester, Mich. 48063 / 9330 line printer / DESCR: medium-speed, electro-mechanical drum printer; standard printing speed, three hundred, 120 column lines per minute, 64 character; optional speed 400 lines per minute, printing 48 characters / USE: output device for a digital data system, analog-to-digital converter, tape or card reader / $10,000 to $17,000 / P8
Potter Instrument Co., Inc.
Straza Industries -- see D3
Teletype Corp.

P9. PLOTTERS, HIGH SPEED

Anelex Corp., *a / 4000 Printer / DESCR: compact printer, 300 lines per minute, up to 150 columns, DATA-PHONE interface / USE: remote terminal installations, small-scale computers, public, private communications systems / - / P9
Anelex Corp., *a / 5000 Printer / DESCR: fully buffered high speed printer, up to 1250 lines per minute, 160 columns, on-line operation with central processor, off-line with tape or memory unit / - / - / P9
Anelex Corp., *a / 5000 Printer / DESCR: fully buffered high speed printer, up to 1250 lines per minute, 160 columns, on-line operation with central processor, off-line with tape or memory unit / - / - / P9

Anelex Corp., Anelex Bldg., 150 Causeway St., Boston, Mass. 02114 / high speed print station / DESCR: 1250 lines per minute, 160 columns, on-line operation with IBM 1400, 7000, 360, off-line with 7 or 9 channel magnetic tapes / USE: business, banking, EDP installation / - / P9
The Bristol Co., Waterbury, Conn. 06720 / high speed printer / DESCR: serial entry printer for data logging or computing system; any standard input code; printout up to 75 characters/ sec. / USE: operate from data processing equipment, punched tape, magnetic tape / - / P9
Control Data Corp.
Data Communications, Inc. -- see P8
Data Products Corp., *a / high-speed LINE/PRINTERS R / DESCR: 300, 600, 1000 line-per-minute LINE/PRINTERS, both commercial and militarized versions / USE: as part of data processing system / $15,000 to $25,000 -- see P8
Data Products Corp. -- see P8
DI/AN Controls, Inc. -- see D3
Franklin Electronics Inc., East Fourth St., Bridgeport, Pa. 19405 / digital printers / DESCR: high speed digital printers; 1 to 32 columns wide; speeds to 40 LPS; alpha numeric print-out optional / USE: on-line printout from computers / $250 to $5500 / P9
Franklin Electronics, Inc., E. Fourth St., Bridgeport, Pa. / digital printers / DESCR: high speed; 1 to 32 columns wide; speeds to 40 lines per second; alpha numeric print-out optional / USE: on-line print-out from computers / $250 to $5500 / P9
General Precision, Inc., GPL Div., Bedford Rd., Pleasantville, N.Y. 10570 / TV hard copy printer / - / - / $7000 to $10,000 / P9
Holley Computer Products Co., Subsidiary of Control Data Corp., 1480 N. Rochester Rd., Rochester, Mich. 48063 / 9300 line printer / DESCR: high-speed electro-mechanical drum printer; standard printing speed one thousand, 136 column lines per minute, printing 48 characters; optional speed 800 lines per minute, printing 64 characters / USE: output device for digital computers / $16,000 to $30,000 / P9
Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / high speed printers / DESCR: line printing at speeds from 450 to 1350 LPM / USE: data processor peripheral / $25,000 to $60,000 / P9
Litton Industries, Monroe DATALOG Div., 343 Sansome, San Francisco, Calif. / MC4000 ultra high speed printer / DESCR: print-out rate compatible with most computer processing rates; basic printers require serial character input with print command; digital waveform generator writes and positions characters on face of cathode ray tube; uses standard direct-write oscillograph papers; image made visible by latensifying with ordinary fluorescent lights; full visibility, less than one second / USE: printing high speed telemetry data, for monitoring in-process control systems and for all applications requiring complete reliability, fast printouts, and quiet operation / $5650 / P9
Oki Electronics of America, Inc., 202 East 44th St., New York, N.Y. 10017 / line printer / DESCR: high speed flying belt type line printer (up to 1000 lpm) / USE: computer input-output / $9000 to $13,000 / P9
Photon, Inc. -- see D1
Soroban Engineering, Inc., Port Malabar Indistrial Park - Palm Bay, P.O. Box 1690, Melbourne, Fla. 32902 / printers / DESCR: page printers, paper tape printers, and punch card printers using Soroban printer digital positioner / - / on request / P9
Stromberg-Carlson Corp., Data Products Div. -- see D3

P10. PRINTERS, KEYBOARD

Connecticut Technical Corp. -- see T17
Invac Corp. -- see D1
Omni-Data, Div. of Borg-Warner Corp., 511 N. Broad St., Philadelphia, Pa. 19123 / electrostatic strip printers / DESCR: high-speed; electrostatic recording technique to print code, symbols or alphanumeric characters on coated paper 1/4" to 12" wide / USE: data processing, communications, telemetry, output devices / $7485 to $200,000 / P10

P11. PRINTERS, LINE-A-TIME

Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / Series 5010 data printer / DESCR: permanent digital data recording; 8 to 20 columns; 2 lines per sec.; parallel entry 8421 cose; low-level logic signals inputs; front panel paper and ribbon replacement / - / $1200 to $2200 / P11
General Radio Co., 22 Baker Ave., W. Concord, Mass. 01781 / line-a-time date printers / DESCR: up to 12 digits can be printed at a rate of 3 prints per second / USE: convert decimal coded information into printed form / $1500 to $1565 / P11
Victor Comptometer Corp., 3900 N. Rockwell St., Chicago, Ill. 60618 / Digi-Matic printers / DESCR: solenoid controlled digital printers, accumulators, listers, calculators, and time-data printers / USE: print-out from data acquisition systems / $385 to $1400 / P11

P12. PROGRAMMING SERVICES

Applied Data Research, Inc., Route 206 Center, Princeton, N.J. 08540 / programming services / DESCR: software development: automatic programming aids; sort/merge systems; operating systems; compilers / USE: manufacturers; large users; commercial; scientific applications / - / P12
Aries Corp., Westgate Research Park, McLean, Va. 22101 / programming services / DESCR: analysis, design, programming and implementation for Management Information Systems, Scientific Problem Solution, Statistical Analysis and Reporting, Information Retrieval and Data Conversion / USE: computer programming / determined by job requirements / P12
Aries Corp., *a / real-time implementation / DESCR: computer software for real-time receipt, processing and output of data in communications based management information systems or on-line data collection and reduction applications / USE: computer controlled real-time communications systems / determined by job requirements / P12
Aries Corp., *a / software development / DESCR: design and development of specialized programming aids and utility routines, executive systems, statistical report generators, hardware diagnostics and program conversion techniques / USE: increase effectiveness of computer operations / determined by job requirements / P12
Automated Data Processing Services, Inc.
Bonner & Moore Associates, Inc., 500 Jefferson Bldg., Houston, Tex. 77002 / programming systems / DESCR: development of specialized application languages and mathematical programming systems; proprietary packages in matrix generation; linear programming and management information system languages / USE: computer systems / contractual or consulting basis / P12
Booz, Allen Applied Research, Inc. -- see C14
Brandon Applied Systems, Inc., 30 E. 42nd St., New York, N.Y. 10017 / planned standard programming services / DESCR: a unique programming service on a firm fixed price basis. A detailed project manual is developed, which includes programming standards before work is begin / - / quoted individually / P12
Celestron Associates, Inc. -- see C15
Computer Associates, Inc.
Computer Sciences Corp.
Computing & Software, Inc. TSI Division, in55 Van Nuys Blvd., Panorama City, Calif. 91402 / programming services / DESCR: scientific computer software employed for processing of missile flight, rocket static test, artillery fire control, intelligence, meteorological, satellite orbital data, and various business computer software / USE: at data centers in Los Angeles and at Government locations / P12
Control Technology, Inc. 1232 Belmont Ave., Long Beach, Calif. 90804 / programming services / DESCR: software development; applications, systems and utility routines; digital simulation models / - / - / P12
Datamation Assistants Co. Inc., Ninianne Blvd. & Rt. 1, Princeton, N.J. 08540 / computer software and service bureau / DESCR: information retrieval and total management operating systems, type and photo setting programs, cost analysis, legal and similar information retrieval and thesarus building programs / USE: service to clients as applicable / $10,000 to $250,000 / P12
Decision Systems Inc.
HRB-Singer, Inc. -- see I1
Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / programming services / DESCR: specialists in on-line, real-time systems; offices from coast to coast and in Europe / P12
Information International Inc., 200 Sixth St., Cambridge, Mass. 02142 / programming services / DESCR: develop sophisticated assemblers and compilers converting software systems and languages from one computer to another / USE: negotiated contract / variable / P12
ITT Data Services, a division of International Telephone and Telegraph Corp. -- see C14
Keystone Computer Associates, Inc., 409 N. Easton Rd., Willow Grove, Pa. 19090 / programming services / DESCR: services in systems design, development, analysis, and programming; systems engineering, scientific and data processing applications; management consulting / - / - / P12
Management Systems Corp., 209 Griffin St., Dallas, Tex. 75202 / programming services / DESCR: specification writing; system design and program definition; software development; applications programming for accounting, inventory and business systems; experienced on GE, Honeywell, IBM, NCR and RCA / - / $12.50 to $20/per net hr. / P12
McDonnell Automation Center, Box 516 St. Louis, Mo. 63166 / programming services / DESCR: programming of nearly any scope or complexity by experienced programmers -- a variety of program languages / USE: scientific or business applications / - / P12
National Computer Analysts, U.S. Highway 1, Lynwood Dr., Princeton, N.J. 08540 / programming services / DESCR: software (assemblers, compilers), commercial systems (management information, payroll, inventory), print composition systems (newspaper, books), job programming, message switching systems / - / - / P12
Profimatics, Inc.
Programmatics Inc., 12011 San Vicente Blvd., Los Angeles, Calif. 90049 / Assembly Programs / DESCR: only commercially available meta-assembler: computer independent; assemble for any machine on any machine / USE: free-standing or system processor / $10,000 to $50,000 / P12
Programmatics Inc., *a / Systems Programming / DESCR: Assemblers, FORTRAN, COBOL, ALGOL, PL-I, Operating Systems, Sort-Merge, PERT / USE: free-standing or system processor / - / P12
Programming Services, Inc.
B. I. Savage Co. -- see C15
The Service Bureau Corp.
Systems Science Corp. -- see C15
Technical Information Processing, 1503 N. Washington, Wheaton, Ill. 60187 / technical programming / DESCR: optimizing programs, including Bellman's dynamic programming, Pontryagin's maximum principle and variational forms; electrical equipment design, networks and delay lines / USE: design and operating problems / $100 to $5000 / P12
Telecomputations, Inc.
Merle Thomas Corp. -- see C15
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / programming services / DESCR: all types of applications-- missile guidance and control; communications code generation, etc. / - / P12
URS Corp., 1811 Trousdale Drive, Burlingame, Calif. 94011 / programming services / DESCR: programming languages, computer simulations, real-time routines, executive routines, operating systems, assembly programs, monitors, report generators, file processors, information storage, retrieval, compilers / - / - / P12
Westinghouse Electric Corp., Advanced Data Systems
Wolf Research & Development Corp., P.O. Box 36, Baker Ave., West Concord, Mass. 01781 / programming services / DESCR: mathematical analysis and programming services; large staff of analysts and programmers experienced in programming scientific, engineering, business, industrial, aerospace, military applications / USE: digital computers / - / P12

P13. PUBLICATIONS

Auerbach Corp., 121 N. Broad St., Philadelphia, Pa. 19107 / Auerbach standard EDP reports / DESCR: 8 vol. reference service, up-to-date analytical information on major computer systems; comparative evaluations by means of standardized "benchmark" tests / USE: analysts; systems designers / - / P13
Bonner & Moore Associates, Inc. -- see I1, P12
Data Processing Management Assoc., 505 Busse Highway, Park Ridge, Ill. 60068 / Introducing Computers to Small Business / DESCR: the uses and misuses of computers and related EDP equipment and services by small businesses / - / $7.75 / P13
Data Processing Management Assoc., *a / Journal of Data Management / DESCR: monthly publication of the DPMA published for the data processing users group / - / $5 per year / P13
Commerce Clearing House, Inc.
Hayden Book Co., Inc., 116 West 14th St., New York, N. Y. / textbooks / DESCR: texts and trade books on subjects of: programming, digital tape recording, digital computers and systems, analog computers, data transmission and systems / USE: training and general information / $3.50 to $15 / P13
Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / publications / DESCR: prepared major software publications for IBM and UNIVAC; nationwide services / - / - / P13

Jonker Corp., 26 N. Summit Ave., Gaithersburg, Md. 20760 / publication indexes / DESCR: indexes to chemical compound spectra including infrared, nuclear magnetic resonance, X-ray diffraction, gas chromatography and mass spectroscopy / USE: to identify unknown chemical compounds or mixtures / $300 to $1000 / P13
Jonker Corp. -- see D3, C15

P14. PUNCH CARD ACCESSORIES

Dolin Metal Products, Inc., 315 Lexington Ave., Brooklyn, N.Y. 11216 / tab card files / DESCR: build-up type drawers in 4 sizes, 2 styles; storage units for tab card boxes / USE: general filing and storage / $3.50 to $4.50 per drawer / P14
Entelek, Inc., 42 Pleasant St., Newburyport, Mass. 01950 / keypunch performance aids / DESCR: 5 flowcharts guide 024 & 026 keypunch operators through preparation of program planning card, alphanumeric punching and error correction / - / $15 / P14
Monarch Metal Products, Inc. -- see D1
Ray Myers Corp., 1302 E. Main St., Endicott, N. Y. 13760 / punch card accessories / DESCR: mobile and fixed equipment / USE: for storage and processing / - / P14
TAB Products Co. -- see D1
Wheeldex, Inc., 1000 N. Division St., Peekskill, N.Y. 10567 / mechanized files and continuous pinfeed forms / DESCR: special automatic files for handling punch cards, tabulating cards in any volume / - / - / P14
Wright Line Division Barry Wright Corp., 160 Gold Star Blvd., Worcester, Mass. 01606 / Gold Star Filing System / DESCR: composed of 14 pieces of equipment including 3 wide files of 30 drawers to 1 drawer desk models; / one tray used in all files / USE: for filing of punched cards / depends on complement of equipment / P14

P15. PUNCH CARD MACHINES

Addo-X, Inc. -- see D3
Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / card reader/punch / DESCR: punched card reading and/or punching at 100-400 cpm / USE: data processor peripheral / $13,500 to $15,750 / P15
Soroban Engineering, Inc., P.O. Box 1690, Melbourne,Fla. 32902 / card equipments / DESCR: card punches, card readers, card interpreters (all endfeed) / USE: computer input-output, punches to 650 cards per min., readers to 1100 cards per min. / on request / P15
Uptime Corp., 15910 West 5th Ave., Golden, Colo. 80401 / SPEED-PUNCH 120 / DESCR: asynchronous serial card punch; speed, 160 char. per sec., echo check punch verification, photoelectric jam detection. Optional: offset reject, hole count verification, 50-cycle, 230-volt power / USE: card output from processing systems / $10,500 to $12,300 / P15
Paul G. Wagner Co., 1227 S. Shamrock Ave., Monrovia, Calif. 91016 / MICRO-PUNCH 461 / DESCR: portable, printing key punch; gang punches and prints fully interpreted numeric data into standard 80 column cards, weighs 8 pounds / USE: production control, inventory recording, etc. / $245 / P15

R1. READERS

Chalco Engineering Corp., 15126 S. Broadway, Gardena, Calif. 90247 / regulated solid state power supplies / DESCR: photoelectric line and block punched tape reading devices; mechanical block tape reading devices; supporting tape handler equipment / USE: numerical controls and data input device / $400 to $3000 / R1
Cook Electric Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / readers / DESCR: paper tape; photoelectric; magnetic tape; character by character / USE: reads data on tape / $4000 to $13,000 / R1
DA-PEX Company -- see C8
General Electric Co., Process Computer Business Section
Omni-Data, Dov. of Borg-Warner Corp., 511 N. Broad St., Philadelphia, Pa. 19123 / photoelectric tape readers / DESCR: for reading virtually all punched tape from translucent to opaque / USE: data processing input, communication terminals, numerical control input / $540 to $3190 / R1
Potter Instrument Co., Inc.
Trak Electronics Co., Inc. -- see C19

R2. READERS -- CHARACTER

Cognitronics Corp. 549 Pleasantville Rd., Briarcliff Manor, N.Y. / remote optical character recognition / DESCR: consists of remotely located scanners transmitting over telephone lines to centrally located, multiplexed character recognition equipment / USE: transmitting of typed or printed data for conversion into machine language / - / R2
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / Control Data 915 Page Reader / DESCR: high-speed character recognition printed page reading device; allows direct transmission of printed data to computer; reads ASA standard type font; handles documents up to 11" x 14" / USE: - / - / R2
Cook Electric Co., Data Stor Dov. -- see R1
Discon Corp. -- see C26
General Precision, Inc., GPL Div., Bedford Rd., Pleasantville, N.Y. 10570 / GPL character vector generator / - / - / $20,000 to $50,000 / R2
OPTOmechanisms Inc., 40 Skyline Drive, Plainview, N.Y. 11803 / photo interpretation film viewers / DESCR: high resolution stereo for 70mm to 9" film; visual display of angular/coordinate measurements; output to tape punch, typewriter, card punch, printer or on-line computer / USE: viewing roll film; taking precise X-Y coordinate measurements on film to 1 micron accuracy / - / R3
Recognition Equipment Inc. -- see D2

R3. READERS -- FILM

General Precision Inc., Link Group -- see D3
Information International Inc., 200 Sixth St., Cambridge, Mass. 02142 / programmable film reader / DESCR: three models available - systems automatically extracts customer specified data from film under program control; reads any data originally collected on or transferred to film; output on magnetic tape -- also writes on film / USE: similar to digital computer except that it has film I/O (16mm-35mm or 70mm) / $241,000 up / R3

R5. READERS, MAGNETIC INK

Cook Electric Co., Data Stor Div. see R1

R6. READERS, MAGNETIC TAPE

Control Data Corp.
Cook Electric Co., Data Stor Div. -- see R1
Lufkin Research Laboratories,210 W. 131st St., Los Angeles, Calif. 90061 / magnetic tape readers / DESCR: accepts tape cartridges from recorders for on-line tape processing / - / $9000 to 12,000 / R6
Midwestern Instruments, Inc., Subsidiary of Tele Corp.
Photocircuits Corp., Glen Cove, N.Y. / tape movement through read head by means of direct drive capstan utilizing printed motor. No pinch rollers, friction brakes, clutches or solenoids used, no adjustments required / USE: data processing accessory equipment, data recording and readout device for paper and magnetic tape / $1575 to $3330 / R6
Trak Electronics Co., Inc. -- see C19

R7. READERS, PAPER TAPE

Addo-X, Inc., 845 Third Ave., New York, N.Y. 10022 / Addo-X tape reader / DESCR: 12 characters per sec. paper tape reader; reads 5, 6, 7 or 8 channel tape; posting to adding or bookkeeping machine / - / - / R7
Carlton Controls Corp. -- see R8
Chalco Engineering Corp -- see R1
Control Data Corp.
Cook Electric Co., Data Stor Div. -- see R1
Creed & Co. Ltd., Hollingbury, Brighton, Sussex, England / teleprinter manufacturer / DESCR: telegraph communications equipment and range of paper tape handling equipment for tape preparation, verification, duplication, translation and editing / USE: in variety of data processing installations where paper tape is used for input or output / - / R7
Ferranti-Packard Electric Ltd., Industry St., Toronto 15, Ontario, Canada / photo electric paper tape readers / DESCR: various models, both military and commercial, from 50 to 1000 characters per second. Latest release is a 1000 character per second reader/spooler / USE: computer I/O; data communications; numerical control; off line editing / $2730 to $10,000 / R7
Invac Corp. -- see T10, T7
Omni-Data, Div. of Borg-Warner Corp. -- see R1
Photocircuits Corp. -- see R6
Rheem Electronics, 5250 W. El Segundo Blvd., Hawthorne, Calif. 90250 / photoelectric punched tape readers / DESCR: transistorized and micrologic character and block readers; speeds 20 ch/sec. to 1000 ch/sec. with or without fanfold tanks, take-up and supply reels / USE: peripheral device for entry of digital information / $400 to $3000 / R7
Soroban Engineering, Inc., Port Malabar Industrial Park - Palm Bay, P.O. Box 1690, Melbourne, Fla. 32902 / tape equipments / DESCR: tape perforators, readers, and printers. Perforators to 300 char. per sec. / USE: tape perforator/readers, perforator/printers / on request / R7
Tally Corp., 1310 Mercer St., Seattle, Wash. 98109 / Tally readers and perforators / DESCR: perforate and read paper, plastic, foil at speeds to 150 char/sec; asynchronous, bidirectional operation. Perforators feature bit for bit read after write mode checking; readers utilize star wheel principle / USE: digital data systems / $325 to $1800 / R7
Teletype Corp.
Wang Laboratories, Inc., 839 North St., Tewksbury, Mass. 01876 / block tape readers / DESCR: parallel readout device from 6 to 32 lines/block with form A contact. Utilizes tape as storage medium, operates by pulsing a solenoid / USE: numerically controlled equipment for programmed production or testing / $1200 to $2200 / R7
Wang Laboratories, Inc. *a / programmable block tape reader / DESCR: parallel readout device for fixed and/or variable block lengths of 4 to 40 lines to drive relays or transistors / USE: numerically controlled equipment for programmed production or testing / $1750 to $3550 / R7
Wang Labs, Inc. -- see C36, D6

R8. READERS, PHOTOELECTRIC

Carlton Controls Corp., 15 Sagamore Rd., Worcester, Mass. 01605 / photoelectric tape reader / DESCR: perforated, for either paper or mylar tape; requires no adjustment or maintenance other than avoidance of abuse. Speed 60 characters per second / USE: to read perforated tape / $400 to $500 / R8
Chalco Engineering Corp. -- see R1
Discon Corp. -- see C26
Ferranti-Packard Electric Ltd. -- see R7
International Rectified, 233 Kansas St., El Segundo, Calif. 90246 / photoelectric readouts / DESCR: silicon array of light sensing and converting elements; converts light energy to electrical energy in conjunction with openings pre-arranged in information carrier / USE: standard or custom designed assemblies / $1 to $95 / R8
Invac Corp. -- see T10, T7
Oki Electronics of America, Inc. 202 East 44th St., New York, N.Y. 10017 / serial card reader / DESCR: 80 column standard card; 100 cards per min. photoelectric reader / - / $6000 to $8000 / R8
Omni-Data, Div. of Borg-Warner Corp. -- see R1
Photocircuits Corp., Glen Cove, N. Y. / militarized tape reader / DESCR: passed tests as required by MIL-E-16400 Class 3 and MIL-T-21200 Class 2 / USE: as check out device for programming pre-flight functions, pre-flight tests and pre-check of all flight programming where severe environmental conditions have to be met / $7390 to $9980 / R8
Rheem Electronics -- see R7
Wyle Labs -- see C10

R9. READERS, PUNCH CARD

AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / card programming system / DESCR: desk top or rack mount, 960 circuits / USE: translates punched information into data or switching control outputs / - / R9
Control Data Corp.
Digital Electronic Machines, Inc., 2130 Jefferson, Kansas City, Mo. 64108 / CRU, card read unit / DESCR: reads punched cards for input to telephone network or conversion for teletype input; interchangeability or code boards / USE: data communications / $1850 up / R9
Drexel Dynamics Corp., Maple Ave., Horsham, Pa. 19044 / card readers / DESCR: static, military, commercial, IBM or Rem Rand format automatic card feeders for static readers; card programmed potentiometers, sequencers; badge readers / USE: programming and control / $150 to $6000 / R9
Friden, Inc., a Subsidiary of the Singer Co., 2350 Washington Ave., San Leandro, Calif. 94577 / automatic card reader / DESCR: reads standard Hollerith coded punched cards. Equipped with automatic card feed system; hopper holds up to 200 cards / USE: provides rapid, accurate conversion of coded source data to a variety of business forms / $2800 to $3100 / R9
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland,

Ohio 44108 / Cardmatic card reader / DESCR: high current-carrying capacity self-actuating card-reader switch handles 50 to 540-hole punched card data; manual and motorized models available / USE: punched card controlled circuitry / $195 to $1240 / R9
Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / card reader / DESCR: punched card reading at 400 or 800 cpm; photoelectric by column / USE: data processor peripheral / $9000 to $11,000 / R9
Soroban Engineering, Inc. -- see P15
Uptime Corp., 15910 West 5th Ave., Golden, Colo., 80401 / SPEED-READER 400 / DESCR: asynchronous serial punched card reader; speed, 400 80-column cards per min., photoelectric reading, timing, misregistration, jam detection. Optional: offset reject, 50-cycle, 230-volt power, 51-column card kit / USE: card input to processing systems / $5700 to $6200 / R9
Uptime Corp. *a / SPEEDREADER 1500 / DESCR: asynchronous serial punched card reader; speed 1500 80-column cards per min., photoelectric reading, timing, misregistration, jam detection. Optional: reject system, 50-cycle, 230-volt power, 51-column card kit / USE: card input to processing systems / $11,700 to $13,500 / R9
Uptime Corp., *a / SPEEDREADER 800 / DESCR: asynchronous serial punched card reader; speed 800 80-column cards per min., photoelectric reading, timing, misregistration, jam detection. Optional: reject system, 50-cycle, 230-volt power, 50-column card kit / USE: card input to processing systems / $8000 to $9100 / R9
Wyle Labs -- see C10

R11. REGISTERS, SHIFTS

DI/AN Controls, Inc. -- see C3
Engineered Electronics Co. -- see C5
Wyle Labs -- see C5

R12. RELAYS (COMPUTER TYPES)

The Bunker-Ramo Corp. -- see I1
Executone, Inc., 47-37 Austell Place, Long Island City, N.Y. 11101 / printact relay / DESCR: miniature, general purpose, plug-in relay for P. C. Board application, Latching and non-latching type / USE: for switching electronic circuitry / $1.75 to $2 / R12

R13. RESEARCH

Ampex Corp., Research Div., 401 Broadway, Redwood City, Calif. 94063 / research and development / DESCR: study and development of foil bearings, magnetic recording heads, core memories, tape transport mechanisms, electron beam and other new recording techniques, ferrite materials for communications / - / - / R13
Booz, Allen Applied Research, Inc. -- see C14, C15
Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. 90804 / research / DESCR: error analysis of digital, analog and hybrid simulations; new methods of problem solution; control system theory and applications / - / - / R13
Design Automation, Inc., 4 Tyler Rd., Lexington, Mass. 02173 / research / DESCR: in area of computer simulation of electronic circuits and systems, and mathematical and physical models of electronic devices suitable for computer simulation of these devices / USE: research and development contract / - / R13
Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / breadboard and training systems / DESCR: contain all required power supplies, indicators, etc., so the various components may be plugged together and form desired combination / USE: a quick method to try various circuit designs / $1000 to $6000 / R13
HRB-Singer, Inc. -- see I1
Informatics, Inc., 5430 Van Nuys Blvd., Sherman Oaks, Calif. 91401 / research / DESCR: synthetic intelligence, command/control, real-time applications / - / - R13
Serendipity Associates
URS Corp. -- see O2
Westinghouse Electric Corp., Electronic & Specialty Products Group

R14. RESOLVERS

Reeves Instrument Co. -- see C9

R15. RESOLVERS -- COORDINATE TRANSFORM

Discon Corp.
General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / resolvers / DESCR: 3- and 4-wire resolvers in size 5 to 54; accuracies down to 5 seconds max. error from EZ; winding-compensated types, matched resolver-amplifier combinations, and transolvers / USE: coordinate conversion, trigonometric functions, vector additions, angle summing, phase conversion / - / R15
Reeves Instrument Co. -- see C9

R16. RESOLVERS, PRODUCT

General Precision, Inc., Kearfott Products Div., -- see R15

R17. RESOLVERS -- SINE-COSINE

Clifton Precision Products, Div. of Litton Industries
General Precision, Inc., Kearfott Products Div. -- see R15
Reeves Instrument Co. -- see C9

R18. ROBOTS

Univation Inc., Bethel, Conn. / UNIMATE -- industrial robot / DESCR: teachable material transfer machine, performs manual labor. Weight handling capacity of 75 lbs. / USE: operates die casting machines, plastic molding machines, forge presses; loads and unloads; starts machine tools / $18,000 to $20,000 / R18

R19. RIBBONS, DATA PROCESSING

Columbia Ribbon & Carbon Mfg. Co., Herb Hill Rd., Glen Cove, N.Y. / data processing ribbons / DESCR: fabric film base ribbons for data processing equipment / USE: OCR, MCR systems, general print-out, plate imaging on high speed equipment / - / R19
Honeywell, Inc., Supplies Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / printer ribbons / DESCR: rolled fabric sheet (typically: nylon, 12-20 inches wide, 10-25 yards long) impregnated with ink, mounted on a stiff, cardboard mandrel / USE: high-speed printers / $15.75 to $23.75 / R19
Standard Products Corp., 856 Main St., New Rochelle, N.Y. / 100% nylon computer-printer uninked fabric ribbons / DESCR: high count precision woven nylon fabrics / USE: inked by ribbon manufacturers for use in high speed printers / - / R19

S1. SCANNERS

Ampex Corp., Research Div., 401 Broadway, Redwood City, Calif. 94063 / scanners / DESCR: silver hallide film scanning by electron beam recording techniques / - / - / S1
Auindar Electronics Inc., 60 Fadem Rd., Springfield, N. J. 07081 / scanners (solid state) / DESCR: solid state equipment for digital telemetering; uses 3 state coding to provide security / USE: for remote supervisory control, data transmission / $1200 to $5000 / S1
The Bristol Co., Waterbury, Conn. 06720 / scanners / DESCR: low-cost, solid-state system utilizing pulse duration modulation code with non-return-to-zero; from 3 to 31 points per rack unit / USE: monitoring process, pipeline or utility / - / S1
Cognitronics Corp. -- see R2
Cohu Electronics, Inc., Box 623, San Diego, Calif. 92112 / input scanner, model 453M / DESCR: scanning accomplished by means of electro-mechanical stepping switches; scanner allows local or remote control, manual or automatic operation / USE: with either digital or analog measuring or recording instruments in any application where multiple signals must be scanned / $2500 / S1
Control Equipment Corp., 19 Kearney Rd., Needham Heights, Mass. 02194 / Series 3010 relay multiplexer / DESCR: 3-pole switching; contact life 1 billion operations; 5 to 100 channels; 200 channels/second scanning; flexible programming; digital outputs isolated by buffer amplifiers / - / $1300 to $3000 / S1
Control Equipment Corp., *a / Series 3020 multiplexer, electronic / DESCR: all solid-state; ± 0.02% accuracy and stability; 5 to 100 channels; 30,000 channels/second scanning; flexible programming; digital outputs isolated by buffer amplifiers / - / $1200 to $12,000 / S1
Control Equipment Corp., *a / Series 3080 crossbar multiplexer / DESCR: 1, 2, or 3 pole switching, 100 to 1000 channels, 50 channel/second scannings flexible programming / - / $1600 to $3000 / S1
Data Trends, Inc.
Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 765 analog multiplexer / DESCR: up to 100 channels ± 50 millivolts to ± 5 volt input; 100 megohm closed input, impedance patchboard sequencing / - / $2100 to $3600 / S1
Hagan Controls Corp., 250 Mt. Lebanon Blvd., Pittsburgh, Pa. / alarm indicating monitor / DESCR: scans various dc volt inputs, compares with preselected set point values, initiates alarm when input is in alarm condition / USE: scans analog voltages of critical process variables, warns operator of hazardous condition. Also, to obtain digital readout of a variable / $16,000 and up / S1
Jonker Corp. -- see D3, C15, P13
F. B. MacLaren & Co., Inc., 15 Stepar Pl., Huntington Sta., L. I., N. Y. 11746 / scanners / DESCR: unit provides servoed optical elements to scan models and maps in azimuth and elevation, introduce image roll, and maintain proper focus for simulation systems / USE: for custom designed simulator programs / variable, depending on application / S1
Nash and Harrison Ltd. -- see C11

S2. SERVOMECHANISMS

Ampex Corp., Instrumentation Div., 401 Broadway, Redwood City, Calif. 94063 / servomechanisms / DESCR: servomechanisms for longitudinal and rotary head instrumentation tape recorders, reel-to-reel and continuous loop / - / - / S2
The Bristol Co., Waterbury, Conn. 06720 / servo mechanisms / DESCR: null-balance, motor-driven units; relay rack mounting; retransmitting slidewire and alarm attachments available / USE: measure and indicate milivolt input / $500 to $800 / S2
Clifton Precision Products, Div. of Litton Industries
General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / servomechanisms / DESCR: 2-, 3-, and 4-component Flite-Line servos, with or without electronics; use size 8 or size 11 Kearfott components. Single and dual speed servos; DC and AC integrating servos / USE: D-A, A-D, coordinate and signal conversion; program actuation; reference positioning; all servo applications / - / S2
F. B. MacLaren & Co., Inc., 15 Stepar Pl., Huntington Sta., L. I. N. Y. 11746 / servo systems / DESCR: custom designed electro-mechanical assemblies to perform addition, subtraction, multiplication, division, integration, differentiation or followup and data conversion functions, in both military and industrial applications / USE: all instrument servo applications / variable, depending on application / S2
Moog Inc., Industrial Div., East Aurora, N. Y. / computer memory access / DESCR: servo components and systems, primarily electro-hydraulic / USE: to position pick-off heads in disk type computer memory systems / $200 to $3000 / S2
Reeves Instrument Co. -- see C9
Lear Siegler, Inc., Power Equipment Div. -- see C13

S3. SIMULATORS

Aircraft Armaments, Inc., York Rd., Cockeysville, Md. 21030 / simulators / DESCR: air traffic control, missile training (REDSTONE, SERGEANT, ATLAS, POLARIS, NIKE-HERCULES), anti-submarine warfare training, space vehicle, radar target, 3-axis flight / USE: training, test and evaluation of personnel, components and systems / custom / S3
Burr-Brown Research Corp., 6730 S. Tucson Blvd., Tucson, Ariz. 85706 / analog simulator/computer / DESCR: accurate simulator/computer utilizing high quality, field proven Burr-Brown operational amplifiers / USE: for teaching physical dynamics to university undergraduates in all engineering and physical science departments / $3000 to $50,000 / S3
COMRESS, Inc., 2120 Bladensburg Rd., N.E., Washington, D. C. 20018 / SCERT (systems and computers, evaluation & review technique) / DESCR: computerized simulation system for evaluating hardware/software. Applications are simulated through the program which outputs specific data regarding costs and performance on computer configurations / USE: managing computer installations; equipment selection, enhancement and design, and as a guide in programming / variable depending on specific job requirements / S3
Exact Electronics Inc. -- see C12
HRB-Singer, Inc. -- see I1
Philbrick Researches, Inc. -- see C9
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / simulators, digital / SDS DES-1 an extension of SDS 9300 general-purpose digital computer; hybrid interface equipment can link any SDS computer to virtually any analog computer creating integrated hybrid computing system / USE: simulation applications and the solution of differential equations / approx. $200,000 (DES-1) / S3
Scientific Educational Products -- see E2
Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / 510 PCM simulator / DESCR: solid state; 5 programmable 33 bit words with main and sub-frame capabilities / USE: checkout data handling equipment / $10,000 to $15,000 / S3
Technical Measurement Corp., Telemetrics Div., *a / 513 stored program simulator / DESCR: solid state PCM, PAM, PDM programmable simulator; can simu-

late any format / USE: checkout of data handling equipment / $20,000 to $30,000 / S3
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / simulators / capability for development and application of simulation models of systems to evaluate systems design and recommend improvements / - / - / S3
URS Corp. -- see 02, P12

S4. STORAGE SYSTEMS

Bryant Computer Products, Div. of Ex-Cell-O Corp., 850 Ladd Rd., Walled Lake, Mich. 48088 / AUTO-LIFT R drum systems / DESCR: rotating, digital, mass storage, random access. Standard line to meet needs. Capacities of 706,500 to 100 million bits / USE: computer peripheral equipment / on request / S4
Bryant Computer Products, Div. of Ex-Cell-O Corp., *a / Model 2A Series 4000 disc file systems / DESCR: rotating, digital, mass storage, random access; modular, non-interchangeable discs. Available one to 26 discs, equal to capacities of 83 million to 3.8 billion bits / USE: computer peripheral equipment / on request / S4
Bryant Computer Products, Div. of Ex-Cell-O Corp., *a / PhD drum systems / DESCR: rotating, digital data, mass storage, random access; up to four independent channels of simultaneous random access to same store; capacities up to 340 million bits / USE: computer peripheral equipment / on request / S4
Control Data Corp., -- see C14
Cook Electrical Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / magnetic storing systems / DESCR: incremental, continuous magnetic tape readers and recorders; systems engineering assistance / USE: various applications / $4000 to $15,000 / S4
DA-PEX Company -- see C8
DI/AN Controls, Inc. -- see M2, C13
Digital Devices -- see D5, M2
Dolin Metal Products, Inc., 315 Lexington Ave., Brooklyn, N.Y. 11216 / mobile storage systems / DESCR: adaptation of existing storage equipment on movable carriages rolling on tracks one row in front of another to increase capacities / USE: where space is limited / - / S4
Fabri-Tek Inc. -- see E2, M2
Image Instruments, Inc., 2300 Washington St., Newton Lower Falls, Mass. 02162 / storage tube systems / DESCR: storage tube systems used for displaying computer output for off line processing or man-machine decision making / USE: temporary storage for output to be visually displayed / $15,000 to $30,000 / S4
Trak Electronics Co., Inc. -- see C19

S5. STORAGE, MAGNETIC

Ampex Corp. -- see D3, I2, and M2
Bryant Computer Products, Div. of Ex-Cell-O Corp. -- see S4
Control Data Corp.
Cook Electric Co., Data Stor Div. -- see S4
Data Communications, Inc. -- see C7
Data Products Corp. -- see D8
Digital Development Corp., 5575 Kearny Villa Rd., San Diego, Calif. 92123 / magnetic storage systems / DESCR: up to 13 commands; 8.5 msec. average access; 6 modular capacities 7.5 to 250 million bits per unit. Up to 8 disc units per system; simultaneous multiple access I/O channels / USE: computer memory / $15,000 to $2,000,000 / S5
Electronic Memories, Inc. -- see M2
General Instrument Corp., Magne-Head Div., 13040 S. Cerise, Hawthorne, Calif. 90250 / magnetic disc memory system / DESCR: electronics to interface with any data source; median access time from 5 to 20 milliseconds; up to 50 million bits of storage / USE: inventory control, process control, communications, multiplexing, data logging, data buffer / $3000 to $50,000 / S5
General Instrument Corp., Magne-Head Div., *a / magnetic drum memory system / DESCR: electronics to interface with any data source; median access time from 5-20 milliseconds; up to 10 million bits of storage / USE: inventory control, process control, communications, multiplexing, data logging, data buffer / $5000 to $100,000 / S5
General Precision, Inc., Librascope Group -- see M2
Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / mass memory file / DESCR: magnetic card storage and retrieval; 15 to 300 million characters / USE: data processor peripheral / $29,250 to $100,125 / S5
Midwestern Instruments, Inc., Subsidiary of Tele Corp.
Scientific Data Systems, Inc. -- D8, M2, T3

S6. SWITCHES

James Cunningham Son & Co., Inc., 10 Carriage St., Honeoye Falls, N.Y. / Cunningham crossbar switch / DESCR: coordinately actuated switch matrix constructed in a 3 axis cartesian format; a co-linear line contact arrangement permits a shielded and balanced system / USE: for switching and routing binary and digital data. Sampling, multiplexing and scanning of analog information / $180 to $1800 / S6
Electro-Miniatures Corp., 600 Huyler St., So. Hackensack, N.J. 07606 / commutator switches / DESCR: circular plastic compounds into which is embedded various metal segments or rings. Unit rotates; contact with rotating unit made by brushes / - / $10 to $3000 / S6
Engineered Electronics Co., 1441 E. Chestnut St., Santa Ana, Calif. 92702 / rotary thumbwheel switches / DESCR: compact; legible switch / USE: to convert dial setting to equipment code and to provide in-line readout / $3.80/switch to $25/switch / S6
F & F Enterprises, Inc., Chicago Switch Div., 2035 Wabansia Ave., Chicago, Ill. 60647 / switches / DESCR: panel switches lighted or unlighted, rocker or push button up to 6PDT, momentary or maintained circuits, push push, plug into PC board / USE: programming, instruction, read out / 50¢ to $6 / S6
Litton Industries, USECO Div.
MICRO SWITCH, a Div. of Honeywell, 11 W. Spring St., Freeport, Ill. 61032 / miniature toggle switches / DESCR: TW Series has 10 tiny, lightweight, long-life SPDT, DPDT switches with 5 different circuitry options each to give widest range of 2 and 3 positions maintained and momentary versions / USE: large scale computer maintanance panels; military and commercial electronic use / - / S6
MICRO SWITCH, a Div. of Honeywell, *a / Series 2 lighted pushbuttons / DESCR: round or rectangular display; over 80 different colored display screens; wide choice in circuitry and handling power in 30 different switch units / USE: control and display functions / - / S6
MICRO SWITCH, a Div. of Honeywell, *a / "SM" subminiature switches / DESCR: "SM" SPDT switches combine small size, light weight with ample precision operation, terminal variety, and long life; available with silver and gold contacts / USE: limit and control / - / S6
MICRO SWITCH, a Div. of Honeywell, *a / Sub sub-miniature switches / DESCR: tiniest of snap-action switches, the "1SX1" weighs 1/28 ounce; plated turret-type terminals; variety of actuators; UL, CSA listed at 7 amps 28 vdc or 115/230 vac capacity / USE: limit and control functions / - / S6
MICRO SWITCH, a Div. of Honeywell, *a / V3 miniature basic snap-action switch / DESCR: postage stamp sized; has wide variety of terminals, contact arrangements, operating characteristics, long operating life (over 10 million). General purpose types, UL, CSA listed at 15 amps 125/250 vac; 1/4 amp vdc / USE: limit and control functions / S6

S7. SWITCHES, STEPPING

James Cunningham Son & Co., Inc. -- see S6

S8. SYNCHROS

Clifton Precision Products, Div. of Litton Industries
General Precision, Inc., Kearfott Products Div., 1150 McBride Ave., Little Falls, N. J. 07424 / synchros / DESCR: low and high Z hi-accuracy CX's, CDX's, TX's, TR's, induction pots, multi-speed synchros, RX's, RDX's, RC's and tandem synchros ranging from size 5 to 100 / USE: data transmission, computing systems and servos / - / S8
Reeves Instrument Co. -- see C9
Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / 6723 bit synchronizer / DESCR: regenerates PCM data to improve S/N ratio, generates 4 phases of clock, converts data to NRZ-S(L) and NRZ-S(L) under program control / - / $25,000 to $30,000 / S8

S9. SYSTEMS ENGINEERING

Advance Data Systems -- see C15
Aircraft Armaments, Inc. -- see S3
Ampex Corp. -- see I2, M2, and R13
Auerbach Corp. -- see C15
Bonner & Moore Associates, Inc. -- see 02, I1, and P12
Booz, Allen Applied Research, Inc. -- see C14, C15
The Bristol Co., Waterbury, Conn. 06720 / systems engineering / DESCR: engineer and fabricate components and packaged systems for recording, controlling and telemetering / USE: analog or digital techniques; loggers (including computer-based equipment); supervisory systems; instrumentation; panels; consoles / no average estimate can be given / S9
The Bunker-Ramo Corp. -- see I1
Control Data Corp. -- see C14
Cook Electric Co., Data Stor Div. -- see S4
James Cunningham Son & Co., Inc., 10 Carriage St., Honeoye Falls, N. Y. / systems engineering / DESCR: custom electronic systems involving switching, routing or scanning of high speed digital data or low level analog signal information / - / N/A / S9
Decision Systems Inc.
Discon Corp.
Ferranti-Packard Electric Ltd., Industry St., Toronto 15, Ontario, Canada / systems engineering / DESCR: design and manufacture of commercial and military digital systems / USE: various / varies / S9
General Atronics Corp. -- see C1
General Instrument Corp., Radio Receptor Div., 100 Andrews Rd., Hicksville, N. Y. 11802 / general support equipment / DESCR: custom design special purpose digital systems utilizing general purpose or special purpose computers / - / - / S9
HRB-Singer, Inc. -- see I1
Innovation Consultants, Inc., 4 E. State St., Doylestown, Pa. 18901 / systems engineering / DESCR: assistance in problem definition, computer systems design and total system engineering / USE: publishing, advertising, marketing, printing, education, associations / per diem / S9
Keystone Computer Associates, Inc. -- see P12
Reeves Instrument Co. -- see C9
Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / systems engineering / DESCR: complete systems engineering services in conjunction with computer system sales / - / no charge for systems engineering if 80% or more of system price is represented by SDS standard products, including SDS digital computer / S9
Scientific Data Systems, Inc. -- see C11
Merle Thomas Corp. -- see C15
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / systems engineering / DESCR: total capability to provide systems engineering and technical direction / USE: data systems applications / - / S9
URS Corp. -- see I1
Wolf Research & Development Corp., P. O. Box 36, Baker Ave., W. Concord, Mass. 01781 / systems engineering / DESCR: computer applications, data control complexes for satellite systems, management information and control systems, feasibility studies, hardware configuration and real-time controls / - / S9

T1. TAPE HANDLERS

Ampex Corp., Computer Products Div., 9937 W. Jefferson Blvd., Culver City, Calif. 90230 / family of servo-driven, interface-compatible, single capstan digital tape transports / DESCR: maximum tape speeds: Model TM-7, 36 ips; Model TM-9, 75 ips; Model TM-11, 120 ips; Model TM-12, 150 ips. Dual or multiple speeds, single within given ranges, packing densities 200, 556, 800 cpi available all models / - / - / T1
Ampex Corp. -- see D3
Bell Telephone Mfg. Co., Automation Systems Div., Berkenrodelel 33, Hoboken, Belgium / digital magnetic tape handlers / DESCR: a wide choice of tape speeds as well as IBM compatibility on 7 and 9 tracks / USE: for connection to any computer / $9000 to $17,000 / T1
Chalco Engineering Corp. -- see R1
Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55440 / 680, 685 and 690 Magnetic Tape Certifiers / DESCR: automatically inspect magnetic tape for variety of faults; also sell certified magnetic tape, plus certification services and actual tape certification equipment / - / - / T1
Cook Electric Co., Data Stor Div., 6401 W. Oakton, Morton Grove, Ill. 60053 / tape handlers / DESCR: magnetic tape readers and recorders; militarized paper tape readers / USE: data acquisition and equipment testing / $4000 to $20,000 / T1
Cycle Equipment Co., P. O. Box 307, Los Gatos, Calif. 95030 / cycle tape handlers (perforated tape) / DESCR: cycle winders, feeders, unwinders and tape transports; speeds up to 35" per second with 3" diameter core; 52" per second with NAB hub in reel sizes to 8" / USE: communications industry, data processing industry, printing industry (automatic typesetting), etc. / $13 to $480 / T1
DA-PEX Company -- see C8
Data-link Corp., Box 177, Los Altos, Calif. 94022 / D-L 40 Splicer-Gauge-Punch / DESCR: punched tape splicer with registration gauge and manual code hole punch / USE: splicer section holds tape; punch will punch individual codes; gauge verifies correct tape jointing / $85 / T1
Data-link Corp., *a / D-L 45 Unwinder / DESCR: center feed unwinder for 5-6-7-8 channel punched paper tape / USE: to

feed tape into EDP or automatic equipment from the center of wound tape / $20 / T1

Data-link Corp., *a / punched tape winder / DESCR: electric winder 3/4" or 1", split or demountable reel, 35 to 70 CPS with friction clutch drive with 2 oz. ±1/2 oz. pull at hub / USE: wind paper tape from original data equipment / $75 to $95 / T1

Dresser Products, Inc., 112-114 Baker St., Providence, R. I. 02905 / #6501 electric tape rewinder / DESCR: designed to rewind punched tape from unwind can onto tape reader reel at 225 feet/min. Unwind can holds full roll of tape / USE: rewinding tape / $107 to $152 / T1

Hewlett-Packard Co., Datamec Div., 345 Middlefield Rd., Mountain View, Calif. 94041 / D-2020 digital magnetic tape unit / DESCR: 1 or 2 tape speeds 1 ips to 45 ips; packing density 200, 556 and 800 bpi; 7 or 9 track / USE: computer tape system / $4800 to $13,000 / T1

Hewlett-Packard Co., Datamec Div., *a / D-3029 digital magnetic tape unit / DESCR: replacement for IBM 729-II or 729-V; low cost, plug interchangeable / USE: with IBM 1400 or 7000 series computers / $14,500 / T1

Hewlett-Packard Co., Datamec Div., *a / D-3030 digital magnetic tape unit / DESCR: tape speed 75 ips; packing density 200, 556 and 800 bpi; single and multiple units / USE: computer tape system / $10,000 to $16,000 / T1

Honeywell, Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / magnetic tape unit / DESCR: digital unit, 1/2" and 3/4" tape, wide variety of speeds and densities / USE: data processor peripheral / $10,000 to $40,000 / T1

Invac Corp. -- see T9

Midwestern Instruments, Inc., Subsidiary of Tele Corp., 41st & Sheridan Rd., Tulsa, Okla. 74101 / tape transport systems / DESCR: complete series of tape transport systems; low to high performance range with all IBM format compatibilities; on-line use with all major computer manufacturers equipments / USE: on-line computer, off-line data processing, data handling and data acquisition / - / T1

Monarch Metal Products, Inc. -- see D1

Omni-Data, Div. of Borg-Warner Corp., 511 N. Broad St., Philadelphia, Pa. 19123 / paper tape reelers / DESCR: high-speed unidirectional and bidirectional tape handler, speeds up to 100" per sec. in either direction with reel sizes up to 10½" / USE: feed and take up paper tape from readers, punches and recorders / $785 to $2000 / T1

Potter Instrument Co., Inc., 151 Sunnyside Blvd., Plainview, N. Y. 11803 / computer peripheral equipment and systems / DESCR: digital magnetic tape handlers and systems; input and output of data to and from computer-on-line and off-line / USE: electronic data processing / T1

Prestoseal Mfg. Corp., 37-12 108th St., Corona, N. Y. / paper tape splicer / DESCR: splicer for punched paper tape, no cements or splicing patches used. Bond is a fusion between the fibers of the tape, 200 splices per hour / - / $672 / T1

Teletype Corp.

T2. TAPE, MAGNETIC

Ampex Corp., Magnetic Tape Div., 401 Broadway, Redwood City, Calif. 94063; (manufacturing facilities) P. O. Box 190, Opelika, Ala. 36801 / magnetic tape / DESCR: research, development, and production / USE: computer, instrumentation, video and audio recording / - / T2

Audio Devices, Inc., 235 East 42nd St., New York, N. Y. / computer tape / DESCR: magnetic recording tape. Variety of reel types and reel colors, in plastic cases, and with reel collars. / USE: computer systems using magnetic tape / varies with size and quantity / T2

Certron Corp., 2233 Barry Ave., Los Angeles, Calif. 90064 / magnetic tape certification / DESCR: certify new magnetic tape, recertify and rehabilitate used magnetic tape / - / $6 to $12 / T2

COMPUTRON, INC., Member of the BASF Group, 122 Calvary St., Waltham, Mass. 02154 / COMPUTAPE / DESCR: high quality, high density magnetic tape for computers and instrumentation exclusively. Guaranteed at 556, 800, or 1000 bpi. Full-width certification available / USE: computers and instrumentation / available upon request / T2

Control Data Corp. -- see T1

Cook Electric Co., Data Stor Div. -- see T1

Honeywell Electronic Data Processing, Supplies Div., 60 Walnut St., Wellesley Hills, Mass. 02181 / ½ inch magnetic tape / DESCR: magnetic oxide-coated, Mylar-base, rolled in various lengths from 700 feet to 2400 feet on heavy plastic reels / USE: store information / $19.50 to $36.50 per reel / T2

Honeywell Electronic Data Processing, Supplies Div., *a / 3/4" magnetic tape / DESCR: magnetic oxide coated, Mylar-base, rolled in various lengths from 700 feet to 2450 feet on heavy metal reels / USE: store information / $30 to $66 per reel / T2

Information for Industry, Inc., 1000 Connecticut Ave., N. W., Washington, D. C. 20036 / magnetic tape Uniterm Index / DESCR: sole owners of data base covering all U. S. chemically related patents issued since 1950 to date. Programs available for IBM, Burroughs, and CDC equipment / USE: patent searching by law firms and research department personnel / $6600 to $11,900 / T2

Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif. 95052 / precision magnetic computer tape / DESCR: heavy duty, long wearing; specially treated surface; low level modulation moise; standard configurations / USE: on digital transports / - / T2

Micronetic Corp., 3127 Colvin St., Alexandria, Va. 22314 / Micronetic 404 magnetic tape / DESCR: patented thermosetting binder system / - / $23 to $29 / T2

Reeves Soundcraft Corp., 15 Great Pasture Rd., Danbury, Conn. 06813 / magnetic tape for computers / DESCR: base material of Mylar film or approved equivalent: tapes of various lengths; magnetic performance measured on all channels of IBM-compatible tape drive; photo-sensing markers / USE: data storage / $10 to $40 / T2

T3. TAPE, FILING SYSTEMS

Ampex Corp. -- see I2

Cook Electric Co., Data Stor Div. -- see T1

Dolin Metal Products, Inc., 315 Lexington Ave., Brooklyn, N. Y. 11216 / "Tape-Stor" units / DESCR: build-up type reel units, 2 stock sizes with reel inserts for 4 standard size reels; special sizes and types also available / USE: storage of data tapes / $15 to $18 / T3

Monarch Metal Products, Inc. -- see D1

Ray Myers Corp., 1302 E. Main St., Endicott, N. Y. 13760 / tape library / DESCR: storage for magnetic tapes / - / - / T3

Scientific Data Systems, Inc., 1649 Seventeenth St., Santa Monica, Calif. 90404 / tape, magnetic--filing systems / DESCR: single-channel tape transport (MAGPAK)(TM), transfer rate 1500 char/sec; seven-channel units, densities 200, 556, 800 bits/inch, read/write speeds 60, 75, 120 inches/sec, transfer rates 12, 15, 33, 41.7, 48, 60, 96 kc / - / $15,000 (MAGPAK) to $43,000 / T3

Scientific Data Systems, Inc. -- see M2

TAB Products Co. -- see D1

Wheeldex, Inc., 1000 N. Division St., Peekskill, N. Y. 10567 / mechanized files and continuous pinfeed forms / DESCR: motorized shelves and similar automatic filing equipment for magnetic tape / - / - / T3

Wright Line Div., Barry Wright Corp., 160 Gold Star Blvd., Worcester, Mass. 01606 / TAPE-SEAL computer tape storage system / DESCR: system developed around flexible polyethylene belt which wraps around tape reel; protects and increases storage capacity of reels up to 100% when stored in a cannister / USE: belt (TAPE SEAL) allows the hanging of reel of tape for storage / $1.50 for belt, equipment in wide price range / T3

T4. TAPE, READERS

Addo-X, Inc. -- see R7

Carlton Controls Corp. -- see R8

Cook Electric Co., Data Stor Div. -- see T1

Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 851A/852 tape search & control system / DESCR: reads time on magnetic tape in either forward or reverse direction. Front panel selection of all IRIG codes; millisecond output resolution. Other codes available / - / $4500 to $8800 / T4

Midwestern Instruments, Inc., Subsidiary of Tele Corp.

Mohawk Data Sciences Corp., Harter St., Herkimer, N. Y. 13350 / Model 700 buffered tape unit / DESCR: provides universal interface to output BCD character serial, bit parallel reading, half-inch tape with 80 character block NRZ recording, accepts and records BCD input / USE: input or output device where magnetic tape is involved / $8000 to $10,000 / T4

Omni-Data, Div. of Borg-Warner -- see T1

S-I Electronics, Inc., 103 Park Ave., Nutley, N. J. 07110 / digital magnetic tape transports / DESCR: ruggedized environmental, computer-compatible; only models qualified to MIL-E-5400 and MIL-I-26600; utilized in airborne, shipboard, vehicular, oceanographic and seismic requirements. Recording methods: RZ, RB, NRZ, NRZI, and phase modulation / USE: on and off line recording and reading of digital information in computer and data acquisition applications / $10,000 to $25,000 / T4

T5. TAPE, RECORDERS

Ampex Corp., Audio and Video Communications Div., 401 Broadway, Redwood City, Calif. 94063; (manufacturing facilities) 600 Wooten Rd., Colorado Springs, Colo. 80909 / tape recorders / DESCR: videotape recorders, color and black-and-white; professional audio recorders / - / - / T5

Ampex Corp. -- see C21, C31, D2, I2, and T1

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. 91109 / magnetic tape recorder/reproducers / DESCR: analog and digital systems available. Types include portable, 1.5 mc response, extra wide and double bandwidth, general laboratory, high-speed digital and continuous loop / - / - / T5

Datapulse Inc., KRS Instruments Div., 780 S. Arroyo Pkwy., Pasadena, Calif. 91105 / DR-2 DATA-STACT(TM) instrumentation recorder / DESCR: 6 magnetic tape cartridges containing endless-loop tapes up to 1200 ft. in length; records or reproduces data in up to 4 channels / USE: fault recording, vibration data analysis, delay simulation, process control, physiological/biological data acquisition / $3200 to $5700 / T5

Datapulse Inc., KRS Instruments Div., *a / MD-2 DATA-STACT(TM) instrumentation recorder / DESCR: single tape continuous-loop cartridge with reverse and fast forward operating modes, push-button controls, solid-state electronics / USE: record and reproduce data / $950 to $2380 / T5

Genisco Technology Corp., Systems Div., -- see A2

Leach Corp., Controls Div., 717 N. Coney Ave., Azusa, Calif. / DDR-3300 digital recorder/reproducer system / DESCR: weighs less than 125 lbs., works off 12 volts, operates during 10g vibration; quantizes and encodes analog signals, records them in computer compatible digital format / USE: oil industry exploration / - / T5

Leach Corp., Controls Div., *a / MTR-3200 recorder/reproducer / DESCR: provides 14 channels analog and FM or 16 digital channels; 7 tape speeds; tape capacity 2400 Ft. standard / USE: high environmental applications including aircraft, missile, nuclear test, etc. / - / T5

Lufkin Research Laboratories, 210 W. 131st St., Los Angeles, Calif. 90061 / digital magnetic tape recorders / DESCR: portable, scientific, airborne and keyboard recorders; battery powered and cartridge loaded / - / $1100 to $2300 / T5

Midwestern Instruments, Inc., Subsidiary of Tele Corp.

S-I Electronics, Inc. -- see T4

Texas Instruments Inc., Industrial Products Group, 3609 Buffalo Speedway, Houston, Tex. 77006 / Series 500/1000 digital tape transports / DESCR: precision magnetic tape transports for recording digital data; tape path permanently aligned for life of instrument / USE: in the field or laboratory; wherever requirements make a portable instrument necessary / - / T5

T6. TAPE, REELS

Audio Devices, Inc. -- see T2

Cook Electric Co., Data Stor Div. -- see T1

Cycle Equipment Co., P. O. Box 307, Los Gatos, Calif. 95030 / tape reels (perforated tape) / DESCR: available in 6", 8", 10½" and 12" diameters; adjustable for widths to accommodate 11/16", 7/8" and 1" wide tape; detachable solid round 3" diameter plastic core / USE: on widers, feeders and tape transports in accumulating, dispensing and storing tape / $17 to $24 / T6

Memorex Corp. -- see T2

Omni-Data, Div. of Borg-Warner -- see T1

T7. TAPE, PAPER

Arvey Corp., Lamcote Div., 3500 N. Kimball Ave., Chicago, Ill. 60618 / perforator tape / DESCR: mylar reinforced paper, foil, and metallized foil combinations; all standard colors, widths and thicknesses / USE: for photoelectric and electro-mechanical readers / - / T7

Chalco Engineering Corp. -- see R1

Data-link Corp., Box 177, Los Altos, Calif. 94022 / D-L 80 Series, splice correction tape / DESCR: self-adhering tape, 1 ft. lengths, for 5, 6, 7, 8 channel tape to make tape splices or cover code errors for hand punched corrections (1-5 code levels) / USE: with a splicer and punch / $8.50 to $15 / T7

Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / Model R-125 photoelectric tape reader / DESCR: accommodates 5 to 8 level, 11/16 to 1" wide tape for photoelectric reading at 0-150 char/sec asynchronously; desk or panel mounting-exceeds EIA standards / USE: peripheral equipment for data processing applications / $750 unit price / T7

Paper Manufacturers Co. -- see P4

T8. TAPE, PAPER-FILING SYSTEMS

Dresser Products, Inc., 112-114 Baker St., Providence, R. I. 02905 / tape file / DESCR: data

processing folders: six styles, letter size documents; two styles, legal size documents. Available in various colors and with one, two or four tape pockets / USE: transporting and filing punched paper tape and punched cards with associated data / $89/M to $120/M / T8
Wheeldex, Inc., 1000 N. Division St., Peekskill, N. Y. 10567 / mechanized files and continuous pinfeed forms / DESCR: motorized and manual files for all material sizes from cards to correspondence including paper and magnetic tapes, reels, etc. / - / - / T8

T9. TAPE, PAPER-PUNCHES

Addo-X, Inc. -- see D3
Control Data Corp.
Cook Electric Co., Data Stor Div. -- see T1
Creed & Co.Ltd. -- see R7
Digital Electronic Machines, Inc. -- see D1
Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / Model P-135 tape punch / DESCR: accommodates 5 to 8 level, 11/16 to 1" wide tape for punching at 0-35 char/sec; DC operated-exceeds EIA standards / USE: peripheral equipment for data processing applications / $460 unit price / T9
Robins Data Devices, Inc. -- see D1
Soroban Engineering, Inc. -- see R7

T10. TAPE, PAPER-READERS

Chalco Engineering Corp. -- see R1
Control Data Corp.
Creed & Co. Ltd. -- see R7
Electronic Engineering Co. of Calif., P. O. Box 58, Santa Ana, Calif. 92702 / EECO 5000 Series photo block readers / DESCR: all solid state drive photo electric readout; 40-160 bit per block, 12 blocks per second. Eliminates need for buffer storage / - / $1200 to $2700 / T10
Invac Corp., 26 Fox Rd., Bear Hill Industrial Park, Waltham, Mass. 02154 / Model R-110 photoelectric tape reader / DESCR: accommodates 5 to 8 level, 11/16 to 1" wide, tape for photoelectric reading at 0-35 char/sec asynchronously; desk or panel mounting-exceeds EIA standards / USE: peripheral equipment for data processing applications / $470 unit price / T10
Invac Corp. -- see T7
Omni-Data, Div. of Borg-Warner -- see T1
Rheem Electoonics, 5250 W. El Segundo Blvd., Hawthorne, Calif. 90250 / punched tape spoolers / DESCR: 15 to 100 IPS., rewind 200 IPS, for 8" and 10½" reels; gentle tape take-up during spooling and rewind / USE: automatic tape supply and take up during tape reader operation / $700 to $2500 / T10
Soroban Engineering, Inc. -- see R7
Tally Corp. -- see R7
Wang Labs., Inc. -- see C36, D6, R7

T11. TELEMETERING SYSTEMS

Airpax Electronics, Inc., P. O. Box 8488, Fort Lauderdale, Fla. 33310 / telemetry / DESCR: frequency discriminator, tape speed compensated / USE: - / $395 / T11
Astrodata, Inc.
The Bendix Corp., Bendix-Pacific Div., 11600 Sherman Way, Hollywood, Calif. 91605 / telemetry systems / DESCR: variety of standard and special purpose telemeter transmitting and receiving systems; IRIG FM/FM standards used / USE: missile and space flight test programs / $2000 to $10,000 / T11
The Bristol Co., Waterbury, Conn. 06720 / telemeters / DESCR: Metameter® analog systems (impulse duration type); Metatronic analog frequency-type systems; digital telemetering / USE: measurement, transmission and readout of variables in process and utility applications / $500 to $1000 / T11
CAE Industries Ltd., P. O. Box 6166, Montreal 3, Quebec, Canada / telepath telemetry / DESCR: on-line open and closed loop systems, unattended remote control and supervision of remotely located station equipment and processes / USE: low speed telegraph and data speed operation applications in utilities, pipeline, process control industry / $5000 to $20,000 per site / T11
DI/AN Controls, Inc. -- see C13
Electro-Mechanical Research, Inc., P. O. Box 100, Sarasota, Fla. 33378 / telemetering instrumentation, components, systems / DESCR: data acquisition coding, transmission, reception, demodulation and/or decommutation including: fm, pam, pdm, pcm; telemetry and data processing systems / USE: test and monitoring of aerospace vehicles / not applicable / T11
General Devices, Inc. -- see C28, D1
General Electric Co., Electronic Components Sales Operation
General Instrument Corp., Defense and Engineering Products Group, Radio Receptor Div., Andrews Rd., Hicksville, N. Y. 11802 / telemetering systems / DESCR: microwave telemetry transmitter, lightweight compact equipment capable of 15 watts CW output power in the 2-3 KMC telemetry band / USE: missiles, aircraft and aerospace environment / $3000 to $12,000 / T11
Genisco Technology Corp., Systems Div., 18435 Susana Rd., Compton, Calif. 90221 / telemetry checkout equipment / DESCR: receivers and discriminators for processing of telemetered signals / USE: ground and production checkout / under $100 and up / T11
International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91502 / telemetry systems / DESCR: transmitters, voltage controlled oscillators, mixer amplifiers to complete RF systems / USE: airborne or aerospace telemetry for data link information / - / T11
Moore Associates, Inc., 893 American St., San Carlos, Calif. / data acquisition systems / DESCR: time division multiplex systems (alarm supervision, remote control, digital telemetering data); also input-output packages for computer interface, automatic sub-program/controller operations related to data acquisitions, and code converters / USE: power utility economic load dispatch; hydroelectric dam operation controlling power generation, oil well production economics and test; etc. / $1800 and up / T11
Quindar Electronics Inc., 60 Fadem Rd., Springfield, N. J. 07081 / solid state analog and digital telemetering / DESCR: analog and digital telemetering modules furnished with or w/o tone keyers and converters, with or w/o computer interface adapters (BCD to decimal, etc.) / USE: for data transmission and handling / $300 to $1500 / T11
Stellarmetrics, Inc., 210 E. Ortega St., Santa Barbara, Calif. 93101 / DD-1024 digital decommutator / DESCR: ground-based solid state telemetry decommutation system featuring integral 10-bit digital output, continuous rate tuning, up to 90 channel readout of standard IRIG and special format signals / - / approximately $17,000 / T11
Stellarmetrics, Inc., *a / Series 200 commutators / DESCR: solid state electronic commutators feature modular flexibility for up to 120 channels on a single unit, and slaving capability to combine more than one unit in a single package / USE: for missile, space vehicle and satellite telemetry applications / $2000 to $4000 / T11
Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / 620 universal PCM decommutator / DESCR: low cost universal system; easily adaptable for all existing or proposed fixed PCM telemetry formats; conditions and decommutates / USE: PCM telemetry signals / $45,000 to $85,000 / T11
Transitel International Corp. -- see C7
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / telemetering systems / DESCR: complete capability exists in PCM telemetry and command decoder equipments; proven space hardware / - / - / T11
Westinghouse Electric Corp., Electronic & Specialty Products Group

T12. THIN-FILMS, MAGNETIC

The Bunker-Ramo Corp. -- see C13
Haddonfield Research & Mfg. Co., 121 Gill Rd., Haddonfield, N. J. 08033 / magnetic thin-films / DESCR: "Memro-film" thin magnetic alloy substrates and planes; fabricated and etching methods; custom and standard parts; maintaining quality and uniformity / USE: computer memory applications / 10¢ per bit to 75¢ per bit / T12

T13. TIMING DEVICES

Chrono-log Corp., 2583 West Chester Pike, Broomall, Pa. 19008 / digital clocks/calendars / DESCR: electronic and electromechanical time of day clocks/calendars to provide digital time readings to computers, data loggers, time displays, and telemetry systems / USE: to provide decimal or BCD time readings to digital systems / $350 to $2500 / T13
Chrono-log Corp., *a / programmable clock/calendar / DESCR: reads date and time of day into memory under program control on IBM 7000, System/360 and CDC computers / USE: to provide date and time for billing and job identification on computers with monitor routines / $2500 to $4500 / T13
Chrono-log Corp., *a / time code generator/readers / DESCR: generate serial time codes for recording on analog tape recorders. Read back time code to identify data recorded on tape for time correlation and quick look analysis / USE: telemetry, wind tunnel tests, seismographic and oceanographic studies, etc. / $2490 to $5000 / T13
General Electric Co., Electronic Components Sales Operation
Logitek, Inc., 42 Central Drive, Farmingdale, L. I., N. Y. 11735 / digital clock / DESCR: generates time of day or elapsed time; displays and makes available for computer entry / USE: determine computer time, count down, process time, etc. / $850 to $2000 / T13
Logitek, Inc., *a / tape search and control / DESCR: searching of magnetic tape to particular time as recorded by time code generator / USE: data correlation and editing / $4000 to $22,000 / T13
Logitek, Inc., *a / time code generator / DESCR: generates precise time information for recording on magnetic tape / USE: correlation and editing of recorded data / $4000 to $6000 / T13
Logitek, Inc. -- see T13
TRW Systems Group, 1 Space Park, Redondo Beach, Calif. 90278 / timing devices / DESCR: latest hardware designs incorporate modularity; flexibility for broad spectrum of mission requirements / USE: programmers-sequencers in spaceborne applications / - / T13

T14. TRANSFORMERS

Aladdin Electronics -- see T15
AMP Inc., Eisenhower Blvd., Harrisburg, Pa. 17105 / CAPITRON transformers / DESCR: high and low voltage custom designed transformers / USE: applications requiring specially designed units / - / T14
Hammond Manufacturing Co. Ltd., 394 Edinburgh Rd. North, Guelph, Ont., Canada / transformers / DESCR: electronic, electrical; all types, power, filament, audio, miniature, printed circuit, inverter, torroids, isolating, voltage adjusting, military, chokes, reactors, control distribution; units to customer specification / USE: power supplies, computer circuits, machine operation / $1 to $250 / T14
Litton Industries, Triad Distributor Div., 305 N. Briant St., Huntington, Ind. 46750 / transformers / DESCR: power (plate, filament, isolation, toroidal, rectifier); audio (input, output, interstage); filter reactors; low frequency instrumentation units; pulse transformers / - / $2 to $30 / T14

T15. TRANSFORMERS, PULSE

Aladdin Electronics, 703 Murfreesboro Rd., Nashville, Tenn. 37210 / pulse transformer / DESCR: micro-miniature and miniature sizes; point to point wiring or P/C application. Commercial and Mil-Spec. Standard catalog items or special units. Engineering service / USE: coupling circuits or blocking oscillator circuits -- step-up or step-down / 80¢ to $3.50 / T15
EL-RAD Manufacturing Co., 4300 N. California Ave., Chicago, Ill. 60618 / pulse transformers / DESCR: units for both conventional wiring and printed circuit applications. Hermetically sealed and epoxy encapsulated construction / USE: interstage coupling; pulse shaping; wide band coupling / 75¢ to $15 / T15
Hammond Manufacturing Co. Ltd., 394 Edinburgh Rd. North, Guelph, Ont., Canada / pulse transformer / DESCR: open bracket mounting, epoxy cast, military, to customer specifications only / USE: trigger SCRs, wave shaping / $10 to $100 / T15
Litton Industries, Triad Distributor Div. -- see T14
Marksmen, Inc. -- see C29
Technitrol Inc., 1952 E. Allegheny Ave., Philadelphia, Pa. 19134 / pulse transformers / DESCR: miniature, subminiature, plastic molded; 10 ns to 5 ms pulse width / - / 75¢ to $5 / T15

T16. TRANSLATING EQUIPMENT

COMRESS, Inc., 2120 Bladensburg Rd., N. E., Washington, D. C. 20018 / TRANSIM (translation via simulation) / DESCR: 100% translation of computer programs from a variety of source machines to a variety of object machines / USE: program translation from various computers to other incompatible machines / variable / T16
George Kelk Ltd. -- see C20
Trak Electronics Co., Inc. -- see C23

T17. TYPEWRITERS, ELECTRIC, CONTROLLED

Connecticut Technical Corp., 3000 Main St., Hartford, Conn. 06120 / input-output typewriters / DESCR: heavy duty electric machine modified to furnish coded and/or uncoded input and/or output. Any code, many special modifications / USE: graphic arts industry, computers, communications systems, data logging, process control / $660 to $2000 / T17
Connecticut Technical Corp. -- see D3
Dura Business Machines -- see D2
Invac Corp. -- see D1
Oki Electronics of America Inc., 202 East 44th St., New York, N. Y. 10017 / OKITYPER / DESCR: alphanumeric typewriter with

integral read punch / - / $2800 to $3400 / T17

VI. VISUAL OUTPUT DEVICES

Astrodata, Inc.
The Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304 / BR-90 visual analysis console / DESCR: display console for man/machine interface; stored program control, combined electronic and photographic displays using rearported CRT / USE: graphical data analysis; data generation; computer control / quote on request / V1
The Bunker-Ramo Corp. -- see D1, C7
Burroughs Corp., Electronic Components Div., P. O. Box 1226 Plainfield, N. J. 07061 / NIXIE® numeric/alphanumeric indicator tube / DESCR: cold cathode tube which can display the numbers 0-9. Another version displays complete alphanumeric / USE: as a visual readout / $5 (in quantities of 1000) / V1
Control Data Corp., Data Display Div.
Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754 / 338 cathode ray tube display system / DESCR: incorporates small, high speed, general purpose computer as buffer; 4096-word memory, display with light pen, subroutining, push-buttons / USE: satellite to larger computer system; off-line as self-contained, self-generating display / $55,000 and up / V1
Discon Corp. -- see C25, C26
Engineered Electronics Co. -- see L1
Ferranti-Packard Electric Ltd., Industry St., Toronto 15, Ontario, Canada / flip disc display / DESCR: magnetically flipped discs to produce alpha numerics in matrix form; requires no power to hold information visible in strong daylight / USE: stock exchange quote boards, airline arrival/departure displays / $20,000 to $500,000 / V1
General Precision, Inc., Kearfott Products Div. -- see C36
Industrial Electronic Engineers, Inc., 7720 Lemona Ave., Van Nuys, Calif. 91405 / rear-projection readouts and display devices / DESCR: designers and manufacturers of rear-projection systems, binary to decimal driver/decoders, and bina-view self-decoding readouts / USE: for visual display / V1
Information Displays, Inc., 102 E. Sandford Blvd., Mt. Vernon, N. Y. 10550 / computer controlled displays / DESCR: high speed presentation of symbols, lines and circles, includes 21" CRT, light pens, keyboards and hard copy devices / USE: as I/O computer device for man-machine interchanges / $5000 to $100,000 / V1
Janus Control Corp. -- see C36
Missouri Research Laboratories, Inc., 2109 Locust St., St. Louis, Mo. 63103 / Model 120/121 binary-to-decimal display / DESCR: converts parallel binary data and displays decimal equivalent. Single nine bit, dual nine bit and 17 bit units available; self-powered / USE: in conjunction with data acquisition systems / $1500 to $2600 / V1
Missouri Research Laboratories, Inc., *a / Model 123 decimal display computer / DESCR: converts up to 24 bit serial or parallel data of any weighted binary code and gray code; built in scaling; provides 8 visual decimal display, BCD, and binary electrical outputs / USE: with data acquisition systems / $7750 / V1
OPTOmechanisms Inc., 40 Skyline Drive, Plainview, N. Y. 11803 / visual display systems / DESCR: photographic type; high resolution; multi-color; screen size up to 16 x 20 ft; update time, less than 10 seconds / - / - / V1
Photomechanisms, Inc., 15 Stepar Place, Huntington Sta., N. Y. 11746 / DATACOPY / DESCR: generates high quality photographic hard copy directly from a CRT display; produces 5 pages/minute; 25 seconds access time / USE: to make permanent records of graphic or alpha numeric CRT displayed information / $4000 to $5000 / V1
Photomechanisms, Inc., *a / DATAFLO / DESCR: coupled processor-printer generating electrostatic hard copy from film exposed on-line with computer; page rate 30/minute; access time 10 minutes / - / $20,000 to $40,000 / V1
Photomechanisms, Inc., *a / DATASTAT / DESCR: generates electrostatic hard copy from CRT display using silver halide internegative; records 6 frames/second, produces 12 pages/min., 26 second access time / USE: to generate hard copy from graphic and alpha numeric CRT displays / $25,000 to $35,000 / V1
Photomechanisms, Inc., *a / DATASTAT II / DESCR: same as DATASTAT, except designed to fit in 24 inch rack / - / $25,000 to $35,000 / V1
Photomechanisms, Inc., *a / DATASTAT III / DESCR: generates electrostatic hard copy from CRT display using silver halide internative; records up to 30 frames/second; produces 24 pages/minute; access time is 35 seconds / - / $30,000 to $50,000 / V1
Photon, Inc. -- see D1
Straza Industries, 790 Greenfield Drive, El Cajon, Calif. 92021 / Mod. 52 line generator / DESCR: generates straight lines from end point coordinates; 10,000 lines/sec.; 4-line types, 2-line widths; constant velocity; .2% linearity, 1% end point accuracy / USE: with visual eisplay equipment / $7500 to $18,000 / V1
Straza Industries -- see D3
Technical Measurement Corp., Telemetrics Div., 2830 S. Fairview St., Santa Ana, Calif. 92704 / Model 650 display system / DESCR: bar-graph display holding 256 channels of changing information and displaying up to 128 channels / USE: high accuracy quick-look / $15,000 to $20,000 / V1
Westinghouse Electric Corp., Electronic & Specialty Products Group

- END -

ROSTER OF ELECTRONIC COMPUTING AND DATA PROCESSING SERVICES

Reprinted with permission from COMPUTERS AND AUTOMATION's "Computer Directory and Buyers' Guide", June, 1966, © 1966, published by Berkeley Enterprises, Inc., 815 Washington Street, Newtonville 60, Mass.

Following is a roster of electronic computing and data processing services.

The survey form asked for:

1. Brief description of the types and quantities of computing and data processing machines and equipment which you have?____________

2. Brief description of the types of problems that you specialize in?____________

3. Number of employees?______
4. Year established?______
5. Any remarks?____________

Filled in by__________ Title______
Organization____________
Address____________

For school, college, and university computing services, see the section of the directory "School, College, and University Computer Centers".

See also in the "Roster of Products and Services" entries under the heading "C14, Computing Services".

Each full entry from an organization that replied to the survey is in the form of: Name and address of electronic computing and data processing service bureau / Equipment / Problems specialized in / Size(number of employees) Established(year of establishment). Other entries should be self-explanatory.

The abbreviations used include the following:

S - Size (number of employees)
E - Established (year of establishment)
*C - "Checked" by the organization; "66" means "in 1966", etc.

All additions, corrections, and comments will be welcome.

Applied Business Controls, Inc., 2512 W. Main St., Norristown, Pa. 19401 / EQPM: IBM unit card system complete complement; TWX on site; Philco 2000 series model 210 complete complement / PROB: general ledger accounting systems; all bookkeeping applications; payroll preparation; school scheduling & rostering; insurance company data accumulations & reporting / RMKS: fully integrated system for business and scientific applications / S 18 / E 1960 / *C 66

Automated Accounting Center of Conn., c/o Waterbury National Bank, Waterbury, Conn. 06720 / EQPM: NCR 315 (100) series), 5 magnetic tapes, paper tape, punched card and magnetic ink input; also CDC G-15 with 2 magnetic tapes / PROB: payroll, accounts receivable, inventory control, real estate processing and engineering calculations / S 52 / E 1959 / *C 66

Bendix Systems Division, 3300 Plymouth Rd., Ann Arbor, Mich. / EQPM: Control Data G20, 32K core, 4 tapes; 1000 lpm printer; 650 cpm reader / PROB: real-time simulation, commercial data processing & scientific applications / S 15 / E 1959 / *C 66

Ernest E. Blanche & Associates, Inc., 10335 Kensington Pkwy., Kensington, Md. 20795 / EQPM: IBM 360 Model 30 (32K, 6 tape drives), (2) 1401's (each with 8K, 4 tape drives); 67 key punches and verifiers; (13) EAM machines; tape to card converter / PROB: statistical analysis, engineering computations, accounting, traffic analysis, origin-destination studies, inventory, payroll, subscription fulfillment / S 120 / E 1955 / *C 66

Booz, Allen Applied Research, 135 South LaSalle St., Chicago, Ill. / EQPM: IBM 1620 II, 1311-2, 1443, card, 40K, index registers, floating point, binary / PROB: systems analysis, mathematical models, simulation, scientific computing / S 690 / E 1955 / *C 66

Computing & Software, Inc. (formerly Telecomputing Services, Inc.), 8155 Van Nuys Blvd., Panorama City, Calif. / EQPM: - / PROB: software development & maintenance services (provided at centers in Los Angeles, New York and at government facility locations): (Scientific) missile flight, rocket status test, artillery fire control, intelligence, meteorological & satellite orbital data; (Business) management information processing, PERT, inventory control, payroll and labor distribution / RMKS: services available on rate schedule basis or full-time contract basis / S 600 / E 1947 / *C 66

Control Data Corp., 8100 34th Ave. S., Minneapolis, Minn. 55440 / EQPM: Control Data 3600's (some 1604's and 160A's) PROB: general business, manufacturing, scientific computation, engineering, some specialized problems / S 600 / E 1962 / *C 66

Control Data Corp., Computech Data Ctre., 575 Lexington Ave., New York, N. Y. / EQPM: full line of computers and peripheral equipment from small commercial machines to largest computers on market / PROB: scientific and commercial; engineering, government and business / S about 10,000 / E 1957 / *C 66

Control Technology, Inc., 1232 Belmont Ave., Long Beach, Calif. / EQPM: hybrid computing facility; Milgo 4020 analog, medium sized digital / PROB: hybrid and analog simulation studies / S 20 / E 1960 / *C 66

Data Center Corp., 3002 Midvale Ave., Los Angeles, Calif. 90034 / EQPM: (3) IBM 1440's / PROB: business applications, management information systems / S 10 / E 1962 / *C 66

Delcos, Inc., 360 Western Federal Bldg., Denver, Colo. 80202 / EQPM: (2) IBM Model 1460 tape systems and punch card equipment; IBM System 360 Model 30 by June / PROB: demand deposit banking, savings & loan, sales analysis, school scheduling, manufacturing, and engineering / S 66 / E 1956 / *C 66

Electronic Associates, Inc., 1500 E. Imperial Hwy., El Segundo, Calif. / EQPM: EAI HYDAC 2400 hybrid computer, EAI 231R-V analog computer; (2 each) EAI TR-48, EAI TR-20. Available later in 1966: EAI 8400 digital computer, EAI 8800 analog computer, EAI 680 analog computer / PROB: analysis & simulation (analog, digital, and hybrid) of aerospace vehicles, petrochemical processes, fluid power control systems, bio-engineering systems, hydrologic systems, electronic components; provide digital software for general simulation needs / RMKS: provide courses in basic and advanced analog, digital, and hybrid computing; also provide consulting / S 20 / E 1956 / *C 66

Electronic Associates, Inc., 185 Monmouth Pkwy., W. Long Branch, N. J. / EQPM: EAI 8900 with peripheral equipment and software; EAI TR-20, EAI TR-48 (Analog); EAI 680, EAI 8800 (Analog-Hybrid); EAI 8400 (Digital) / PROB: scientific computation -- particularly simulation / RMKS: employees spread among four centers: Princeton, N. J.; Washington, D. C.; Los Angeles, Calif.; San Francisco, Calif. Also in Burgess Hill, England; Brussels, Belgium / S 250 / E 1945 / *C 66

Electronic Data Service, Inc., 802 Philadelphia Pike, Wilmington, Del. 19809 / EQPM: IBM 1401 tape 8K; IBM 1401 card 4K; 30 key punch machines / PROB: business applications; large volume K/P jobs / S 45 / E 1958 / *C 66

General Kinetics, Inc., 2611 Shirlington Rd., Arlington, Va. / EQPM: - / PROB: research, development and manufacture of magnetic tape equipment and computer tape testing equipment / S 399 / E 1954 / *C 66

GPS Instrument Co., Inc., 188 Needham St., Newton, Mass. 02164 / EQPM: complete line of analog computers featuring high performance and great flexibility. Computers tailored to meet individual needs of many users. GPS Computer Series 10,000 and 200T feature compressed time, real time and hybrid capabilities / PROB: statistical and iterative techniques, including automatic control, basic physical phenomena, evaluation of data, expressible by differential and algebraic equations. Specialize in wide bandwidth operation for high dynamic accuracy in compressed timescale computing with ability to read out in real time / S 60 / E 1951 / *C 66

IDR Co., 325 Chestnut St., Philadelphia, Pa. 19106 / EQPM: IBM System 360 Model 30 and IBM punch card equipment / PROB: publisher's service bureau / S 50 / E 1961 / *C 66

Mathematical Engineering Associates, Inc., 2929 Cedar Springs, Dallas, Tex. 75219 / EQPM: IBM System/360 model 40 with real time communication access, tapes and disks / PROB: petroleum technical applications, information retrieval management, business data processing. Keypunching and clerical data preparation services available / S 13 / E 1959 / *C 66

McDonnell Automation Center, Box 516, St. Louis, Mo. 63166 / EQPM: 30 digital and 19 analog computers including 2 IBM 7094's, an IBM 7080, IBM System 360, 7-Model 30's, a Model 40, a Model 50; a CDC 3200; and EAI-PACE, REAC and CEAC analog computers / PROB: complete consulting, systems design, programming, data processing and computing for business and scientific applications / S 1000+ E 1960 / *C 66

Midwest Research Institute, 425 Volker Blvd., Kansas City, Mo. 64110 / EQPM: System 360 Model 30 64K, 2501 reader, 1403 printer, (2) 2311 drives; Benson-Lehner incremental plotter (on line); various EAM equipment / PROB: engineering, applied math, physics, chemistry and economic research; also operations research and business systems / S 350 / E 1944 / *C 66

National Physical Laboratory, Mathematics Div., Teddington, Middlesex, England / EQPM: ACE and KDG9 / PROB: numerical analysis, applied mathematics, theoretical physics, data processing / S 60 / E 1945 / *C 66

Pacific Tabulating & Statistical Ltd., B202, Marine Bldg., Vancouver 1, B. C. / EQPM: Univac SS80, Univac 1050 III, Honeywell 200, IBM peripheral equip. / PROB: general accounting & statistics, programming, consulting, engineering & scientific / S 32 / E 1952 / *C 66

Recording & Statistical Co., 176 Broadway, New York, N. Y. / EQPM: multi-branch operation using Burroughs B300's, 280's, 160's; Univac 1004's and 5580 plus IBM conventional equipment / PROB: insurance company and agency accounting; all commercial applications / S 250 / E 1911 / *C 66

Reeves Instrument Co., 100 E. Gate Blvd., Garden City, N. Y. / EQPM: REAC 600 general purpose analog computer with hybrid capability expansion. Also computation centre for scientific problem solving / PROB: product analysis and systems simulation / S 1150 / E 1947 / *C 66

Rockford Research Institute Inc., 140½ Mt. Auburn St., Cambridge, Mass. / EQPM: on-line Teletype model 33 (private wire to BBN "Hospital" PDP-1) / PROB: research on: information retrieval, artificial intelligence, reactive typewriter user languages / RMKS: Rockford Research took over research in 1961 from Zator Co. (est. 1946) / S 3 / E 1961/1946 / *C 66

Sperry Rand Corp., UNIVAC Div., 1290 Ave. of Americas, New York, N. Y. / EQPM: complete range of electronic data processing systems and computers -- specializing in real-time, on-line operations / PROB: business, industrial, technical, and scientific / S 19,000 / E 1951 / *C 66

System Development Corp., 2500 Colorado Ave., Santa Monica, Calif. 90406 / EQPM: IBM System 360 Model 50; Philco 2000-210; IBM 7094; IBM Q-32 / PROB: development of computer-based information systems / RMKS: System 360 Model 50 to be replaced by Model 65; eventually, Model 67 / S 3000 / E 1957 / *C 66

Systems Data Processing Co., 908 Fifteenth St., Sacramento, Calif. / EQPM: B260 computer, punch card equipment / PROB: business applications: programming and systems analysis / S 22 / E 1958 / *C 66

Tata Institute of Fundamental Research, Colaba, Bombay 5, India / EQPM: CDC 3600-160A system including 12 magnetic tape units, card reader, card punch and printer. 160A is capable of working as an independent computer or in satellite mode / PROB: cosmic rays, nuclear physics and engineering problems / RMKS: Computer Center used by scientists and engineers from different research laboratories and universities in the country / S approx. 50 / E 1964 / *C 66

Technical Advisors, Inc., Municipal Court Bldg., Ann Arbor, Mich. 48108 / EQPM: RPC 4000 with 4 I-O stations and 300 cps punch; to be replaced August '66 with a PDP-7 with 8K core & 250K disc and peripheral equipment / PROB: surveying and civil engineering / S 15 / E 1959 / *C 66

Telecomputing Services, Inc., name changed to Computing & Software, Inc. -- which see

United Data Processing, Inc., 1001 S. W. 10th Ave., Portland, Ore. 97205 / EQPM: IBM 1401 with tapes; IBM System 360 Model 30 with tapes; MICR / PROB: business, demand deposit accounting, consulting services / S 60 / E 1958 / *C 66

UNIVAC Div., Sperry Rand Corp. -- see Sperry Rand Corp., UNIVAC Div.

Universal Data Processing Corp., 8404 Beverly Blvd., Los Angeles, Calif. 90048 / EQPM: IBM 1401, IBM 1460; (on order for August '66) IBM System 360; also 40 keypunches and various EAM equipment / PROB: business data processing, payrolls, accounts receivable and payable, inventories, merchandizing reports etc. / S 150 / E 1957 / *C 66

URS Corp., Corporate Hq., 1811 Trousdale Dr., Burlingame, Calif. / EQPM: IBM 1440/1311 digital computer; and punch card equipment; (IBM 360/30 on order) / PROB: accounts receivable, credit union accounting, retail accounting, job analysis, general ledger accounting, statistical reporting, payroll, engineering calculations, inventory control / S 175 (70 software specialists) / E 1951 / *C 66

Wolf Research & Development Corp., P. O. Box 36, Baker Ave., West Concord, Mass. / EQPM: Whirlwind I computer with comprehensive on-line communication features; H-200 computer with 4 magnetic tape units, 900 lpm printer, card reader-punch; CDC G-15D computer system with 2 magnetic tape units, paper, punched card input and output device, tracing table generator; various equipment for processing paper tape and punched cards / PROB: scientific engineering, management, business, industrial, military and space exploration applications / S 300 / E 1954 / *C 66

- END -

ROSTER OF SCHOOL, COLLEGE, AND UNIVERSITY COMPUTER CENTERS

Reprinted with permission from COMPUTERS AND AUTOMATION's "Computer Directory and Buyers' Guide", June, 1966, © 1966, published by Berkeley Enterprises, Inc., 815 Washington Street, Newtonville 60, Mass.

Following is a roster of school, college, and university computer centers. Much of the information is derived from a survey form returned by many organizations. This form asked for: 1. Brief description of your main purposes or mission? / 1a. Do you provide computing services commercially? / 2. Your equipment and facilities? / 3. Courses given in conjunction with your computing center? / 4. Any remarks? / 5. Number of your staff? / 6. Year established? / Filled in by: Name______ Title_____Organization________Address__________

In the following each entry contains: Name and address / Purpose or mission ? Equipment ? Courses / Notes.

The abbreviations used include the following:

S - Size (number of employees)

E - Established (year of establishment)

*C, Information checked by the organization (C for checking) / 66: information furnished in 1966 /

EAM, Electric punch-card accounting machine

coml svc, Computing services provided commercially

K, thousand (words or digits of core storage)

CPM, cards per minute

For computer identifications, see the survey of digital and analog computers.

Academy of Aeronautics, LaGuardia Airport, Flushing, N. Y., 11371 / *C 66
Education / Burrough's E101 & Flexowriter / Computer Concepts & Programming; Analysis of Circuitry / S 4 / E 1962

Adelphi Univ., Garden City, N. Y. / *C 66
Research and education / RECOMP III / Programming I, II; Numerical Analysis I, II / S 3 / E 1962

Alfred Univ. Computing Center, Alfred, N. Y. / *C 66
Research and education (undergraduate and graduate) / coml svc / 40 K card 1620 Model I plus unit record equipment / Introduction to Computing Techniques / S 4 / E 1963

Allegheny College, Meadville, Pa. 16335 / *C 66
Academic and administrative functions / IBM 1620 plus unit record equipment / Course in Introduction to Computers / S 1 / E 1963

Amarillo College, Box 447, Amarillo, Tex. 79105 / *C 66
Instructional and administrative / Unit record equipment for instructional purposes / Several data processing certificate and degree programs offered day and evening / S 5 / E 1962

American River Junior College, 4700 College Oak Way, Sacramento, Calif. 95841 / *C 66
Training of data processing technicians — EAM & computer, operators and programmers / EAM complement; IBM 1620 with disk and printer; IBM 360 Model 30 - on order / Control Panel Wiring, Machine Language & Symbolic Programming; Fortran and Cobol / S 5 / E 1961

Anderson College, Anderson, Ind. / *C 66
Education and administration / coml svc / IBM 1620 Model I with 1622 card reader-punch and 2 IBM 1311 disk drives, plus other peripheral equipment and punch card equipment / Introduction to Computers and Data Processing; Computers (Hardware Oriented); Numerical Analysis; Electronic Data Processing in Business / S 3 / E 1965

Angelo State College, San Angelo, Tex. / *C 66
Education; administrative / IBM 1620 card I-O Model 30-360 on order; series 50 unit record equipment / Introduction to Computer Programming; Advanced Computer Programming; Machine Accounting; Electronic Data Processing; Statistics / S 3 / E 1963

Antelope Valley College, Lancaster, Calif. 93534 / *C 66
Train data processing technicians and handle student record systems / IBM punch card equipment / Several data processing courses; Electric Machine Accounting; Introduction to Computer Programming / S 2 / E 1963

Appalachian State Teachers College, Computer Center, Boone, N. C./ *C 66
Student records, accounts, business applications / IBM 1620, peripheral and punch card equipment / Math; Digital Computers; Numerical Analysis / S 5 / E 1961

Arlington State College, Arlington, Tex. 76010 / *C 66
Education and research / coml svc / IBM 1620 (60k card read punch); IBM 1620 II (60K card read punch, 1311 disk); IBM 1401 (16K 4 mag. tapes 1311 disk) / FORTRAN programming; Symbolic Programming / S 2 / E 1961

Auburn Community College, Franklin St., Auburn, N. Y. / *C 66
Prepare students for Business Management in data processing and programming (A.A.S. in Data Processing) / coml svc / IBM 1440 system with peripheral equipment / Introduction to Data Processing Machines (Unit Record); Introduction to Computers; Systems & Procedures; Programming I & II; Computer Case Studies I & II; Math of Data Processing I & II / plan workshops, seminars for educators and management / S 18 / E 1964

Auburn Univ., Computer Center, Auburn, Ala. / *C 66
Research and education / coml svc / IBM 7040-1401; IBM 1620 / Programming courses in Fortran and Cobol; Basic Computer Concepts / S 25 / E 1958

Augustana College, Rock Island, Ill. / *C 66
Education / IBM punch card equipment / Course in computer programming, FORTRAN / IBM 1130 system on order / S 3 / E 1965

Austin College, Sherman, Tex. 75091 / *C 66
Education / IBM 1620 Model I, with peripheral equipment / Basic Computer Programming; Numerical Analysis / S 1 / E 1964

Stephen F. Austin State College, Box 4607 SFA Sta., Nacogdoches, Tex. 75961 / *C 66
Administration, teaching, research / 1620 IBM with card reader-punch, 2 disk drives, on-line printer; IBM accounting machine and peripheral equipment / Business Administration; Math; Forestry / S 7 / E 1959

Abraham Baldwin College, Tifton, Ga. / *C 66
Instruction and service to all college departments / IBM 1401G and peripheral equipment / two year terminal program with a degree / S 3 / E 1965

Bakersfield College, 1801 Panorama Drive, Bakersfield, Calif. 93305 / *C 66
Education and administrative research / IBM 1620 card system 1-1311; Punch card equipment / Introduction to Data Processing; Basic Machines I & II; 1620 Programming; 1401 Programming; FORTRAN/ S 7 / E 1963

Baylor Univ., Waco, Tex. / *C 66
Education and research / coml svc / IBM 1620 Model I with peripheral equipment / Fortran courses / S 2 / E 1963

Bellarmine College, 2000 Norris Place, Louisville, Ky. 40205 / *C 66
Education; preparation for CDP certificate / None / Accounting 405 Principles; Accounting 406 Systems and Programming / S 2 / E 1962

Beloit College, Computing Center, Beloit, Wis. 53512 / *C 66
Education for all students, regardless of major field / coml svc / IBM 1620 with card I/O, indirect addressing; punch card equipment / IBM Fortran programming; Computer Programming for Engineers; Concepts of Data Processing; Fortran for 360 / S 5 / E 1962

Bethany College, Bethany, W. Va. 26037 / *C 66
Academic work / IBM series 50; IBM 360/20 on order / Data Processing / S 4 / E--

Bishop's Univ., Lennoxville, Quebec, Canada / *C 66
Research / IBM 1620, 20K storage, card input/output/ 4th year science students courses / S 1 / E–

Bloomsburg State College, Bloomsburg, Pa. 17815 / *C 66
Administration and education / IBM 1401 and peripheral equipment / Introduction to Data Processing and Business Education; Introduction to Computers and Programming / S 3 / E 1962

Boise College, Boise, Idaho / *C 66
Total systems installation / IBM 1440 / Curriculums for programmers; machine operators; console operators / S 3 / E 1966

Boston Univ. Computing Center, 700 Commonwealth Ave., Boston 15, Mass. / *C 66
Education and research services / IBM 1620-II, 60K, 2 Disks, 1443 Printer / Computers and Information Processing; Introduction to Computer Programming; Intermediate and Advanced Programming; Systems and Procedures; The Computer in Management Control and Research; Data Processing in Social Sciences and for School Systems; Scientific Computing; Computers and Accounting; Computers and Marketing; Logical Design of Electronic Computer Systems; Teaching Machines and Programmed Instruction / S 12 / E 1956

Bowdoin College, Computing Center, Brunswick, Me. 04011 / *C 66
Educational and administrative / coml svc / IBM 1620, 1622, 1311, 407, 2 keypunches / Fortran Programming; Numerical Analysis; Mathematical Statistics; Linear Programming; Economical Statistics / S 2 / E 1965

Bradley University Computer Center, Holmes & Laura Aves., Peoria, Ill. / *C 66
Education for undergraduates and graduates / coml svc / IBM 1620-I; 1622-II; DPC 4620-II on-line printer; IBM 1311 disk files; sorter and keypunches / Support vocational education program in data processing / S 5, Peoria Public School System / E 1963

Brigham Young Univ., Computer Research Center, Provo, Utah 84601 / *C 66
Education, research, and administration / coml svc / IBM 7040; IBM 1401 / Computers and Their Use; Computer Program Languages; Algorithmic Languages and Compilers; Information Systems Analysis; and others / S 47 E 1958

The Brooklyn Center of Long Island Univ., Brooklyn, N. Y. 11201 / *C 66
Education, research and administration / coml svc / 1620 IBM (Mark I) 20K and peripheral equipment / Fortran Programming; Operating Research; System and Proceedures; Statistics / S 5 / E 1962

Broome Technical Community College, Binghamton, N. Y. / *C 66
Education / IBM 1620 card I/O; IBM 407 plus supporting tab equipment / Introduction to Commercial Programming; Numerical Methods; Introduction to Digital Computers / S 3 / E 1963

Bucknell Univ., Freas-Rooke Computing Center, Lewisburg, Pa. 17837 / *C 66
Education / coml svc / IBM 1620 Model I with 2 Disks, plotter, printer, 60K, digital clock; 5-026's and 407 / Introduction to Computers; Programming; Numerical Analysis and Advanced Seminars / S 16 / E 1961

California State College, Hayward, Calif. / *C 66
Education / IBM 1620-I, 1622-I; auxiliary equipment / Programming courses; numerical analysis courses; a data processing course / S 2 / E 1964

California State Polytechnic College, San Luis Obispo, Calif. 93401 / *C 66
Undergraduate instruction / G-15 (CDC); IBM 1620 Model I / Programming - mostly FORTRAN and S.P.S. techniques / Computational facilities for Engineering courses / S 5 / E 1960
Carleton College, Northfield, Minn. 55057 / *C 66
Education & administrative services / 1620 card system plus unit record equipment / Courses in FORTRAN, SPS, and Numerical Analysis / S 4 / E 1964
Carleton Univ., Ottawa, Canada / *C 66
University research, graduate and undergraduate teaching in Arts, Science and Engineering/ IBM 1620-I, 40K; Card, tape and disks / Programming; Numerical Methods; Introductory Computer Science / S 2 / E 1962
Carroll College, Waukesha, Wis. 53186 / *C 66
Education / IBM 1620 Model I; 20K card system; 407; sorter, 2 key punches / Elementary Programming; Digital Computing; Numerical Analysis / S 4 / E 1962
John Carroll Univ., Mirimar Blvd., Cleveland, Ohio 44118 / *C 66
Education and research / General Precision LGP-30; Goodyear GEDA / Ph-51 Basic Computer Programming; Ph-316 Applied Digital Computer Programming / S 1 / E 1960
Case Institute of Technology, University Circle, Cleveland, Ohio 44106 / *C 66
Education and research on software systems and languages / coml svc / Univac 1107 plus peripherals / Six, ranging from basic numerical methods to mathematical linguistics / S 15 / E 1956
Catholic Univ., Computing Center, Washington, D. C. 20017 / *C 66
Instruction and research / coml svc / IBM 1620-60K, plus peripheral equipment / Fortran programming / S 4 / E 1961
Central Connecticut State College, Stanley St., New Britain, Conn. / *C 66
Education / IBM 1620, 1311, 1622;unit record / Unit record; Introduction to Computers / S 3 / E 1965
Central Florida Junior College, Ocala, Fla. 32670 / *C 66
Education, research, administration / IBM punch card equipment / Programming; Basic Data Processing / IBM 1130 on order / S 3 / E 1962
Central Missouri State College, Computer Center, Warrensburg, Mo. 64093 / *C 66
Administrative; teaching; research / IBM 1620-20K (an additional 20K is ordered); IBM 1440-4K (both are card system) / Introduction to Unit Record; Basic Programming on both computers; Numerical Analysis, Linear Programming; Programming Business Applications on 1440 / S 5 / E 1961
Central State Univ., College of Business Administration, Wilberforce, Ohio 45384 / *C 66
Education / IBM equipment; Univac auxillary equipment / Keypunch; Introduction to Data Processing; Elementary Computer Operation / S 1 / E 1962
Central Washington State College, Ellensburg, Wash. / *C 66
Administration and education / IBM 1620-1622 with peripheral equipment / Elementary Programming; Advanced Programming; Numerical Analysis / S 5 / E 1964
Centre de Calcul, Universite de Montreal, C.P. 6128, Montreal 3, P. Que., Canada / *C 66
Research and teaching / coml svc / CDC-3400; CDC-3100; and peripheral equipment / Computer sciences / S 25 / E 1964
Cerritos Junior College, 11110 E. Alondra, Norwalk, Calif. / *C 66
Instruction and student record keeping / IBM 1440 computer & punch card equipment / All Data processing "major" courses / S 5 / E 1964
Chaffey College, 5885 Haven Ave., Alta Loma, Calif. 91701 / *C 66
Education / 407 and associated punched card equipment / Introduction to Machine Wiring / IBM 360 Model 20 on order; will be giving programming courses / S 4 / E 1966
Chico State College, Chico, Calif. 95922 / *C 66
Education / IBM 1620 Model I 20K, card, disk / Basic and Advanced Programming / S — / E 1962
The Citadel, The Military College of South Carolina, Charleston, S. C. / *C 66
Education and administration / coml svc / IBM 1620 computer system with disk pack and 1401 card system/ Fortran on 1620; Basic Autocoder on 1401 / S 8 / E 1964
Clarion State College, Clarion, Pa. 16214 / *C 66
Education, research and administration / IBM 1620 Model I 20K, 1622 card-read-punch, (2) 026 key punch; 407 accounting machine / Computer Principles I and II / S 1 / E 1963
Clark Univ., 950 Main St., Worcester, Mass. / *C 66
Public Health Research / IBM 1620 - 40K, 407, sorter / Language / S 5 / E 1963
Clarke College, Dubuque, Iowa 52001 / *C 66
Education and research / IBM 1130 installed in May (replaces 1620) includes printer, paper-tape I/O, disk storage, 2 Friden Flexowriters / Introduction to Computer Sciences; Information Science; Computer & Programming Systems; Theory of Automata; Systems Simulation; Heuristic Programming; Numerical Analysis I & II; Constructive Logic / Undergraduate minor in c.s. may be combined with any major; adult courses & special group seminars / S 6 / E 1965
Clarkson College, Potsdam, N. Y. 13676 / *C 66
Education and research / IBM 1620 Model I / Fortran programming; Computer science / S 7 / E 1960
Clemson Univ. Computing Center, Clemson, S. C. / *C 66
Teaching and research / coml svc / RPC-4000 / Computer Programming; Numerical Methods; Principles of Computing; Formal Languages / IBM 360 Model 40, July '66 / S 6 / E 1961
College of the Holy Cross, Data Processing Center, Worcester, Mass. 01610 / *C 66
Undergraduate education, faculty research, administrative services / IBM 1620, 1622, 026 (several) 056, 082, 085, 407, 514, bursting, deleaving equipment / FORTRAN (non-credit); Machine Language Programming / S 5 / E 1965
College of St. Thomas, 2115 Summit Ave., St. Paul, Minn. 55101 / *C 66
Education / coml svc / Control Data 160A, peripheral equipment and supporting tab equipment / Data Processing for Business; Numerical Analysis and Computer Programming; Applied Statistics; Computer Programming / S 13 / E 1964
College of San Mateo, 1700 W. Hillsdale Blvd., San Mateo, Calif. / *C 66
Education and administration / IBM 1620 with 1 disk file, 600 lpm printer; IBM 1440 system on order for August, 1966 / Introduction to Data Processing; Electro-Mechanical Equipment; Data Processing Systems and Procedures; Basic Computer Programming; Computer Programming Systems; Advanced Computer Systems; COBOL Programming; Key Punch; Data Processing Field Projects; Introduction to Numerical Methods; FORTRAN Programming / S 7 / E 1963
College of the Sequoias, Visalia, Calif. / *C 66
Coordinate data processing program; administrative / IBM 1130 system; unit record equipment / Introduction to Data Processing; Electro-Mechanical Machines; Computer Programming I & II / S— / E 1966
The College of Wooster, Wooster, Ohio 44691 / *C 66
Administrative and educational / IBM 1620, 20K; plus peripheral equipment / Computer Concepts; Programming / S 4 / E 1960
Colorado School of Mines, Golden, Colo. 80401 / *C 66
Education and research / CDC 8090, LGP-30 / Programming for all students, computing taught as integral part of engineering education by most departments / S 7 / E 1964
Colorado State College, Bureau of Research Services, Greeley, Colo. 80631 / *C 66
Education and research for undergraduate and graduate school / IBM 407 acct., unit record equipment / data processing in business education; programming course / S 3 / E 1966
Columbia Basin College, 2600 N. Chase, Pasco, Wash. / *C 66
Education / IBM 1620 with discs; punch card equipment / 2-yr. course training programmers; related courses in Economics, Math, Statistics, Accounting, etc. / S 7 / E 1964
Community College, Yakima, Wash. / *C 66
Student instruction / IBM 1620 disk system / Day & evening classes "Introduction to Computer Sciences"; Computer Programming; Languages; Techniques; Systems / S 1 / E1963
Compton College, 1111 E. Artesia Blvd., Compton, Calif. 90221 / *C 66
Education at all levels / Univac 1004 and optical scanner computer laboratory / Introduction to Data Processing; Punch Card Concepts; Computer Programming; Programming Techniques and Languages; Accounting Systems; Management Reporting; COBOL; Real-Time Systems; Computer Sales / Data Processing program is based on Data Processing Management Association (DPMA) requirements for the CDP / S 9 / E 1965
Concordia College, Moorhead, Minn. 56560 / *C 66
Education, research, administration / coml svc / IBM 1620-I, sorter, collator, 407 accounting machine / Elementary Programming (Fortran and SPS); Numerical Methods using computer / S 3 / E 1963
Contra Costa College, 2801 Castro Rd., San Pablo, Calif. / *C 66
Processing of all aspects of student records / IBM 1620 Model II; 1 disk drive; 20K core / Machine Language; FORTRAN; 141 SPS / S 4 / E 1963
Cornell Univ., Cornell Computing Center, Rand Hall, Ithaca, N. Y. 14850 / *C 66
Research and education / coml svc / Control Data 1604 with 160A peripheral computer / Fortran programming; other courses given by department of Computer Science / S 30 / E 1953
Dalhausie Univ., Halifax, Nova Scotia / *C 66
Research & education / coml svc / IBM 1620 (40K) card I/O printer, sorter / Numerical Analysis (full credit); short courses in programming / S 3 / E 1963
Dartmouth College, Hanover, N. H. / *C 66
Education and research / GE-265, time sharing system / No formal courses / computer available to all faculty and students / S 5 / E 1964
Davidson College, Davidson, N. C. 28036 / *C 66
Undergraduate instruction and faculty research / IBM 1620 model I with one disk drive; Monitor I system / Numerical Analysis using computer as laboratory / S 2 / E 1962
De Paul Univ., 25 E. Jackson, Chicago, Ill. / *C 66
Administrative and student research / IBM 1401 - 1311 / Introduction and Computer Programming Courses / S 5 / E 1964
Del Mar Technical Institute, Corpus Christi, Tex. / *C 66
Education of engineering technicians / Burroughs 205 Datatron / Computer Programming; Computer Circuit Applications / S 3 / E 1961
Delta State College, Cleveland, Miss. 38732 / *C 66
Administrative work; teaching; some research / IBM unit record equipment on campus; access to outside IBM 1620, 1440, 1401 / undergraduate lab taught in conjunction with Business Dept.; special Math course on programming offered at night / S 7 / E 1964
Denison Univ., Granville, Ohio / *C 66
Education, research, and limited administration / Burroughs 205 with cardatron input and output; datafile and 3 tape units; paper tape input/output; 407 output / Numerical Analysis; Algol Programming / S 3 / E 1964
Detroit College of Business, 4801 Oakman Blvd., Dearborn, Mich. / *C 66
Education / Unit record equipment / Computer Programming I & II; Systems and Procedures I & II; Automation Accounting; Punch Card Accounting; Introduction to Electronic Computers / S 2 / E 1959
Devry Technical Institute, 4141 Belmont Ave., Chicago, Ill. 60641 / *C 66
Educational / Rem Rand 409-2R; July, 1966, IBM 1401 / Digital and analog courses / S 6 / E 1931
East Carolina College, Greenville, N. C. 27834 / *C 66
Computer orientation and experience for graduates; research / coml svc / IBM 1620 and peripheral equipment / Introduction to Digital Computers; Introduction to Data Processing; Electronic Data Processing and Accounting / S 3 / E 1963
East Tennessee State University Computer Center, Johnson City, Tenn. 37601 / *C 66
Education, research and administration / coml svc / IBM 1620-22-23; IBM 870; IBM 026 keypunch / Programming; Introduction to Digital Computers; Mathematics Analysis; Linear Programming, etc. / S 4 / E 1962
East Texas State Univ., Commerce, Tex. / *C 66
Education, research, administration / IBM 1620-20K and peripheral equipment / Introduction to Computer Science; Digital Computer Programming; Computer Languages; Numerical Analysis; Advanced Programming; Punch-card Machines / S 8 / E 1963
Eastern Kentucky Univ., Faculty Box 310, Richmond, Ky. 40475 / *C 66
Education and administration / IBM unit record equipment; computer on order / 2 yr. data processing program / S 10 / E 1963
Eastern Washington State College / Cheney, Wash. 99004 / *C 66
Education for undergraduates and faculty research / IBM 1620 / Faculty programming courses; programming and numerical analysis courses; programming and systems analysis / S 7 / E 1963
El Camino College, El Camino College via Torrance, Calif. / *C 66
General education and vocational instruction in computing / Complete tab installation; IBM 1620 computer system with two disk drives and printer / Introduction to Data Processing; Punched Card Processing Machines; Business Computer Programming I & II; Computer Mathematics with Statistics; Business Systems Development and Analysis / S 9 / E 1964
Elizabethtown College, Elizabethtown, Pa. / *C 66
Education / IBM 1130 and supporting equipment / Computer Science I & II / S 3 / E 1966
Evansville College, Evansville, Ind. 47704 / *C 66
Education and administration / IBM 1620, 1622, 1443 and peripheral equipment / Computer Programming; Data Processing / S 4 / E 1963
Fayetteville State College, Fayetteville, N. C. / *C 66
— / IBM 1620; keypunch, printer / Mathematics; Probability and Statistics; Introduction to Computer Science / S 2 / E 1965
Flint Community Junior College, 1401 E. Court St., Flint, Mich. 48503 / *C 66
Education for students, research for faculty and students / IBM 1620 with 1622 card read punch; punch card equipment / Introduction to Computer Programming; Introduction to Numerical Analysis and Digital Computing; Data Processing Mathematics; Data Processing Applications; Electric Accounting Machines / S 2 / E 1963
Fordham Univ., Bronx, N. Y. 10458 / *C 66
Instruction and research / IBM 1620-II with disk and supporting unit-record equipment / Fortran; SPS / S 8 / E 1965
Fort Hays Kansas State College, Hays, Kans. 67601 / *C 66
Process applications of registrar and business office / IBM 1620 and peripheral equipment / Vocational education courses in unit record operation; Computer Programming; Survey of Data Processing; Scientific Computer Programming / S 3 / E 1963
Fort Nicholls State College, Thibodaux, La. 70301 / *C 66

Administration and education / IBM 1620 with peripheral equipment / Fortran courses; IBA course / S 4 / E 1963

Franklin & Marshall College, Lancaster, Pa. / *C 66
Research and education / Burroughs 205 with paper tape, magnetic tape, floating point hardware / None / S 1 / E 1964

Fresno State College, Cedar and Shaw, Fresno, Calif. / *C 66
Education, research and administration / IBM 1620 Model II and peripheral equipment / FORTRAN and Business Applications; FORTRAN-engineering; COBOL; Operations Research / S 3 / E 1964

Fullerton Junior College, 323 E. Chapman Ave., Fullerton, Calif. / *C 66
Education and training for operators and programmers / IBM 1620 and peripheral equipment / Survey of Data Processing; Introduction to Data Processing; Programming; Systems; Work Experience / S 9 / E 1961

Gallaudet College, Washington, D. C. 20002 / *C 66
Education; research on deafness and related subjects / IBM 1620 Model I and peripheral equipment / Programming courses / S 4 / E 1962

General Motors Institute, 1700 W. Third Ave., Flint, Mich. 48502 / *C 66
Accredited engineering college / IBM 1620-II, 40K card, 1627 graph plotter; 1440 12K, 2 disk drives, card reader/punch, 1443 printer; punch-card equipment / Introduction to Computing, for all students; Numerical Methods; Advanced Digital Computing; Programming / S 9 / E 1961

The George Washington Univ. Computer Center, 2013 G St., N. W., Washington, D. C. / *C 66
Education and research / IBM 1620 Model II, 60K, Index Registers, 2 disk drives, on-line printer, card read-punch / number of courses with computer labs / S 3 / E 1963

Georgetown Univ., Computation Center, 37th and O Sts., N. W., Washington, D. C. 20007 / *C 66
Educational and research / IBM 1620 Model II computer with 60K core storage, IBM 1311 disk drives, peripheral equipment / Mathematics dept. offers credit courses; informal, non-credit courses by Center / S 8 / E 1963

Georgia Institute of Technology, Atlanta, Ga. 30332 / *C 66
Education and research / coml svc / Burroughs 5500 (2); Burroughs 220 / Non-credit seminars; computation courses given in Schools of Information Science, Industrial Engineering, Industrial Management, and Electrical Engineering / S 65 / E 1955

Georgia State College, Computer Center, 33 Gilmer St., Atlanta, Ga. 30303 / *C 66
Education and research for students and faculty / coml svc / IBM 1040 with 32K main memory; IBM 1301 disk storage unit; 5 IBM 729 tape drives; IBM 1402, 1403 / Introduction to Computer Programming and Logic; Computer Languages / S 12 / E 1959

Grays Harbor College, Aberdeen, Wash. 98520 / *C 66
Train programmers through a terminal, two-year vocational program / IBM 1620 card system with 1311 disk storage; IBM unit record equipment / Unit Record Operations & Wiring Computer Programming; Data Processing Applications; Systems Analysis; Systems Development & Design / S 2 / E 1964

L. A. Harbor College, 1111 Figuena Pl., Wilmington, Calif. / *C 66
Training and institutional research / IBM 1620 card system / Mathematics: Digital Computer Programming; Numerical Analysis / S 3 / E 1962

Harvard Univ., Computing Center, 33 Oxford St., Cambridge, Mass. 02138 / *C 66
Educational, research, and administrative use for students and faculty / Two IBM 7094's; three IBM 1401's; IBM 360/50; PDP 338; terminals for G.E. time sharing; 20,000 square feet of space / FORTRAN courses / S 100 / E 1962

Heald Business College, 1215 Van Ness Ave., San Francisco, Calif. / *C 66
Education / IBM punch card equipment / train tabulating, card punch operators and computer programmers / Installing 1401 card system (1401,1402,1403) June, 1966 / S 7 / E 1959

Hinds Junior College, Raymond, Miss. 39154 / *C 66
Education and administration / IBM 1620 and basic IBM tabulating equipment / Programming; Board Wiring; Systems and Procedures; etc. / S 4 / E 1964

Hofstra Univ. Computer Center, Hempstead, Long Island, N. Y. / *C 66
Student training in computer programming and faculty research / IBM 1620-20K; 1622, 407, three keypunch machines; verifer / Programming courses / S 6 / E 1963

Humbolt State College, Computer Center, Arcata, Calif. / *C 66
Educational and research / IBM 1620 Model I-40K, 407 sorter / Business, mathematics, scientific / S 6 / E 1964

Illinois Institute of Technology, Chicago, Ill. 60616 / *C 66
Education, research, administration / IBM 7040-1301; this summer IBM 360, model 40 / Introduction to the Computer, Programming, Iverson Notation; Numerical Calculus; Survey of the Fundamental Structures, Notations, and Programming Languages (both higher and machine level), used in algorithmic processes; Basis for creation and analysis of procedural and problem oriented computer languages and compilers; Freshman-level introduction to computers and computer programming / S 30 / E 1962

Illinois State Univ., Normal, Ill. 61761 / *C 66
Instruction, research for faculty and students, administration / 60K IBM 1620-1443 with 4 disk drives plus auxilliary unit record equipment / Data Processing and Management Decision; Industrial Education; Numerical Analysis / S 9 / E 1965

Illinois Teachers College (South) 6800 S. Stewart Ave. Chicago, Ill. 60621 / *C 66
Train and develop teachers in the field of data processing / Complete punch card equipment; IBM 1440, 1460, 7074; availability of Honeywell 200 and Burroughs 200 / Program primarily designed for post-B.A. work for teachers / Introduction; 1401 Machine Language; 1401-Autocoder; Unit Record Methods; COBOL (total of 15 graduate hours) / S 3 / E 1963

Indiana State Univ., Terre Haute, Ind. / *C 66
Education / IBM 1620 disk-card-printer; 2 complete tab installations / Business; Mathematics; Computer Science / S 16 / E 1963

Indiana University of Pennsylvania, Clark Hall, Indiana, Pa. 15701 / *C 66
Education, research, student and university administration / IBM 1620-1622; peripheral equipment / Computer Programming; Numerical Analysis; Automatic Data Processing (for certified teachers only) / S 7 / E 1963

Indiana University Research Computing Center, HPER Bldg., Bloomington, Ind. / *C 66
Research and education / CDC 3600-CDC 3400 with shared core-65K and peripheral equipment / 3600 Fortran; Introduction to Computing / courses are non-credit / S 30 / E 1954

InterAmerican Univ., San German, P. R. / *C 66
Maintenance of academic & financial records / EAM current installation / None at present; plan to give several / IBM 1440 on order for Dec., 1966 / S 14 / E 1912

Iowa State Univ., Computation Center, 125 Service Bldg., Ames, Iowa 50010 / *C 66
Scientific computing & administrative data processing / coml svc / IBM 360 model 40 & model 50; two IBM 1401's; Cyclone (modified Illiac); also two SDS 910's and IBM 1401 in Ames Laboratory / Graduate program in Computer Science leading to M.S. and Ph. D. degrees / Undergraduate Dept. of Computer Science expected in immediate future / S 15 / E 1962

Johns Hopkins University Homewood Computing Center Baltimore, Md. 21212 / *C 66
Research and education for faculty and students / IBM 7094-1401 linked by high speed data link / Informal courses in programming; other courses given by academic departments / S 12 / E 1960

Juniata College, Huntingdon, Pa. 16653 / *C 66
Education / coml svc / IBM 1620, 20,000 digits; card-read punch / Freshman Calculus; Digital Computer Programming; Linear Algebra; Physical Chemistry; Adv. Physical Chemistry / S 1 / E 1964

Junior College of Broward County, 3501 Southwest Davie Rd., Fort Lauderdale, Fla. / *C 66
Two-year technical degree and three-semester certificate program for programmers; administrative applications-registrar, counseling and financial offices / IBM 1620 and an IBM 1460 with various intervals; IBM 1460 and an IBM 360 are on order to replace above / Complete data processing program / S 12 / E 1962

Kalamazoo College, 1200 Academy, Kalamazoo, Mich. 49001 / *C 66
Education and administrative / coml svc / IBM 1620 - II, 1311-1622-20K; IBM punch card equipment / Programming; Numerical Analysis / S 2 / E 1964

Kansas State Teachers College, Emporia, Kansas 66801 / *C 66
Educational - instruction & administrative / IBM 1620 20K; IBM 1440 4K / Introduction to Computers & Programming; Computer Programming; Advanced Programming; Systems & Applications; several courses in Data Processing / S 3 / E 1962

Kansas State Univ. Computing Center, Manhattan, Kan. 66502 / *C 66
Education and research / IBM 1401; IBM 1410; IBM 1620 / Elementary Computing Techniques; Business Computing; Numerical Analysis / IBM 360-50 on order / S 12 / E 1958

Kellogg Community College, Battle Creek, Mich. 49016 / *C 66
Education and administration / IBM 1620-20K and peripheral equipment / EDP courses; some math courses include FORTRAN as required / S 8 / E 1963

Kent State Univ., 202 Merrill Hall, Kent, Ohio 44240 / *C 66
Education and research / IBM 1620,1622, 407, 40K core; Honeywell 2200 with peripheral equipment / Elementary and Intermediate Programming; Accounting Applications / S 3 / E 1963

Kilgore College, 1100 Broadway, Kilgore, Tex. / *C 66
Education, registration, business office reports / IBM 1620, 1622, 1443; two 1311's, and punch card equipment / Data processing; Introduction to EDP; Punch Card Accounting; Programming I & II / S 5 / E 1958

King's College, Wilkes-Barre, Pa. / *C 66
Education / coml svc / IBM 1620-1311 and unit record equipment / Electronic Data Processing; Fortran Programming; Operations Research; Linear Programming / S 3 / E 1961

Lamar State College of Technology, Lamar Research Center, Beaumont, Tex. / *C 66
Education and research / coml svc / Burroughs 205 with Cardatron / Engineering; Introduction to Digital Computers; Math; Introduction to Data Processing; Advanced Data Processing / S 2 / E 1956

Lansing Community College, 419 N. Capitol Ave., Lansing, Mich. 48914 / *C 66
Administrative work and education / coml svc / IBM 1620 and peripheral equipment / Introduction to Data Processing; 1620 Programming; 1401 Autocoder; Cobol; Fortran; System Development / S 8 / E 1964

Laredo Junior College, P. O. Box 738, Laredo, Tex. 78040 / *C 66
Education, administrative, research / IBM 360-20 on order, August delivery; presently, unit record equipment / Introduction to Unit Record; Introduction to Computers / S 5 / E 1948

LaSalle College, 20th & Olney Ave., Philadelphia, Pa. / *C 66
Education and business application / coml svc / IBM 1620-Model A-2 with peripheral equipment / Programming and Introduction to Electronic Data Processing / S 4 / E 1965

Lawrence Institute of Technology, 21000 N. 10 Mile Rd., Southfield, Mich. 48075 / *C 66
Education / Univac SS-80; Burroughs E-102 / Computing Techniques for Engineering; Computing Techniques in Business Systems; Numerical Methods / S 9 / E-

Lawrence Univ., Appleton, Wis. 54911 / *C 66
Research and administration / coml svc / IBM 1620-40X, Model I; 407; printing card punches; sorting machine / An Introduction to FORTRAN Programming, open to students and faculty / S 1 / E 1964

Lee College, Mont Belvieu, Tex. 77580 / *C 66
Instruction and administration / IBM 1620; punch card equipment / Introduction to Data Processing; Programming I and II; Unit Record Equipment Operations; Accounting Systems; etc. / S 4 / E 1963

Lehigh Univ., Bethlehem, Pa. / *C 66
Education and research / GE 225 for general use / Engineering and Math departments offer problem-solving, programming, languages, operating systems, and digital hardware courses / S 8 / E 1957

Lewis College, Educational Data Center, Route 66A, Lockport, Ill. 60441 / *C 66
Administrative / Honeywell 200 - 20K 5 tape computer, 500 points IBM tab equipment / Fundamentals of Data Processing / S 12 / E 1964

Linfield College, McMinnville, Ore. 97128 / *C 66
Educate students in the many applications of a computer / IBM 1620 Model I; 1622 card read-punch / Math; Introduction to Computer Programming / Plan to give course for Social Science & Business majors; also one in SPS / S 2 / E 1966

Loma Linda Univ., Scientific Computation Facility, Loma Linda, Calif. / *C 66
Research, education, and statistical computation / IBM 1620 Model II with peripheral equipment / non-credit programming courses / S 8 / E 1964

Long Beach City College, 1305 Pacific Coast Highway Long Beach, Calif. / *C 66
Education / IBM 1620, 1311 disk, and punch card equipment / Principles of Data Processing; Computer Programming; Fortran / S 15 / E 1960

Los Angeles Metropolitan College, 1601 S. Olive, Los Angeles, Calif. / *C 66
Education / IBM 1620; 2 disk drives, printer, and complete tabulating set-up; document writing system / Principles of Business Data Processing; Information Storage & Retrieval; Introduction to PERT and Critical Path Techniques; Introduction to Punched Card Machine Accounting; Business Computer Programming; Programming Laboratory; Cobol Programming; Computer Software Programming; Programming Language I; Business Data Processing Systems; IBM 1401 Programming; IBM 1620 Programming / S 25 / E 1960

Louisiana Polytechnic Institute, Ruston, La. 71270 / *C 66
Education, research and administration / coml svc / IBM 1620 with peripheral equipment / Senior-graduate course in programming and data processing; evening seminars in computer programming and machine operation / S 7 / E 1961

Lower Columbia College, Longview, Wash. / *C 66
Educational data processing / IBM 1620-1311; IBM punch card equipment / 2-yr curriculum leading to Assoc. of Technical Art in Data Processing / S 4 / E 1964

Loyola College, 7141 Sherbrooke St. W., Montreal, Que., Canada / *C 66
Educational / IBM 1620, card 20K / Computing Science; Fortran Programming; Elementary Numerical Analysis / S 4 / E 1964

Loyola Univ., New Orleans, La., 70118 / *C 66
Education and research / IBM 1620 with peripheral equipment and punch card equipment / Panel Wiring; Machine Operation; Programming; Numerical Analysis; Experimental Design / S 6 / E 1963

Loyola Univ. of Los Angeles, 7101 W. 80th St., Los Angeles, Calif. 90045 / *C 66
Education of students, both application and design / Alwac II; TR 48; and peripheral equipment / Introduction to Computers; Digita Computer Design I & II / S 2 / E 1958

Lyons Township High School and Junior College, 100 S. Brainard Ave., LaGrange, Ill. 60525 / *C 66
Programmer training, Junior College; administration, high school and junior college / Unit record plus Burroughs B160 / Two yr junior college curriculum — Business Data Processing Programmer / S 3 / E 1965

Manatee Junior College, 5840 26th St. West, Bradenton, Fla. / *C 66
Education (2 year Associate Degree); Administrative work of junior college and county school board / IBM 1620 and peripheral equipment; unit record equipment / Unit Record Equipment; Basic Computer Concepts; Computer Programming; Data Processing Applications; Systems Development & Design; Advanced Programming / S 8 / E 1962

Manhattan College, Bronx, N. Y. 10471 / *C 66
Education and administrative / coml svc / CDC 8090 with peripheral equipment; LGP-30, Clary DE-60; also IBM punch card equipment / Machine language; basic computers; Fortran programming / S 26 / E 1962

Mansfield State College, Mansfield, Pa. 16933 / *C 66
Administration and education / IBM 1620; IBM unit record equipment / Computer Programming; Numerical Analysis and Programming / S 4 / E 1962

Marin Junior College, Kentfield, Calif. / *C 66
Education / IBM 1440 with twin disc packs; IBM 1620 and tabulating equipment / Introduction to Business Data Processing; Electromechanical Machines; Computer Programming for Business; Data Processing Applications / students may graduate with a two year degree in electronic data processing / S 4 / E 1962

Marquette Univ., 1515 W. Wisconsin Ave., Milwaukee, Wis. 53233 / *C 66
Research and education / IBM 7040; misc. others / Various computer courses in several schools and colleges / S 11 / E 1958

Marshall Univ., Huntington, W. Va., 25701 / *C 66
Education, research, administration / IBM 1620-I with card I/O, 40K memory, 3-1311 disk drives and punch card equipment / General Engineering; Introduction to Fortran and Data Processing; Computational Methods; Fortran and Mathematical Methods / S 6 / E 1964

McMaster Univ., Data Processing & Computing Centre Hamilton, Ontario, Canada / *C 66
University data processing and computing needs provided / coml svc / IBM 7040 and peripheral equipment / FORTRAN IV programming / S 11 / E 1964

Medical College of Georgia, 1459 Gwineth St., Augusta, Ga. / *C 66
Administrative, research and education / coml svc / IBM 1620 / Graduate Division course in general computer principles and FORTRAN programming / S 20 / E 1964

Memorial University of Newfoundland, St. John's (Newfoundland), Canada / *C 66
Teaching and research / coml svc / IBM 1620 card input-output, 2 key punches; 407 printer; 083 card sorter / Math 308 (numerical analysis) / S 2 / E 1964

Memphis State Univ. Computing Center, Memphis, Tenn. / *C 66
Research and instruction / coml svc / IBM 1620-1311 and related machines / Programming course; Numerical Analysis; Engineering Analysis / S 5 / E 1963

Mesa College, Grand Junction, Colo. 81501 / *C 66
Education and administration / coml svc / IBM 1620 with disk; tab equipment thru 407 with storage / Data processing; programming for engineering students; operator courses / S 4 / E 1961

Metropolitan Junior College, 560 Westport Rd. Kansas City, Mo. 64111 / *C 66
Educational and service for college / IBM 1401; IBM 1440 tape-disc system; IBM 360-30 on order / Computer Programming; Programming Languages; Systems Design; FORTRAN; COBOL; RPG; ALGOL / S 6 / E 1964

Miami Univ., Oxford, Ohio 45056 / *C 66
Research, education / IBM 1620 - 1311 / Seminars — University has academic dept. of Systems Analysis / S 3 / E 1959

Michigan State Univ., Computer Center, East Lansing, Mich. 48823 / *C 66
Service and research / coml svc / CDC 3600 / 1200 students in associated programming courses / S 75 / E 1956

Middle Tennessee State Univ., Murfreesboro, Tenn. / *C 66
Education and research / Recomp II digital computer; Geda analog computers; IBM 360-30 on order / Digital computing; analog; supporting work in analysis and statistics / S 3 / E 1962

Milwaukee Vocational Technical & Adult School, 1015 N. 6th St., Milwaukee, Wis. / *C 66
Process student records and teach Business Data Processing / IBM 1401 & 1620 / Courses in Data Processing, Marketing, and Business Machines / S 10 / E 1960

Mississippi College, P. O. Box 796, Clinton, Miss. 39056 / *C 66
Educational and administration / coml svc / IBM 1620 Model I, 20K; 407 and peripheral unit record / Fortran Programming; SPS Programming; Introduction to Data Processing / S 3 / E 1964

Mohawk Valley Community College, Sherman Drive, Utica, N. Y. / *C 66
Academic records of all students / Univac 120 / Data Processing; Computer Programming; Computers I and II / S 3 / E 1962

The Monmouth College, 700 E. Broadway, Monmouth, Ill. 61462 / *C 66
Administration and research / IBM 403 and supporting equipment; computer on order / — / S 2 / E 1966

Montana State Univ., Computing Center, Bozeman, Mont. 59715 / *C 66
Education and research / coml svc / IBM 1620 Model II, 2-1311 disk drives; 1622 Model II-60K; 1443 printer; 1627 plotter / Introduction to FORTRAN; Advanced Programming / S 6 / E 1958

Monterey Peninsula College, 980 Fremont, Monterey, Calif. 93940 / *C 66
Education / coml svc / IBM 1620, 407 shop; IBM 1440, 1231 shop / EAM and programming instruction / S 10 / E 1961

Morrisville Agricultural and Technical College, Morrisville, N. Y. / *C 66
Service: Business office and administration; Education: Departments of Business and Engineering / Standard unit record, IBM series 50; terminal connection to a large computer through an IBM 1978 terminal / Several in Business Data Processing; one in Computer Logic and Fortran Programming / S 4 / E 1966

Morton Junior College, 2423 S. Austin, Cicero, Ill. 60137 / *C 66
Education / IBM 360 Model 30 with peripheral equipment / AA degree-2 year program; Operation, programming, systems analysis divisions / S 7 / E 1963

Muhlenberg College, Allentown, Pa. 18101 / *C 66
Education and some outside business / Burroughs 205 with magnetic tape; IBM sorter and key-punch / Fundamentals of Computer Programming / S 2 / E 1965

Nassau Community College, Stewart Ave., Garden City, Long Island, N. Y. / *C 66
Educational / IBM 026, 082, 548, 514, 402 / Principles of Data Processing; Introduction to Computers, Data Processing, Systems and Installations / S 3 / E 1966

New Haven College, 300 Orange Ave., West Haven, Conn. / *C 66
Education / Lease line to GE 235; Unit record IBM facilities / Programming; Introduction to Computers (Engineers); Business Games / S 3 / E 1964

New Mexico State Univ., University Park, N. M. 88070 / *C 66
Academic and research / IBM 1620; CDC 3300 / Computer Programming I, II, III / S 23 / E 1965

New York Univ., Heights Academic Computing Facility, University Heights, New York, N. Y. 10453 / *C 66
Education; unsponsored and academic research / IBM 360 Model 30, 64K; (2) 2311 disk files; 250 cps communication link, 5 typewriter terminals / 27 courses in undergraduate and graduate schools / S 6 / E 1961

Newark College of Engineering, Newark, N. J. 07102 / *C 66
Education and EDP services for college research / coml svc / IBM 1620-I; IBM 1620-II, 40K, 2 disks and printer / Programming and Numerical Analysis; FORTRAN Programming / S 8 / E 1961

North Dakota State School of Science, Wahpeton, N. D. 58075 / *C 66
Education / IBM 1620 (20K card); punch card equipment / Electromechanical Machines; Data Processing Applications; Systems; Computer Programming; Advanced Computer Programming / S 1 / E—

North Dakota State Univ., Fargo, N. D. / *C 66
Education, research / coml svc / IBM 1620 40K Card I/O / Fortran; Advanced Fortran; Symbolic Programming / S 4 / E 1961

North Texas State Univ., North Texas Station, Denton, Tex. 76203 / *C 66
Education, research and administrative / IBM 1620 with card and printer I-O; IBM 1440 and peripheral equipment / Digital Computer Programming; Numerical Analysis; Principles of Data Processing; Data Processing Systems Analysis; Problems in Electronic Data Processing / S 19 / E 1962

Northeast Louisiana State College, 4001 Desiard St., Monroe, La. 71201 / *C 66
Administration / IBM 1620-1622 with unit record system / Introduction to Digital Computers; Computer Programming (FORTRAN) / S 4 / E 1963

Northeastern Oklahoma A&M College, Miami, Okla. / *C 66
Education / IBM 1620 - 1311 and unit record equipment / 2 year business data processing curriculum / S 9 / E 1961

Northern Oklahoma College, Tonkawa, Okla. 74653 / *C 66
Education / IBM 1620 with 1622 card reader and peripheral equipment / Six courses in data processing; programming / S 3 / E 1963

Northrop Institute, 1155 W. Arbor Vitae, Inglewood, Calif. 90306 / *C 66
To teach engineers how to program and to provide administration with reports / IBM 1620, 1622, 1311, 407 / 1620 programming in machine language and FORTRAN / S 10 / E 1962

Northwestern Michigan College, Traverse City, Mich. 49684 / *C 66
Education and administration / coml svc / LGP-30, off-line punch tape reader and punch / Introduction to Information Processing; Business Computer Programming; Scientific Computer Programming; Advanced Problems / S 10 / E 1964

Northwestern Univ., Vogelback Computing Center, 2129 Sheridan Rd., Evanston, Ill. 60201 / *C 66
Research and education / CDC 3400 Computer System / Computer used by students in approximately 125 courses / S 23 / E 1957

Norwich Univ., Northfield, Vt. 05663 / *C 66
Education / coml svc / IBM 1620 with peripheral equipment / Introduction to EDP; Introduction to Computer Programming; Numerical Analysis; Advanced Computer Programming / S 6 / E 1962

Oberlin College, Oberlin, Ohio / *C 66
Education and research for students and faculty / IBM 1620-I with peripheral equipment. Due January 1967 — IBM System/360 Model 30 and peripheral equipment / Fortran Programming / S 2 / E 1965

Occidental College, Los Angeles, Calif. 90041 / *C 66
Education / IBM 1620 Model II, 1311, 1622, 20K memory / Computer Programming and Applications; Numerical Analysis; Econometrics / S 3 / E 1963

Ohio Northern Univ., Ada, Ohio / *C 66
Educational / coml svc / IBM 1620-1311-1443-1622; 4-026 / Fortran Programming / S 1 / E 1963

Ohio Univ., Computer Center, Athens, Ohio 45701 / *C 66
Research, education, and administration / coml svc / IBM 360, model 40 and peripheral equipment / programming courses for business, engineering, and science / S 46 / E 1956

Ohio Wesleyan Univ., Delaware, Ohio 43015 / *C 66
Academic instruction and research / IBM 1620 Model I; 1622 / Non-credit programming; Numerical analysis courses / S 2 / E 1963

Oklahoma College of Liberal Arts, Chickasha, Okla. 73019 / *C 66
Education / IBM 1130 on order / Programming; Numerical Analysis; Statistics; Data Processing / using Univ. of Oklahoma's IBM 1620 and G-15 until own computer delivered / S 1 / E 1965

Oklahoma State Univ., Computer Center, Stillwater, Okla. 74074 / *C 66
Education & research / coml svc / IBM 7040; peripheral equipment / Non-credit language courses / S 5 / E 1956

Old Dominion College, School of Engineering, Box 6173, Norfolk, Va. 23508 / *C 66
Educational / coml svc / IBM 1620; IBM 1622; IBM 407; IBM 082; IBM 026 / Introduction to Computer Programming; Intermediate Computer Programming; Introduction to Engineering; Introduction to Digital Computers; Methods of Engineering Analysis; Statistics and Quality Control / S 22 / E 1964

Olympic College, Data Processing Dept., 16th & Chester, Bremerton, Wash. / *C 66
Training systems programmers / IBM 1620 & support equipment / Computer courses, 2-year curriculum students / S 4 / E —

Orange Coast College, 2701 Fairview Rd., Costa Mesa, Calif. / *C 66
Education / IBM 1401, IBM 1620, Unit record equipment / Intro; Unit Record; Programming; Systems courses / S 9 / E 1947

Orange County Community College, Middletown, N. Y. / *C 66
Administrative & education / Unit record equipment / Basic Machine Operation and Wiring; Programming. Full curriculum being planned for data processing / expect switch to a computer next few months / S 4 / E 1963

Oregon State Univ. Computer Center, Corvallis, Ore. 97331 / *C 66
Provide computing facilities for instruction, research, and administration / CDC 3300; IBM 1620; ALWAC IIIE; NEBULA (University designed & constructed) / courses related to computing given in Mathematics, Statistics, Elect. Engineering, Business Administration / S 20 / E 1966

Parsons College, Fairfield, Iowa 52556 / *C 66
Education / IBM 1460 with 5 disk drives; 1050 Teleprocessing system / Computer Programming and Systems Design / S 6 / E 1963

Peirce Junior College, Mid-City Center, 1622 Chestnut St., Philadelphia, Pa. 19103 / *C 66
Education on a post secondary level / IBM punched card equipment; Monrobot XI; June 1966 delivery IBM 1401G / Key Punch; Office Automation; Computer Programming; Business Automation Management / S 20 / E 1959

Plattsburgh State University College, Plattsburgh, N. Y. / *C 66
Education, research, and community service / coml svc / IBM 1440 / Computer Science / S 4 / E 1965

Polytechnic Institute of Brooklyn, Computer Center, 333 Jay St., Brooklyn, N. Y. 11201 / *C 66
Education for students and staff, research /

coml svc / IBM 7040 with full options and channel B; IBM 1401, 1402, 1403; 8-729V tape drives; punch card equipment / 10 half-semester and 2 one week non-credit courses in Fortran IV and MAP languages (open to all registered students and to staff); credit courses by academic departments / S 14 / E 1960

Pomona College, Computer Center, Millikan Laboratory, Claremont, Calif. 91713 / *C 66
Educational and administrative functions / IBM 360, Model 40; 32K, 1442 reader-punch, 1443 printer; peripheral equipment / Numerical Analysis; independent student and faculty research / S 1 / E 1965

Portland State College, Portland, Ore. / *C 66
Education and research / IBM 1620-1622; peripheral equipment / Fortran Coding; SPS Coding / S 8 / E 1963

Prince George's Community College, 5000 Silver Hill Rd., Suitland, Md. 20028 / *C 66
Junior College / IBM series 50 / two courses; Introduction to EDP, Basic Programming Concepts / S 3 / E 1964

Princeton University Computer Center, Princeton, N. J. 08540 / *C 66
Education and scientific research / IBM 7094-1410; IBM 7044-1401; IBM 1410; IBM 1620; IBM 360-40 / Junior level courses in Math. Dept.; senior and graduate courses in Dept. of Electrical Engineering; Elementary Programming; lecture series on FORTRAN, SNOBOL, etc. / S 32 / E 1961

Queensborough Community College, Bayside, N. Y. 11364 / *C 66
Education / DIGIAC 3080 / Computer Programming / S 2 / E 1964

Randolph-Macon College, Computer Center, Ashland, Va. 23005 / *C 66
Undergraduate liberal arts education / IBM 1620 Model I, 20K, card; off-line 407 / Introduction to Digital Computation (mostly programming); Numerical Analysis / S 3 / E 1963

Reed College, Portland, Ore. 97202 / *C 66
Education and research for faculty and students / coml svc / IBM 1620 with 1311 disk unit, plus associated card equipment / extensive use within a number of courses in natural and social sciences / S 2 / E 1965

Rensselaer Polytechnic Institute, Computer Laboratory, Troy, N. Y. / *C 66
Education / coml svc / IBM 360 Model 50 / courses given in conjunction with computing center / S – / E 1952

Rhode Island College Computer Lab., Mt. Pleasant Ave., Providence 8, R. I. / *C 66
Administration and education / coml svc / IBM 1440 disk system and peripheral equipment / Fortran Programming for faculty and students / S 5 / E 1965

Richmond Professional Institute, 901 W. Franklin St., Richmond, Va. 23220 / *C 66
Educational / IBM 1620 with keypunch, sorter, reproducer; 1004 UNIVAC / Functional Wiring; Computer Programming / S 3 / E 1965

Riverside City College, Riverside, Calif. / *C 66
Education / IBM 1620; peripheral equipment / Introduction to Data Processing; Electro-mechanical Machines; Keypunch Training for the Deaf; Problems in Punched Card Data Processing; Computer Programming; Problems in Computer Data Processing; Data Processing Systems / S 8 / E 1963

Rochester Institute of Technology, 65 Plymouth Ave. South, Rochester, N. Y. 14608 / *C 66
Educational / IBM 1620 Model I-20K / Programming and Numerical Methods / S 3 / E 1963

Roosevelt Univ., 430 S. Michigan Ave., Chicago, Ill. 60605 / *C 66
Research and education / IBM 1620 and peripheral equipment / Data Processing; Programming; Systems and Procedures / S 10 / E 1963

Rose Polytechnic Institute, 5500 Wabash Ave., Terre Haute, Ind. 47803 / *C 66
Engineering education and research / IBM 1130; CDC G15 / Fortran Programming; Numerical Analysis / S 1 / E 1960

Rutgers, The State University, Center for Information Processing, New Brunswick, N. J. / *C 66
Education and research computing / coml svc / IBM 7040; 1401; 1620; IBM 360-67 on order / Theory of Programming; Programming & Data Processing; Programming & Numerical Analysis; Numerical Solution of Differential Equations; Programming for Research / S 16 / E 1958

St. Cloud State College, St. Cloud, Minn. 56301 / *C 66
Educational / IBM 1620, 1622; peripheral equipment planned / Basic programming; Business programming; Math for Scientists & Engineers; Numerical Analysis / S 1 / E 1964

St. Edward's Univ., 3001 S. Congress, Austin, Tex. 78704 / *C 66
Education and administrative use / coml svc, limited / IBM 1620-1622 system, model I; 026 keypunch; 084 sorter / Introduction to Digital Computers; Numerical Analysis / Math required / S– / E 1964

St. Francis Xavier Univ., Computation Centre, Antigonish, N. S. / *C 66
Research and education / IBM 1620, 40K; Off line printer, sorter, two key punch / Numerical Analysis / S 3 / E 1964

St. Johns River Junior College, Palatka, Fla. 32077 / *C 66
Education; service for administrative & business offices / IBM punch card equipment / Unit record equipment courses, Key punch course, & beginning, intermediate and advance 1401 program courses / S 3 / E 1962

St. Mary's Univ., 2700 Cincinnati Ave., San Antonio, Tex. 78228 / *C 66
Education, research and administrative support / coml svc / IBM 1620 and peripheral equipment / Introduction to Programming; Numerical Methods for Computers / S 4 / E 1962

St. Michael's College, Winooski, Vt. 05404 / *C 66
Education, administration, research / Burroughs Datatron 205; tape punch 466; tape unit 544, 4K memory drum, photoelectric reader / Introduction to Electronic Data Processing; Advanced Electronic Data Processing / S 2 / E –

St. Peter's College, Kennedy Blvd., Jersey City, N. J. 07306 / *C 66
Education and research / LGP-30; tape typewriters; photo-electric reader; high speed punch unit / Digital Computer Programming; Numerical Analysis / S 3 / E 1964

Samford Univ., Birmingham, Ala. 35209 / *C 66
Education and administration / IBM 1620 Model I card system; supporting equipment / Business Data Processing; Introductory Programming / S 6 / E 1964

San Antonio College Computer Center, 1300 San Pedro, San Antonio, Tex. / *C 66
Education and administration / IBM 1440; punch card equipment / Programming; Punch Card Accounting; Computer Concepts; Advanced Programming; Systems and Procedures; Advanced Systems & Procedures / S 13 / E 1954

San Jacinto College, 8060 Spencer Hwy., Pasadena, Tex. / *C 66
Teaching / IBM 1620, unit record equipment / two unit record and four computer courses / S 3 / E 1963

San Joaquin Delta College, Processing Dept., Stockton, Calif. / *C 66
Education / IBM 1620; EAM equipment / Fundamentals of Data Processing; Machine Operation and Wiring; Programming; Business, Scientific, Fortran; Data Processing Systems / S 4 / E 1959

Santa Ana College, 1530 W 17th St., Santa Ana, Calif. 92706 / *C 66
Education and administration / IBM computer, 2 disk drives, peripheral equipment / AA degree in Business Data Processing; AA degree in Computer Science / S 4 / E 1964

Savannah State College, Savannah, Ga. / *C 66
Administration, instruction, research / IBM 1620 / Computer Programming; Computer Concepts / S 2 / E 1965

Seton Hall Univ., Computer Center, S. Orange, N.J. / *C 66
Support of faculty and student research; educational program and computer science; administrative data processing / IBM 1620-20K card I/O disk file; unit record support equipment / Numerical Analysis, Numerical Methods in Matrix Algebra; Numerical Methods in Ordinary Differential Equations; Numerical Methods in Partial Differential Equations; Computer Programming & Numerical Methods; Introduction to Electronic Data Processing / Plans for program in Computer Science and for Introduction of Remote Terminals / S 10 / E 1963

Shippensburg State College, Shippensburg, Pa. 17257 / *C 66
Education / coml svc / IBM 1620-20K, 1311 disk drive, 1622 / Computer programming; graduate and undergraduate data processing / S 2 / E 1963

Siena College, Loudonville, N. Y. 12211 / *C 66
Administrative applications / IBM 1620; punch card equipment / Introduction to Programming; Accting Systems; special ADP course / S 3 / E 1963

Slippery Rock State College, Slippery Rock, Pa. 16057 / *C 66
Administrative / IBM record equipment / Rental of IBM system / 360 Model 20 being considered. Computer courses will then be offered / S 2 / E 1963

Snow College, Ephraim, Utah 84627 / *C 66
Student records and library control / 402; 026; 082; will change over to 1130 as soon as one can be obtained / Key Punch / S 2 / E 1965

South Dakota School of Mines and Technology, Computation Center, Rapid City, S. D. 57701 / *C 66
Education and scientific research / IBM 1620 (card I/O); IBM 407 (on order) / Digital Computer Programming; Fall 1966, Numerical Methods / S 7 / E 1962

South Dakota State Univ., Brookings, S. D. 57006 / *C 66
Research and teaching / IBM 1620 40K with punch card equipment / FORTRAN programming course / S 3 / E 1961

Southeastern Mass. Technological Institute, New Bedford Branch, Purchase St., New Bedford, Mass. / *C 66
Education and faculty research / Burroughs Datatron 205; paper tape input-output / Introductory Digital Computer Programming / S 1 / E 1965

Southern Colorado State College, Pueblo, Colo. / *C 66
Education and research, business application / coml svc / IBM 1620; 1622, 1443, 1311, plus unit record equipment / Introduction to Digital Computers; Numerical Analysis; Linear Programming; Business Machine Accounting Systems / S 7 / E 1963

Southern Illinois Univ., Computing Center, Carbondale, Ill. / *C 66
Administration, research, education / equipment located on both Carbondale and Edwardsville campuses and at Vocational Technical Institute – IBM 7040, 1620, (2) 1401's, Optical Scanner (Carbondale campus); IBM 1401, 1620 (Edwardsville campus); and IBM 1401 (Vocational Technical Institute) / Carbondale, ten courses related to Engineering, Department of Accounting and Business, and Applied Science; Edwardsville, four courses (Management, Mathematics); and Vocational Technical Institute, twelve courses / S 56 (Carbondale campus) / E 1958

Southern Univ., Computing Center, Baton Rouge, La. / *C 66
Education / IBM 1620, IBM 1440; IBM 1622, IBM 1443, IBM 1311 and other peripheral equipment / Theory and Use of Computing Machines; Introduction to Data Processing I & II; Automations and Computers; Numerical Analysis /S 1 / E 1952

Southwest Texas Junior College; P.O. Box 70; Uvalde, Tex. 78801 / *C 66
Education / 2– 26 Key punch machines; 1-82 Sorter; 1-514 Reproducer; 1-402 Accounting machine; 1-85 Collator / Introduction to Data Processing; Card punch machines; Systems; Applications; Programming / IBM 360 Model 20, delivery January, 1967 / S 1 / E 1963

Southwestern State College, Dept. of Physics, Weatherford, Okla. 73096 / *C 66
Instruction in pure Sciences and Mathematics / IBM 1130 with card I/O (to be delivered Jan. 1967) / Computer Programming for Science (others being developed)/ S 2 / E 1966

Stanford Univ., Comoutation Center, Stanford, Calif. / *C 66
Education / IBM 7090-1401, CDC 8090; Burroughs B5500; PDP-1 / some "Quickie" courses offered by Center itself; university has large well-rounded Computer Science Department / S 100 / E 1953

State College of Iowa, Cedar Falls, Iowa 50613 / *C 66
Administration, research and education / IBM 1401-8K and peripheral equipment; IBM 1620-20K; unit record / Center used for demonstration purposes at present / S 10 / E 1949

State Teachers College, Data Processing Center, Kirksville, Mo. / *C 66
Facilitate administration of the college / IBM 1440 / Programming the 1440, Information Systems and Computers / S 2 / E 1966

State University Agricultural & Technical College, Alfred, N. Y. 14802 / *C 66
Education / IBM 1620 and peripheral equipment / AAS degree offered in data processing / S 8 / E 1963

State University College at Buffalo, 1300 Elmwood Ave., Buffalo, N. Y. 14222 / *C 66
Education and research / IBM 1130 due in Nov., 1966 / Introduction to Computer Science; Introduction to Computer Programming / S – / E 1965

State University College, Cortland, N.Y. 13045 / *C 66
Primarily administrative; slowly moving toward computer education and research / IBM 024 (2); 056, 514, 548, 083, 085 for support of UNIVAC 1004-I with read punch / Introduction to Computing Science; Programming the UNIVAC 1004 / S 6 / E 1958

State University College at Potsdam, Potsdam, N.Y. 13676 / *C 66
Education, research, administration / Unit record equipment; Sept. 1966 IBM 1440 / S 5 / E 1965

State University of New York, Agricultural and Technical College, Cobleskill, N. Y. / *C 66
Educational facilities and administrative services / IBM 1401 card system and complete unit record / DP curriculum leading to AAS in Data Processing / S 3 / E 1964

State University of New York at Albany, Albany, N. Y. 12203 / *C 66
Education and research / CDC 3100 / Introduction to Computer Science / S 15 / E 1965

State University of New York, Binghamton, N. Y. 13901 / *C 66
Education / IBM 1460-1448; IBM 1130 / Computer Concepts / S 19 / E 1965

State University of New York at Buffalo, Computing Center, Goodyear Hall, Buffalo, N. Y. 14214 / *C 66
Research and education / coml svc / IBM 7044 32K, B, C channels, off-line 4K 1401; two IBM 1620-60K, one with 1311 disk; IBM 360-40 in October / Mathematics, statistics; education; engineering / S 30 / E 1961

State University of New York, College of Forestry, Syracuse, N. Y. 13210 / *C 66
Service and education / IBM 1620 Model II / Introduction to Computer Programming; Computer Concepts and Applications / S 3 / E 1962

State University of New York College at Oswego, Piez Hall, Oswego, N. Y. 13126 / *C 66
Provides computer facilities for instruction in their use / IBM 1620 Model I 20K card I/O; IBM 082 card sorter; two IBM 026 printing card punches / IBM 1130 on order for next year / Math, programming for students with and with-

out calculus background / S 4 / E 1964
State University of New York, Downstate Medical Center, 450 Clarkson Ave., Brooklyn 3, N. Y. / *C 66
Administrative and scientific computing needs / IBM 1620; 1410 coupled directly to 1440 real time system / Seminars on Fortran / S 50 / E 1963
State University of New York Maritime College, Fort Schuyler, Bronx, N. Y. 10465 / *C 66
Research and student instruction / LGP-30; 1130 system on order / Elementary programming all students / S 1 / E 1961
Stetson Univ., De Land, Florida / *C 66
Administration, education, research / coml svc / IBM 1620; IBM 407 and related tab equipment / Introductory programming course / S 8 / E 1962
Swarthmore College, Swarthmore, Pa., 19061 / *C 66
Education and research / coml svc / IBM 1620-II with 40K, disk pack and monitor / None / S 6 / E 1964
Syracuse Univ., Computing Center, Syracuse, N. Y. / *C 66
University research using Computers. Teaching and research on computers and in Computer Science / IBM 7074; IBM 1460; February 1967 delivery of IBM 360-50 / Numerical Analysis; Systems Programming; Mathematical Programming; etc. / S 22 / E 1956
Teachers College Computer Center, 525 W. 120th St., New York, N. Y. 10027 / *C 66
Research, administration, and education / IBM 1620 Model II with disk and printer; Digitek optical scanner, EAM equipment / FORTRAN II D programming / S 20 / E 1964
Temple Junior College, Temple, Tex. 76501 / *C 66
Instruction / IBM unit record equipment / Key punch; Principles of Unit Record Machines; Introduction to Computer Programming; 403 Acct. machine / anticipate computer installation soon / S 2 / E 1963
Tennessee Tech, D. W. Mattson Computer Center, Box 21A TTU, Cookeville, Tenn. / *C 66
Education / coml svc / IBM 1710; IBM 1620 and off-line equipment / courses offered by another dept / S 5 / E 1960
Tennessee Wesleyan College, Athens, Tenn. 37303 / *C 66
Education and training / IBM 402 series 50 / Function and operation of IBM machines; Introduction to EDP / S 2 / E 1963
Texas A & M Univ., Data Processing Center, College Station, Tex. / *C 66
Education and research / IBM 7094; three IBM 1401 / M.S. degree in computer science; expanding computer science graduate program; short course programs provide a teaching service to industry / S 75 / E 1958
Texas Tech Computer Center, Lubbock, Tex. / *C 66
Education and research / IBM 1620-I; IBM 1620-II; IBM 1401; IBM 7040 and peripheral equipment / Fortran programming for credit and noncredit / S 8 / E 1962
Thornton Township Junior College, 151st & Broadway, Harvey, Ill. 60426 / *C 66
Education; administrative needs / IBM 1440 with 2 disk drives; peripheral equipment / Data processing courses / S 3 / E 1965
Trenton Junior College, 101 West State St.; Trenton, N.J. / *C 66
Data processing instruction for students; prepare reports for administrators; prepare statistical reports for administrative & academic staffs / coml svc / IBM 1620; IBM unit record equipment / Fifteen courses offered including: Introduction to Electronic Data Processing; Programming I & II; Basic Computer Systems I & II; Computer Systems & Applications I & II / S 4 / E 1962
Tri State College, Angola, Ind. / *C 66
Service bureau for various school departments, complete billing service for cities water utility / coml svc / IBM 1620 Model I; punch card equipment / Data Processing for business students; Computer Programming for all students; evening course in Management Decision / S 3 / E 1963
Trinidad State Junior College, Trinidad, Colorado / *C 66
Education / IBM 1401 with a 1402 punch reader, 1403 printer; G-15 Control Data Computer with magnetic tape storage; IBM unit record equipment / Data Processing Department offers several computer related courses which award an Associate of Applied Science Degree upon completion of program / S – / E 1964
Trinity Univ., 715 Stadium Drive, San Antonio, Tex. 78212 / *C 66
Research for university personnel and student education / Coml svc / LGP-30; CDC 1700 / Programming; Numerical Analysis; Computer Techniques; Pulse and Digital Techniques; Statistics / S 6 / E 1960
Tulane Univ., Tulane Computer Laboratory, 6823 St. Charles Ave., New Orleans, La. 70118 / *C 66
Educational and research for university / coml svc / IBM 7044 / Introductory courses in computer sciences / S 10 / E 1958
Tuskegee Institute, Computer Center, Tuskegee, Ala. 36088 / *C 66
Education and service to academic, research and administrative areas / coml svc / IBM 1620-60K; IBM 40F; keypunch; sorter / Introductory Computing; Advanced Computing / S 9 / E 1961
Tyler Junior College, Tyler, Tex. / *C 66
Education and administration / IBM 1620 card system and peripheral equipment / Electronic Data Processing I & II; Computer Programming I & II / S 2 / E 1964
Union College, Computer Center, Schenectady, N.Y. 12308 / *C 66
Computing and data processing services to students, faculty, and administration / IBM 1620 and peripheral equipment. Equipment to be replaced with larger computer shortly / Computer programming; starting next year, will offer Advanced Programming; System Design / S 7 / E 1962
U.S. Coast Guard Academy, Computing Center, New London, Conn. / *C 66
Education and research / IBM 1620-40K, peripheral equipment and punch card equipment / 2 semesters required of all students / S 3 / E 1963
United States Merchant Marine Academy, Kings Point, N.Y. / *C 66
Instruction in use of analog computers; simulation—Nuclear Ship Savannah / (2) EAI 231R analog computers; X-Y plotters, oscillographs, ship simulation equipment / Analog Computer Technology, NSS Savannah Nuclear Reactor Operator Training / planning expansion to digital computers / S 5 / E 1963
United States Military Academy, West Point, N.Y. 10996 / *C 66
Education, research, and academic administration / GE Datanet-30; GE-225 with peripheral equipment; time-sharing remote terminals / programming in first semester and use of computers in subsequent courses / S 16 / E 1959
United States Naval Academy, Annapolis, Md. / *C 66
Education / IBM 1620-1622-1311-407 / FORTRAN Programming; Digital Computing / S 5 / E 1962
U. S. Naval Postgraduate School, Monterey, Calif. 93940 / *C 66
Research and consulting / CDC 1604; 2-CDC 160; IBM 1401 / 25 courses on aspects of the computer field / S 21 / E 1960
The Univ. of Akron, 302 E. Buchtel Ave., Akron, Ohio 44304 / *C 66
Educational and administration / coml svc / IBM 1620-60K with peripheral equipment; Burroughs 205 magnetic tape system / Computer Science; special topics in computer science / S 16 / E 1961
Univ. of Alabama, P. O. Box 2511, University, Ala. / *C 66
Education, research, and testing analysis / Univac Solid-State 80; Univac 1004 with remote access to 1107 / Introduction to Computer Science; Programming; Numerical Analysis; Management and Marketing; Application courses / S 3 / E 1961
Univ. of Alberta, Calgary, Alberta, Canada / *C 66
Research, education, administrative service / IBM 360 Model 30 (64K) with 2 disk drives / Several computing science and extension courses / S 12 / E 1962
Univ. of Arkansas, Computing Center, Fayetteville, Ark. 72701 / *C 66
Education and research / coml svc / IBM 7040, 6 tapes; IBM 1401, 2 tapes / Digital Computer Programming; Computer Organization and Programming; Introduction to Computers / S 15 / E 1960
Univ. of California, P. O. Box 112, Riverside, Calif. 92502 / *C 66
Academic research and education / coml svc / IBM 7040 with peripheral equipment / Computer Methodology and programming; Numerical Analysis; extension courses in Business and Scientific Programming / S 13 / E 1963
Univ. of California Computer Center, 201 Campbell Hall, Berkeley, Calif. / *C 66
Research and maintenance of general purpose computer / IBM 7094-7040 / Non-credit courses in: Computer Programming; Computers in Engineering; etc. / S 53 / E 1956
Univ. of California, Computer Center, Davis, Calif. 95616 / *C 66
Education and research on computer application and development / IBM 7044; Calcomp plotter, Model 750 / Introduction to FORTRAN IV Programming Language (non-credit) / S 22 / E 1960
Univ. of California, UCLA Computing Facility, Los Angeles 24, Calif. / *C 66
Education and research for faculty and students IBM 7094 with 9-729 IV magnetic tape units and peripheral equipment; 2 IBM 1401 with 2-729 IV magnetic tape; on-line console; IBM 360-40 with peripheral equipment; SWAC computer with electrostatic memory and drum storage and peripheral equipment / Non-credit courses in Fortran IV, MAP, 1401 and 360 machine languages and others; various courses given by individual departments / S 30 / E 1950
Univ. of Chattanooga, Chattanooga, Tenn. 37403 / *C 66
Education / coml svc / IBM 1620 - 1443 printer and tab installation / Engineering and Business Administration / S 6 / E 1963
Univ. of Cincinnati, Computing Center, Cincinnati 31, Ohio / *C 66
Education and research / coml svc / IBM 1620 with 40K core, 1311 disk; 1410, five 729 (II) tapes, 1403 printer / Business Adm., engineering, arts, sciences, etc. / S 7 / E 1958
Univ. of Colorado, Graduate School Computing Center, Boulder, Colo. / *C 66
Research and education / coml svc / IBM 7044 (32K) and peripheral equipment; IBM 1401 (4K) and peripheral equipment; Calcomp plotter / Institute of Computing Science offers graduate level courses. Computing Center offers non-credit courses in basic programming / S 18 / E 1962
Univ. of Connecticut, University Computer Center, Storrs, Conn. / *C 66
Provide computer facilities for all types of University research and education / IBM 7040 with 10 tapes, 1401 in/out, IBM 1620 with disk; PACE 231R / FORTRAN programming workshops 5 times a year / S 9 / E 1961
Univ. of Delaware, Newark, Del. / *C 66
Research and education / coml svc / SDS 9300/DES-1, IBM 1620-II, EAI 231R-V, EAI TR-48 / undergraduate and graduate degree programs in computer science / S 20 / E 1957
Univ. of Denver, Denver, Colo. 80210 / *C 66
Research and education / coml svc / Burroughs B 5500 / Programming; Numerical Analysis / engineering courses use computer / S 10 / E 1958
Univ. of Detroit, 4001 W. McNichols, Detroit, Mich., 48221 / *C 66
Research, instruction, and administration / coml svc / IBM 1410, 40K and peripheral equipment / Numerical Analysis, Engineering Graphics, Computer Technology / S 20 / E 1963
Univ. of Florida, Computing Center, Gainesville, Fla. 32601 / *C 66
Education and research / coml svc / IBM 1401; IBM 709; Calcomp 363 / Fortran programming; seminars in ADP / S 25 / E 1962
Univ. of Georgia, Athens, Ga. 30601 / *C 66
Education and research / coml svc / IBM 7094; (2) IBM 1401; IBM 1620 / Four computer science courses / S 47 / E 1958
Univ. of Hawaii, Statistical and Computing Center, Honolulu, Hawaii 96822 / *C 66
Academic research and teaching computing / IBM 1401; IBM 7040 / computing courses given / S 21 / E 1960
Univ. of Idaho, Moscow, Idaho 83843 / *C 66
General university computing / IBM 1620-40K; (2) 1311 disk files; unit record equipment / Computer programming and applications / S 7 / E 1962
Univ. of Illinois, Department of Computer Science, Urbana, Ill. 61801 / *C 66
Education and research for students and faculty / IBM 7094; Illiac II; Illiac III being built by University / Digital Computing; Data Processing; Programming; Numerical Analysis; Boolean Algebra; Logical Design of Automatic Digital Computers; Circuit Design; Threshold Logic; Semiconductor Computer Devices; Advanced Theory of Magnetic and Optic Computer Memory Devices; Switching Theory / S 32 / E —
Univ. of Iowa, Computer Center, Iowa City, Iowa / *C 66
Research and education / coml svc / IBM 7044-32K, 8 729 III & II tape units; 1301 disc; 1401; 360-30 16K; 4 tape units / Computer Science Dept. offers courses / S 53 / E 1958
Univ. of Kansas, Computation Center, 110 Summerfield Hall, Lawrence, Kan. 66044 / *C 66
Education and research / coml svc, limited / IBM 7040, 1401; GE 415, Datanet 30 / Four computing courses and thirty teaching applications / S 20 / E 1957
Univ. of Kentucky, Computing Center, Lexington, Ky. 40506 / *C 66
Educational, research and administrative activities / coml svc / IBM 7040 with peripheral equipment; IBM 1410 with peripheral equipment; IBM 1620 with peripheral equipment; IBM 1401 with peripheral equipment; IBM 1050 remore consoles; IBM punch card equipment / Automatic Data Processing; Fundamentals of Programming; Design of Digital Computer; Numerical Analysis; Introduction to Algorithmic Processes; Computer Organization and Programming; Information Processing Systems; Algorithmic Languages and Compilers; Analog and Hybrid Computer Techniques; System Simulation; Non-numerical Application of Computers; Computers and Programming Systems / full degree program in Computer Science at B.S. level / S 40 / E 1958
Univ. of Louisville, Speed Scientific School, Computing Lab., Louisville, Ky. 40208 / *C 66
Education and research / IBM 1620-1311-1710; IBM 704, 32K; PACE 221R / Numerical Math; Digital Computation; Analog Computation; Adv. Digital Computation; Eng. Appl. of Digital Computation / S 6 / E 1958
Univ. of Manitoba, Winnipeg, Manitoba, Canada / *C 66
Research and education / coml svc / IBM 1620-disc; IBM 360-65, 4 disc, 2 tapes; communications facilities, etc. / M. Sc. (computer science); Undergrad electives: Programming, Numerical Analysis, Statistics / S 25 / E 1964
Univ. of Maryland, Computer Science Center, College Park, Md. / *C 66
Education, Institutional and Academic Research, Central Computing Facility / IBM 7094-1401 system; IBM 360-30 system / Many computer-related courses / S 80 / E 1963
Univ. of Massachusetts Research Computing Center, Amherst, Mass. / *C 66
Provide computing facilities and service to the University community / coml svc / CDC 3600-32K, 6 tapes / M. S. in computer science; undergraduate minor in C. S. / S 20 / E 1960

Univ. of Miami, Coral Gables, Fla. 33124 / *C 66
Research and education in computer theory and applications / coml svc / IBM 7040-1401; card sorter, duplicator, interpretor / Computer Programming; Computer Applications; Computer Systems Simulation; Numerical Analysis / S 14 / E 1965

Univ. of Michigan, Ann Arbor, Mich. / *C 66
Education and research / IBM 7090 with IBM 1410 as a peripheral processor / Many courses concerned with one or more aspects of the theory, design, development, or programming of computers. Rackham School of Graduate Studies offers several courses in information and control / S 37 / E 1959

Univ. of Minnesota Duluth, Duluth, Minn. 55812 / *C 66
Provide computer services for research and instruction / IBM 1620 with 60K core storage, 1311 disk storage drive, 1443 line printer; peripheral unit record equipment / Math; Computer Programming (3 cr/quarter); Bus & Econ; Accounting Systems & Data Processing; Ed. Psych.; Data Processing in Education / S 2 / E 1965

Univ. of Minnesota, School of Business Administration, Computer Center, Minneapolis, Minn. / *C 66
Research and education / Univac Solid-State 80; IBM 1620 / Introduction to Computers; Fortran / S 12 / E —

Univ. of Mississippi, University, Miss. 38677 / *C 66
Education / coml svc / IBM 1620 Model I with 60K memory / Basic Fortran Programming/ S 6 / E —

Univ. of Missouri, Computer Research Center, B & P.A Bldg., Columbia, Mo. 65201 / *C 66
Research for faculty and graduate students; education / IBM 7040 and peripheral equipment; IBM 1710 with 1620 Model II and peripheral equipment / Fortran IV; Fundamentals of Digital Computer Programming; Numerical Analysis; Advanced Numerical Analysis / S 25 / E 1960

Univ. of Missouri at Rolla, Rolla, Mo. / *C 66
Education / coml svc / IBM 1620; Calcomp Model 566 / Introduction to Computing Techniques; Introduction to Algorithmic Processes; Computer Organization and Programming; Introduction to Information Structures; Algorithmic Languages for Digital Computers; Business Data Processing Techniques; Introduction to Numerical Methods and Digital Computer; Computer and Programming Systems; Computational Methods of Numerical Analysis; Logic of Digital Computers; Digital Computer Programming Languages; Data Processing for Management; Techniques of Information Processing and Retrieval; Special Problems in Computer Science; and others / B.S. and M.S. degrees in Computer Science are offered / S 46 / E 1959

Univ. of Montana Computer Center, Missoula, Mont. 59801 / *C 66
Support University research and train students / coml svc / IBM 1620 / Introduction to Computer Programming; Digital Computers & Coding; Computer Methods; Application of Digital Computers; Numerical Analysis / S 5 / E 1964

Univ. of Nevada, Reno, Nev. / *C 66
University-wide computing service to the University / coml svc / IBM 1620 Model II 60K, 3 disk drives; 1013 teleprocessing unit / Principles of electronic data processing and computer programming / Center conducts numerous programming workshops / S 18 / E 1960

Univ. of New Brunswick, Fredericton, N.B., Canada / *C 66
Education and research / coml svc / IBM 1620-II; 60K memory, 2-1311 disk-packs; 1443 printer; 1627-II plotter / Programming; Numerical Analysis; Computer Logic / S 5 / E 1959

Univ. of New Hampshire, Computer Center, Durham, N.H. / *C 66
Research and instruction / coml svc / IBM 1620 with 2 tape drives, IBM 360, model 40 / Numerical Methods and Computers, 16 other courses / S 10 / E 1961

Univ. of North Carolina, Computation Center, Chapel Hill, N.C. 27515 / *C 66
Research and education / UNIVAC 1105, UNIVAC 1004 III, IBM 360, Model 30 / Introduction to Digital Computer Usage; Fundamentals of Information Processing; Metaprograms; Symbolic Logic; Intermediate Symbolic Logic; Business Data Processing; Introduction to Numerical Analysis; Introduction to Automatic Digital Control; related courses for graduates / S 70 / E 1959

Univ. of North Dakota, P.O. Box 8282, University Station, Grand Forks, N.D. / *C 66
Education / coml svc / IBM 1620; punch card equipment / Programming for Engineers; Numerical Analysis; Statistics / Expanding to IBM 360 Model 30 in Dec., 1966 / S 3 / E 1961

Univ. of Ottawa Computing Centre, 700 King Edward Ave., Ottawa 2, Ontario, Canada / *C 66
Education of undergraduates and graduates / IBM 1620 Model II; disk packs and 40K core storage; interpreting keypunches and card sorting facilities / Numerical Analysis; Computer Programming; Scientific Computations / IBM 360 model G40 expected early this fall / S 7 / E 1958

Univ. of the Pacific, School of Engineering, Stockton, Calif. 95204 / *C 66
Education, some research / LGP-30 with high speed read punch and off-line flexowriter / Basic Programming / S 1 / E 1964

Univ. of Pennsylvania, Computer Center, Philadelphia, Pa. / *C 66
Education and research / Two IBM 7040; two IBM 1401; two IBM 1620; RCP 4000; PDP-8; PDP-6 / computing courses given / S 40 / E 1956

Univ. of Portland Computer Center, 5000 N. Willamette Blvd., Portland, Oregon / *C 66
Education, research, administration / coml svc / Burroughs 205 with 4000 - 10 digit word memory, 6 magnetic tape units; IBM punch card equipment / —/ S 10 / E 1964

Univ. of Puerto Rico, Rio Piedras, Puerto Rico / *C 66
University administration and research / IBM 1401 with peripheral equipment / Introduction to Punched Card Methods; Punched Card Methods; 1401 Symbolic Programming System / S 25 / E 1962

Univ. of Rhode Island, Kingston, R. I. / *C 66
Research and education for entire university / IBM 360-40; 131k, disk oriented / Computer Science; Introduction to Digital Computers; Scientific Applications of Digital Computers; Problems in Computer Science; Digital Computation / S 10 / E 1959

Univ. of St. Thomas, 3812 Montrose Blvd; Houston, Tex. 77006 / *C 66
Programming education and computing facility for students and staff / coml svc / CDC G15 computer; Friden Flexowriter; IBM 026 Key Punch / Algebra for Computation; Digital Computer Programming; Differential Equations; Numerical Analysis / S 3 / E 1961

Univ. of Scranton, Scranton, Pa. 18510 / *C 66
Educational, administrative and commercial / coml svc / Burrough 205 cardatron & Datafile full system / Programming for 205 & Algol; Advance Programming & Numerical Analysis / S 7 / E 1965

The University of the South, Sewanee, Tenn. 37375 / *C 66
Education and research / IBM 1620-I with paper tape read-punch / Basic Programming; Introduction to Numerical Analysis / S 2 / E 1963

Univ. of South Carolina, Computer Science Center, Columbia, S. C. 29208 / *C 66
Provide computer service, guidance, and instruction for University community / coml scv / IBM 7040 - 32K, 8 tape; IBM 1401 - 8K, 4 tape / Fortran; Cobol; Computer Design; Systems Design / S 18 / E 1957

Univ. of South Dakota, Vermillion, S.D. 57069 / *C 66
Education / IBM 1620 Model I 40K, card I/O, disk; 1443 printer on order / Computer oriented courses given / S 1 / E 1963

Univ. of Southern California, Computer Sciences Laboratory, 1020 W Jefferson Blvd., Los Angeles, Calif. 90007 / *C 66
Academic and research; computers and governmental systems research; under and post graduate training / H-800; H-400, H-200 and supporting tabulating equipment / Compiler Languages: COBAL and FORTRAN; Assembly languages; Quantified Research Design; Statistics; Bio statistics / S 30 / E 1961

Univ. of Southern Mississippi, Box 48, Southern Station, Hattiesburg, Miss. 39401 / *C 66
Education and research / coml svc / IBM 1620-I and peripheral equipment / Basic Programming-Fortran; Linear Programming Techniques; Digital Computer Programming-symbolic, machine, and complier programming; Construction of Compliers; Advanced Digital Programming / S 4 / E 1963

Univ. of Southwestern Louisiana, Box 133, USL Station, Lafayette, La. 70501 / *C 66
Education, research, administration / coml svc / IBM 1620-40K with peripheral equipment / Advanced Digital Computer Programming; Construction of Compilers; Design of Computer Languages; Information Theory and Information Retrieval; Heuristic Programming and Artificial Intelligence; Real time and Hybrid Computation; Theory of Automata and Finite State Machines / S 5 / E 1960

The Univ. of Tennessee, University Computing Center, Knoxville, Tenn. 37916 / *C 66
Research / coml svc / IBM 7040-1401 / Mathematics; Fortran IV; Accounting; Engineering / S 48 / E 1960

Univ. of Texas Medical Branch, Research Computations Center, Galveston, Tex. 77550 / *C 66
Assist medical researcher in design and analysis of research / IBM 1620-I with 2 disks and 40K memory; IBM 1232 / — / S 11 / E —

Univ. of Toledo, Computation Center, 2801 Bancroft, Toledo, Ohio 43606 / *C 66
Academic, research / coml svc / IBM 1620 Model I 40K memory, 1311 disk file, 1627 plotter / Introduction to Computing Techniques; Digital Computing & Numerical Analysis; The Use of Computers in Engineering / S 4 / E 1962

Univ. of Toronto, Institute of Computer Science, Toronto, Ont., Canada / *C 66
Education and research / coml svc / IBM 7094 II; IBM 1460; Calcomp plotter / Degree program in computer science / S 25 / E 1948

Univ. of Tulsa, 600 S. College, Tulsa 4, Okla. / *C 66
Education for undergraduates and graduate research / coml svc / IBM 1620 and peripheral equipment / Fortran Programming / S 2 / E 1963

Univ. of Utah, Salt Lake City, Utah 84112 / *C 66
Research and education at university / coml svc / IBM 7044-1401; CDC 3200; Univac 1108 on order / Programming; Use of Computers in Science and Engineering; Computer Science / S 25 / E 1958

Univ. of Virginia, Computer-Science Ctre., Charlottesville, Va. 22903 / *C 66
Education and research support / coml svc / Burroughs B5500 / — / S 12 / E 1959

Univ. of Waterloo, Computing Centre, University Ave., Waterloo, Ontario, Canada / *C 66
Research and education / coml svc, limited / IBM 7040 with on-line; IBM 1401; IBM 1710; IBM 1620 II; Pace Tr-48; IBM 1620; and supporting peripheral equipment / Analogue Computation; Numerical Methods; Digital Computer Programming; Numerical Analysis; Principles of Computer Science; Series of graduate courses in Numerical Analysis; Computer Programming; Advanced Computer Techniques; many more / S 21 / E 1960

Univ. of Western Ontario, London, Ontario / *C 66
Research, teaching and administrative / IBM 7040 (32K) and peripheral equipment / Graduate and undergraduate, MA or BA in Computer Science / S 30 / E 1959

Univ. of Windsor, Computer Centre, Windsor, Ont. Canada / *C 66
Education and research, administrative work / coml svc / IBM 1620-II, 40K core memory, 2-1311 disc drives, card I/O, off-line 407 / Courses offered by departments of mathematics and electrical engineering / S 2 / E 1964

Univ. of Wisconsin, 3203 N. Downer Ave., Milwaukee, Wis. / *C 66
Administration, education and research / IBM 1401 and peripheral equipment; IBM 1620 Model 2 and peripheral equipment; Calcomp printer, Unit-record equipment / Fortran Programming; Systems Programming; Introduction to Computing Machinery / S 34 / E 1962

Univ. of Wisconsin, Computing Center, 5534 Sterling Hall, Madison, Wis. / *C 66
Education with satellites / coml svc / CDC 3600 with CDC 924 and link satellites; CDC 1604B/160; IBM 1460 / Introduction to Programming (no credit); credit courses given by Computer Sciences Dept. / S 77 / E 1964

Univ. of Wyoming, University Station, P.O. Box 3275, Laramie, Wyo. 82070 / *C 66
Educational and faculty research; theses / coml svc / Philco 211-1 / Introduction to FORTRAN; Introduction to Machine Language; Introduction to Metalanguage / S 9 / E 1963

Utah State Univ., Logan, Utah 84321 / * C 66
Education and research / coml svc / IBM 1620-I, 40k core, card I/O; IBM 1401 G 4K core, card I/O / Data Processing; Computer Programming; Programming Business Problems; Programming Scientific Problems; Advanced Programming; Compiler Languages; Monitors and Systems Designs; Techniques in Operations Research; offer degree program with emphasis in mathematics or in management science / S 10 / E 1961

Valparaiso Univ., Valparaiso, Ind. 46383 / *C 66
Scientific computation and liberal arts approach to computer and programming / IBM 1620 with disk-unit record / Introduction to Programming; Numerical Analysis / S 4 / E 1961

Vanderbilt Univ., Computer Center, Nashville, Tenn. 37203 / *C 66
Education, research, administrative / coml svc / IBM 1401-7072 complex, 10K memory; peripheral equipment; tab equipment / Aiming for graduate degree program in computer science / S 12 / E 1959

Vassar College, Poughkeepsie, N.Y. 12601 / *C 66
Faculty and student research; education / IBM 360, Model 30 E. — disks / Introductory programming (no credit); intermediate level semester course in Statistics; Numerical Analysis (full year) at advanced level in Math / Computer Center opens December, 1966 / S 5 / E 1966

Vincennes Univ., Vincennes, Ind. 47591 / *C 66
Education and administration / IBM 1620 card system 20K with 1443 printer / Machine Language; SPS courses; Fortran; Programming project / two year curriculum in Science Data Processing, and Industrial Data Processing / S 6 / E 1962

Virginia Military Institute, Lexington, Va. 24450 / *C 66
Education, research and administration / IBM 1620-40K with peripheral equipment / Introduction to Symbolic Programming; Introduction to Automatic Programming; Computer Programming Systems and Methods; Advanced Programming / S 5 / E 1963

Virginia Polytechnic Institute, Blacksburg, Va. / *C 66
Education and administration / coml svc / IBM 7040, 2 IBM 1401 tape systems and unit record equipment / Introductory programming courses by academic departments / S 20 / E 1954

Virginia State College, Petersburg, Va. 23803 / *C 66
Education and research / coml svc / IBM 1620-60K, 407, 85 collator, 514 reproducing, etc. / Basic Computer Concepts; Computer Programming; courses in computer science are service courses / Institution has no major pursuit in computer science / S 5 / E 1964

Washburn Univ., Crane Observatory, Topeka, Kans. / *C 66
Education and research / coml svc - for service only, no solicitation / IBM 1620-1622; keypunch, verifier, sorter / Digital Computer Programming; Numerical Methods / S — / E 1964

Washington and Lee Univ., Computer Center, Lexington, Va. 24450 / *C 66
Education and administrative services / IBM 1620, data processing / one semester; Computer Programming / S 3 / E 1962

Washington State Univ., Pullman, Wash. / *C 66
Research and teaching / IBM 709, System 360-30; System 360-67 will be installed Nov. 1966 / Full graduate program in Information Science / S 35 / E 1957

Wayne State Univ., Computing and Data Processing Center, Detroit, Mich. 48202 / *C 66
Education, research and service to the University / IBM 7074; 2 IBM 1401; IBM 1460 / 64 courses offered / S 100 / E 1947

Weber State College, Ogden, Utah / *C 66
Two year programmer training course / coml svc / IBM 1401 4K with two 1311 disk drives / several courses in 1401 and related programmer training / S 4 / E 1963

Wesley College, College Square, Dover, Del. / *C 66
Education and administration; commercial / coml svc / IBM 1620, 402 printer, reproducer, sorter, punches, collator / Introduction to Data Processing; Scientific Data Processing / S – / E 1962

Westchester Community College, 75 Grasslands Rd., Valhalla, N.Y / *C 66
Education / Burroughs 205 with magnetic tape key punch / Basic programming & FORTRAN / S 1 / E 1964

West Chester State College, West Chester, Pa. 19380 / *C 66
Educational; maintain student records / IBM 1620; 1622 card-read punch; 407 accounting machine; and peripheral equipment / Basic Computer Science; Computer Programming / S 2 / E 1964

West Georgia College, Carrollton, Ga. 30117 / *C 66
Computational services for education and college administration / IBM 1620 model I-60K, 2 disk drives, on-line printer, peripheral equipment / Mathematics 200; Introduction to Computer Programming / S 5 / E 1964

West Texas State Univ., Canyon, Tex. 79015 / *C 66
Education, research, administration / IBM 1620 Model II with disk, 1401 tape, 360 in Nov. / 8 courses in School of Business; 2 courses in Math dept. / Degree program in School of Business with emphasis in data processing / S 14 / E 1964

West Virginia Institute of Technology, Montgome West Va. 25136 / *C 66
Education and administration / coml svc 1130 / Computer Programming (engineering science, business) / S 1 / E 1966

West Virginia University Computer Center, Ad. Morgantown, W. Va. 26506 / *C 66
Provide facilities for administration, tion and research / coml svc / IBM 32K ... IBM 8K 1401; IBM 60k 1620 / Industrial Engineering; Math / S 53 / E 1963

Western Carolina Computer Operations, Western Carolina College, Cullowhee, N. C. 28723 / *C 66
Education, research, administration / IBM 1620 with disk, sorter; peripheral equipment / Courses range from introductory automatic and electronic data processing through systems analysis and data processing management / S 5 / E 1963

Western Kentucky Univ., College Heights, P.O., Bowling Green, Ky. / *C 66
Educational / estimated delivery date July, 1966 IBM 1130 / Introduction to Computers; Intermediate Computer Programming; EDP Systems Design; Unit-record Data Processing / S 6 / E 1966

Western Michigan Univ., Kalamazoo, Mich. / *C 66
Provide research, training and service facilities for faculty, staff and students / IBM 1620, Model I; 1622, 1311, IBM punch card equipment. IBM 360 Model H50, 262 storage, 1052, 1442-1443, 2504, 1403, 2701; 3 remote consoles on order / Fortran workshop (no-credit); Introduction to Computers I; Introduction to Computers II; Programming for Computers; Numerical Analysis; Automatic Programming Systems / S 5 / E 1962

Western State College, Gunnison, Colorado 81230 / *C 66
Education and administration / IBM 1620-1622 Model I; unit record equipment / Computer Programming / S 4 / E 1963

Western Washington State College, Computer Center, Bellingham, Wash. / *C 66
Education, research, administration / coml svc / IBM 1620-40K card with disk / Introductory Programming; Numerical Methods / S 4 / E 1962

Westminster College, Fulton, Mo. 65251 / *C 66
Education, student and faculty research, and school business / IBM 1620 Model I, disk drive, tape input / Basic Programming (Machine Language, SPS, FORTRAN), Advanced Programming, computer oriented research in other Depts. / S 1 / E 1963

Wheaton College, 501 E. Seminary Ave., Wheaton, Ill. 60187 / *C 66
Education, research, and business management and registration applications/ coml svc / IBM 1620-1622 and peripheral equipment / Basic programming course using SPS and FORTRAN / S 6 / E 1958

Whitman College, Walla Walla, Wash. / *C 66
Student education, faculty research / IBM 1620 Model I; 1622 Model 2, 1311, 1443 / Introductory Programming; Numerical Analysis / S 2 / E 1964

Sir George Williams Univ., 2015 Drummond St., Montreal, Quebec / *C 66
Provides central computer center for academic and administrative needs / coml svc / IBM 1620 Model I with disk drives & 40K core; back-up auxiliary machines / Introduction to Computer Programming / S 9 / E 1963

Wilkes College, Wilkes-Barre, Pa. 18703 / *C 66
Scientific computation in conjunction with graduate and undergraduate program / Burroughs 205, with magnetic tape units / Advanced student individual study / S — / E 1965

Winston-Salem State College, Data Processing Center, Winston-Salem, N. C. / *C 66
Administration, research and testing / coml svc / IBM 1620 with punch card equipment / programming the IBM 1620 computer; keypunching / S 5 / E 1964

Wisconsin State Univ., Eau Clairr, Wis. 54701 / *C 66
Administrative / IBM 1620 Model I and peripheral equipment / Basic Programming; Advanced Mathematics; Business Courses / S 5 / E 1962

Wisconsin State Univ., LaCrosse, Wis. 54601 / *C 66
Just now establishing center for administrative, research & educational purposes / Data processing equipment in operation; IBM 360 and 1130 on order / One course at present; More courses next year / S 4 / E 1961

Wisconsin State Univ., Computer Center, River Falls, Wis. / *C 66
Instructional and faculty research / IBM 1620 20K / three courses in Computer Coding; Numerical Analysis / S 3 / E 1963

Wisconsin State Univ., 1800 Grand Ave., Superior, Wis. 54880 / *C 66
Administrative use & research / IBM 402, unit record equipment; IBM 1130 on order–to replace the 402 / Introduction to Data Processing; Computer Programming (FORTRAN) / S 5 / E 1964

Yale Computer Center, 60 Sachem St., New Haven, Conn. / *C 66
Education for faculty, students, and staff / IBM 1401-4K; IBM 7094-7040 DCS / Engineering and applied sciences courses; Fortran / S 35 / E 1958

York Junior College, Country Club Road, York, Pa. / *C 66
Educational and administrative / IBM 1620 with card reader and card punch / Introduction to Data Processing; Basic Computer Systems; Fortran Programming; 1440 Programming / S 4 / E 1962

The Youngstown Univ., 410 Wick Ave., Youngstown, Ohio 44503 / *C 66
Education and research / coml svc / IBM 1620 with card input/output; IBM 403 as printer and related auxiliary equipment / Computer Techniques; Principles of Business Computer / S 8 / E 1963

- END -

ANNOTATED DIRECTORY OF PERIODICALS FOR THE COMPUTER INDUSTRY

PREFACE

§ 040.

This directory is a list of periodicals concerned with the computer industry. In this issue, we have limited our selections to those English language publications directly covering the computer industry. Included are: Biographical Services, Computer References, News Periodicals, and Technical Periodicals. Those periodicals which publish an occasional article related to electronic data processing have not been included at this time. Some periodicals which consistently cover EDP, but from a particular industry viewpoint have been omitted until future expansion of the directory. Engineering journals, concerned basically with hardware, are not included.

In those cases where a publication has been noted as being available through controlled circulation, qualified readers may apply for free subscriptions. Applications may be obtained by writing to the address listed with the publication. The indicated costs are annual subscription rates.

ANNOTATED DIRECTORY OF PERIODICALS FOR THE COMPUTER INDUSTRY

§ 040.

American Documentation

Suite 413
1025 Connecticut Avenue, N.W.
Washington 6, D.C.

Quarterly

Published by the American Documentation Institute as a scholarly journal and forum for the discussion of new and experimental work dealing with documents - their storage and retrieval.

$12.50 (to non-members)

Automatic Data Processing

See "Data and Control"

Business Automation

OA Business Publications, Inc.
288 Park Avenue West
Elmhurst, Illinois

Monthly

Articles describing specific business computer applications and utilizations; generally written in non-technical language and accompanied by many pictures. Other articles occasionally serve as a forum for new directions and problems to be conquered by the EDP profession.

$5.00

Business Automation News Report

OA Business Publications, Inc.
288 Park Avenue West
Elmhurst, Illinois

Weekly

News service covering events within the computer and electronics industries. Includes such features as annual reports, earnings figures, corporate organization developments, personalities in the news, schedule of meetings, and new equipment announcements.

$5.00

Communications of the Association for Computing Machinery

14 East 69th Street
New York 21, New York

Monthly

Technical articles devoted to new applications of digital computers, new techniques for problem solution with computers, and news and notices of computer industry activities.

$10.00 (to non-members)

Computer Abstracts

Technical Information Co., Ltd.
Chancery House
Chancery Lane
London W.C. 2, England

Monthly

A comprehensive abstracting service. It includes about 300 abstracts per issue with an average length of 50 words. Each sheet is printed on one side only to allow for clipping. It is well organized and indexed. The coverage includes periodicals from America, Europe, and Asia, as well as books and patents. The service includes the issues of Computer News.

$96.00

Computer Bulletin, The

British Computer Society Ltd.
Finsbury Court, Finsbury Pavement
London E.C. 2, England

Quarterly

In addition to several papers that might well be included in the Computer Journal, there are news items, editorial comments on the news and events, surveys of different fields and book reviews. There are also a variety of short letters, communications, and abstracts of future conferences.

$2.80 (to non-members)

§ 040.

Computer Characteristics

Adams Associates
Bedford, Massachusetts

Quarterly

A table of the salient features of commercially-available, U.S. produced, digital computers. Entries are coded for twenty-five features plus supplementary notes.

$10.00

Computer Journal, The

British Computer Society Ltd.
Finsbury Court, Finsbury Pavement
London E.C. 2, England

Quarterly

Contains papers of wide interest to users and suppliers of computers, both technical and non-technical. The topics range from computer and compiler construction to acceptance tests and specific applications, mathematical and commercial. Most papers are ones that have been presented at British Computer Society meetings and the resulting discussions are reported as edited transcripts. There are also some book reviews and correspondence on earlier papers.

$9.80 (to non-members)

Computer News

Technical Information Co., Ltd.
Chancery House
Chancery Lane
London W. C. 2, England

Monthly

A supplementary service to Computer Abstracts. A separate document with a limited coverage of news items, new equipment, special applications, and an editorial.

Received with Computer Abstracts.

Computers and Automation

Berkeley Enterprises, Inc.
815 Washington Street
Newtonville 60, Massachusetts

Monthly

Articles covering problems and work done in the computer industry. Some attention devoted to the sociological problems associated with electronic data processing, as well as a section on new hardware installation and application developments within the computer field. A periodic computer census is included,

$15.00

Computing Reviews

Association for Computing Machinery
14 East 69th Street
New York 21, New York

Bi-Monthly

Contains reviews of articles in selected periodicals furnished by a variety of people active in related areas of the computer industry. There is frequently a strong bias in the review and the length depends upon the industry of the various reviewers. A few reviews do not discuss the document. The coverage is extensive but not timely, and includes important material ante-dating the reviews.

$12.00 (to non-members)

Control Engineering

McGraw-Hill Publishing Co., Inc.
330 West 42nd Street
New York 36, New York

Monthly

Technical articles devoted to design, application, and testing of instrumentation and automatic control systems. Includes sections on information systems, new applications in control instrumentation, and new products in the control field.

$3.00

Data and Control
formerly Automatic Data Processing

Business Publications Ltd.
180 Fleet Street
London E. C. 4, England

Monthly

Articles, reports, and news items covering the areas of production control and automation, production planning and control, operational research, stock control, data capturing, and transmission.

$9.50

Data Processing

American Data Processing, Inc.
22nd Floor, Book Tower
Detroit 26, Michigan

Monthly

Columns and articles describing EDP techniques and practices presented in non-technical terms. Specific articles written to cover individual case histories of selected installations.

$8.50

§ 040.

Data Processing

Associated Iliffe Press Ltd.
Dorset House
Stamford Street
London S.E. 1, England

Quarterly

Although aimed at top management and the chief executives this periodical is of interest to all users in business and industry. The majority of the articles deal with specific applications of specific equipment. Each article is illustrated by good diagrams and photographs. Other peripheral subjects are also covered; for example, descriptions of new equipment and general interest topics such as insurance of equipment.

$12.00

Data Processing Digest

1140 South Robertson Blvd.
Los Angeles 35, California

Monthly

Digests of data processing articles of interest to management and technicians in EDP. Digests are mainly prepared by a good selection of extensive quotations from each article. A reading list is suggested for material not possible to digest. Provides wide, timely coverage of over one hundred current publications plus editorial comment from invited contributors.

$24.00

Datamation

F. D. Thompson Publications, Inc.
141 East 44th Street
New York 17, New York

Monthly

Most widely circulated periodical of the computer applications industry. Contains editorials and articles speaking out on controversial subjects related to professional development trends. It is laced with satire, parody, and squibs. Carries news of people, computers, and events concerning the EDP industry.

Controlled circulation.

EDP Newsletter

Industry Reports, Inc.
1327 F. Street, N.W.
Washington 4, D.C.

Weekly

A newsletter service carrying computer industry press releases pertinent to marketing, equipment, contracting, and personnel events. Presented in capsule style for quick reading about "what's new" in the computer field.

$50.00

Electronic News

Fairchild Publications, Inc.
7 East 12th Street
New York 3, N.Y.

Weekly

A weekly newspaper covering events and announcements pertinent to the electronics field. Has a separate section for news coverage of computer events and highlights major EDP industry trends in featured articles.

$3.00

IBM Journal of Research and Development

International Business Machines Corp.
590 Madison Avenue
New York 22, New York

Quarterly

Technical articles, generally devoted to the detailed documentation of the results of IBM research projects such as semi-conductors, logic circuits, and a few programming techniques, using excellent illustrations.

$5.00

I.R.E. International Convention Record
Computer Sessions

Institute of Radio Engineers
1 East 79th Street
New York 21, New York

Technical papers devoted to engineering and mathematical problems related to computer design and utilization. Includes papers on use of computers in hardware design.

I.R.E. Transactions on Electronic Computers (PGEC)

Institute of Radio Engineers
1 East 79th Street
New York 21, New York

Bi-monthly

The scope of subject articles covers design, theory, and practice relating to digital and analog computation devices. Emphasis on techniques for accomplishing the functions of logic, arithmetic, storage, control, mass data storage input-output, as well as allied fields of switching theory, symbolic logic, number systems, pattern recognition, etc.

$17.00 (to non-members)

Information and Control

Academic Press, Inc.
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§ 040.

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$3.00

SPECIAL REPORTS

STANDARD EDP REPORTS

AUERBACH INFO, INC.

PRINTED IN U. S. A.

SPECIAL REPORTS
CONTENTS

SPECIAL REPORT

FACTORS TO CONSIDER IN CONTRACTING FOR AN ELECTRONIC DATA PROCESSING SYSTEM

prepared by

the Technical Staff of
AUERBACH Corporation

AUERBACH/BNA SPECIAL REPORT FACTORS TO CONSIDER IN CONTRACTING FOR AN ELECTRONIC DATA PROCESSING SYSTEM

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.1 INTRODUCTION

The acquisition of an electronic data processing system is a major expenditure for any company. Therefore, the user should carefully consider the factors which are involved in a contract for procuring a computer system. A checklist of factors, which should be considered before final negotiation of a contract, is given in the Summary, paragraph .8, and their implications are discussed in this Special Report. Most of these items, once called to the user's attention, will be familiar to him, but many of them are not covered in a manufacturer's initial proposal nor in his standard contract.

It is desirable to obtain from the manufacturer a copy of his U.S. Government General Services Administration schedule (including sample government contracts and operating practices) as well as his standard commercial contract form. These documents will indicate the type of conditions to which the manufacturer is willing to agree.

Additional specific data is best obtained by discussion with other users, perhaps through the appropriate users' group. Although contract information is considered confidential, users will generally discuss specific points, if asked.

It is often desirable to obtain specific statements from the manufacturer covering all of the points discussed in this Special Report as a means of defining the system and services being acquired. The degree to which manufacturers are willing to negotiate special contracts varies. Some do not deviate from a standard contract while others permit great flexibility.

This Special Report does not cover the numerous legal considerations involved in a contract of the size and complexity encountered for a computer system. Legal counsel should be obtained.

.2 BASIC CONTRACT DETAILS

.21 Specifications

.211 Equipment

The manufacturer should provide detailed specifications of the equipment units at contract initiation. These detailed specifications will permit the initiation of effective preparation for the arrival of the system. If specifications are not complete, programmers may be unable to complete effective, detailed coding. (This is less critical, however, if a firm, process-oriented language is available.) The hardware unit specifications should be carefully determined to insure obtaining an expected level of performance.

.212 Software

In addition to the specification of the equipment configuration, it is reasonable to expect a complete definitive delineation of the specific program "packages" which are to be made available.

Perhaps the one area that will be most difficult to specify is the software to be provided by the manufacturer. Software includes program translators (compilers, assemblers, generators, etc.) as well as utility routines, report generators, merge and sort routines, etc. The ideal objective would be to have all languages and routines fully documented, completely free of errors, easy to learn and easy to use. At the present

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state-of-the-art, provision should be made for additional manufacturer's assistance in the utilization and implementation of these techniques.

Prior to actual acceptance of the equipment, there should be an evaluation of the use of the translator.

The user should determine if a process oriented (compiler) language will be useful. Experienced programmers often prefer assemblers. (See Sections 15 through 18 of each Computer System Report in Standard EDP Reports for data to assist in these decisions.) The user should determine that the translator for the language to be used is readily available and fully tested. It may be found that the sort routines, report program generators, utility debugging routines, etc., will not fit within the conceptual ideas of the user's intended operational practices. The manufacturer may, therefore, be asked to modify them as necessary.

The user should assure himself that all of the software he is obtaining will operate on the equipment configuration he is to receive. (See Standard EDP Reports, Computer System Reports, :180.6.)

.22 Method of Payment

The method of payment should be specified in the contract. Apart from outright purchase and normal rental contracts, it is also possible to obtain a rental contract which includes a purchase option (usually exercisable within a fixed time period). With a purchase option, a major portion of the rental charge can be applied to subsequent purchase.

Before a decision is made relative to the type of payment, the user should determine if his expected amortization schedule is acceptable by the Internal Revenue Service so that some evaluation can be made of the various alternatives in the light of corporate profits. (Reference #1, paragraph .9).

The term of the contract should be established. Rental contracts are usually renewable on a year-to-year basis and cancellable (after an initial period) on 30 to 90 days' notice. One year is the minimum acceptable time by manufacturers as an initial period in conventional contracts. The user might obtain more service by agreeing to a minimum term which is longer than one year.

The responsibility for personal property and sales and use taxes should also be specified in the contract.

.23 Amount of Chargeable Time

Rental contracts should clearly define the amount of chargeable time included in the basic rental fee. Some of the more common definitions of the amount of chargeable time are:

a) any 176 hours per month.

b) 176 hours plus "lunch" hours.

c) any 8 hours per day.

d) the time during a specific period such as: 9AM to 5PM, or 8AM to 5PM (with the lunch hour available to the user).

Additional charges beyond the amount included in the basic rental fee should also be defined. These charges are usually a stated percentage of the basic hourly rental rate; forty (40) to fifty (50) percent being common. Charges for time beyond the basic time are usually based directly on the actual time used on each unit or subsystem.

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.24 Chargeable Time

The time to be counted as chargeable time is usually defined similarly to serviceable time (see Standard EDP Reports, Glossary, 7:261.27). This is the time during which the system is productive or could have been productive, if the user operated efficiently. It is not unusual to declare rerun time as nonchargeable, provided it is caused by equipment malfunction rather than operator error.

.25 Assurance of Serviceable Time

The manufacturer guarantees (at least implicitly) a number of serviceable hours per day (or month). In some cases, when the number of serviceable hours is less than the guarantee, the user can reduce his rental pro rata: e.g., if 176 hours per month are agreed upon and 6 hours of that time are unavailable, the rental fee can be reduced by 6/176. In case of major failures, a back-up facility should be provided (see .51, last paragraph).

.3 ACCEPTANCE

.31 Shipping and Installation Charges

Payment for these services should be mutually agreed upon during contract negotiations. It is customary for shipping charges to be borne by the prospective user; however, the costs of in-transit insurance, physical installation and final test of the hardware are absorbed by the manufacturer.

The site preparation for the equipment is the user's responsibility, but should be designed in accordance with the manufacturer's recommendations in order to insure proper installation and operating conditions (Reference #2, paragraph .9). The manufacturer will usually be most cooperative in supplying physical installation data and advice. Complete environmental details should be specified by the manufacturer's site-installation engineering staff and should include: air conditioning, power, equipment layout, cable lengths, floor loads, special power outlets and service area layout. Manufacturers sometimes overstate floor space requirements (systems can be operated in "crowded" conditions if necessary), but otherwise, provide good assistance on site design (see paragraph .4).

In cases where the manufacturer delivers equipment which differs from that specified and requires site changes, the manufacturer may then be held responsible for such changes.

.32 Delivery and Acceptance Dates

Delivery and acceptance dates should be established. The user can normally postpone the delivery date with as little as 30 days notice without penalty. Should the equipment be delivered before program preparations are completed a considerable amount of money can be wasted unnecessarily. Therefore, the delivery date should be carefully reviewed as the implementation of the system progresses, and postponed, if necessary.

Any program packages specified in the contract should be available at their promised date. Software should be delivered several months earlier than hardware to permit time for familiarization and use.

The actual delivery date is not as important as the acceptance date, which is the date before which the acceptance tests should have been passed. In some cases, manufacturers have agreed to penalty clauses should the acceptance date be delayed. This is not common, but penalty clauses as high as $1,000.00 per day have been negotiated.

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.33 Acceptance Tests

Acceptance tests should be specified and should include additional tests of the system after it has passed the diagnostic and engineering program tests used by the manufacturer's installation team.

It is important in any new system to test all components and their interactions as part of the overall system. A system should operate without serious equipment failure for a mutually agreed-upon period (usually 40 to 80 hours) before being considered for final acceptance tests.

The final acceptance test procedures should be explicit. Good acceptance procedures involve these factors (Reference #3, paragraph .9):

a) The schedule for the acceptance test period should be clearly defined. This schedule should show how the time throughout the day should be allocated to periods of operation, idleness, preventive maintenance, etc. The acceptance test period should last at least 30 days in order to obtain a good estimate of both the mean-time-between-failures (MTBF) and mean-time-to-repair (MTTR).

b) During each of the operating periods, the nature of the work which the computer is to be doing should be clearly defined. The work which the computer should do during the operating period might be divided into cycles. In each cycle the following should be performed:

    (1) process actual, but tested, data for key applications;

    (2) process special data designed to test all of the special features of the equipment and any program packages supplied. (Experience has shown that a selection of actual data will not begin to test all of the possible conditions, therefore, a special input is desirable. Conversely, a set of special data can never be developed to predict all the unusual conditions which occur in practice, therefore, a large section of actual data is also desirable).

    (3) use diagnostic routines which exercise all parts of the equipment, including peripheral units.

By repeating this cycle of tests throughout an operating period, a good test of the system can be obtained. Of course, each program should be designed to check its own operation so that any errors which the system makes are promptly reported. Any output should be checked against specified standard results. The minimum performance level required for acceptability during the test period must be agreed upon in advance. This agreement might include minimum mean-time-between-failures, maximum mean repair time, maximum repair time, and minimum percentage operating time out of total on-time. Estimated performance speeds (as listed in Standard EDP Reports) can be used as a basis to establish anticipated performance times.

Rental charges for the equipment should not be effective until the system components have passed the stipulated acceptance tests.

For well established equipment with many prior satisfactory installations, the acceptance testing may be considerably simplified. A method often used is to operate the system for a continuous period of one month on the normal work, loaded to the expected schedule. Rent is then paid retroactively to the beginning of the period, provided a ratio of 0.90 (or better) chargeable time to scheduled operating time has been achieved.

.4 ENVIRONMENT

The minimum environmental conditions under which the manufacturer's equipment will perform satisfactorily should be stated. Allowable variations in the following requirements should be specified:

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.41 Temperature and Humidity

- equipment - in use and on standby
- magnetic tape - in use and in storage

In these two areas, the specification will help determine the amount of air conditioning that the user will have to install.

.42 Power

- voltage requirements and permissible variation
- frequency requirements and permissible variation
- waveform variations allowable

Advance specification of these factors will help determine requirements for power transformers and/or a motor-generator set.

.43 Space

- free floor space around each equipment unit to permit access for maintenance.
- space to be devoted to the maintenance engineers, equipment and spare parts.

.5 MAINTENANCE

.51 Reliability

Reliability is measured as a ratio of serviceable time to the sum of serviceable time and down-time (time when faults are awaiting repair or are being repaired or fault-caused rerun time). It is frequently quoted as a percentage and often called percentage "up-time" (values of 95 to 98 percent are generally expected). In general, only time that had been scheduled for work by the user is considered in this calculation. A guaranteed up-time should be negotiated at least in the form of minimum serviceable hours per day (usually equal to the time required by the user for his basic jobs ranging from 8 to 20 hours).

A more technical method of specifying acceptable reliability is to indicate the mean-time-between-failures and the mean-time-to-repair equipment failures. Proportions of up-time and down-time can be estimated from these figures.

Under certain conditions, the importance of the data or of the workload situation will not permit delays due to equipment (or any other) failure. In such cases, it is desirable to specify that an emergency or "back-up" facility be available. Charges incurred under such circumstances are usually absorbed by the equipment manufacturer if the emergency is caused by the total system failure.

.52 Maintenance Responsibility

The contract should define maintenance requirements and procedures, describing the types of maintenance: fully attended, resident, non-resident - unattended, or emergency. In connection with a purchase agreement, there may be a need for a separate maintenance and spare parts contract. In most rental contracts, the equipment manufacturer guarantees a minimum percentage of up-time or other assurance of usable time. The responsibility for reliability then rests with the manufacturer. For both rental and separate maintenance contracts, the level of skill, number of people and their location (e.g., user's installation or manufacturer's office) can be considered as discussion points. In the case of on-site maintenance personnel, facilities such as space, power and furniture are usually supplied by the user.

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Duration of scheduled maintenance should be specified in the contract after the level of acceptable reliability has been agreed upon. The user should have the right to establish his operating hours and the manufacturer should adjust scheduled maintenance times accordingly. Attention should be given to the availability of maintenance services during scheduled extra shift operation and also during occasional unscheduled overtime requirements. The maximum time between the call for maintenance and the arrival of maintenance personnel might also be specified.

The method of scheduling and charging the time required to make any changes to equipment and/or engineering improvements should be stipulated. These items are usually a matter of mutual agreement at the time of occurrence. For rental contracts, however, these usually include modifications or substitutions to maintain the equipment equivalent to the "current product-line." In any case, an agreement should be reached on those types of improvements which will be installed at no cost and those which will be paid for by the user. When improvements for increased reliability are necessary (e.g., marginal components or units to be replaced) to maintain the percentage of uptime, they should be made at no cost to the user.

.6 USER'S RIGHTS

In the case of rental contracts, the conditions under which the user can modify and/or maintain the equipment (if any) should be specified. Usually the user may rent time on his own system to outside users in order to utilize slack periods. Sometimes the manufacturer will agree to buy time. In this case, rates and procedures should be established.

.7 ADDITIONAL FACTORS

.71 Special Equipment

If any unit of the system is being constructed especially for the user, the contract should include complete technical performance specifications. If the unit involves the interconnection of equipments of two manufacturers, the individual responsibilities for performance and maintenance should be carefully defined.

Price, delivery and acceptance conditions for special units should be stated within the terms of the contract. The policies adopted for regular equipment can usually be modified for special equipments.

.72 System Design

Often the user's system is based on a design outlined in the manufacturer's proposal. In this case, the detailing of the system design and the extension of the system concept should be accomplished with assistance from the manufacturer. The degree and level of system design assistance is a point of negotiation. The number, level and type of skill of personnel assigned, the assignment of specific individuals, the responsibility of the manufacturer's personnel, as well as their qualifications, are points which should be considered. The tenure of their assignment should also be agreed upon in addition to the availability of additional manufacturer's support personnel for specific needs such as writing special programs, debugging or design of difficult parts of the procedures.

.73 Training

Training courses may be specified to be held on the user's premises and/or at the manufacturer's training centers. The program language to be used should be decided upon early in the implementation program, and this language should be used in the training courses. The choice of a program language is dependent on the availability of an operational translator prior to the delivery date.

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A "reasonable" number of programmers and systems analysts should be trained (usually as many as the user actually intends to employ in these positions). Training is also necessary for console operators. Advanced programming courses and orientation programs to be presented to top management personnel should be considered. If good systems courses (as opposed to programming and coding) can be made available, they are especially desirable for training new analysts.

As part of the training program, it is usual for the manufacturer to provide complete training materials and reference manuals. Manuals and training materials should apply to the equipment and the languages to be used, not to earlier systems.

.74 Program Testing

Ideally, the user's first application should be pre-tested. This might be accomplished on equipment provided by the manufacturer at another site. Usually no charge is made for a limited number of machine hours for this purpose. The exact number of hours is subject to negotiation. It is good practice to utilize the translator program and learn how to use it during this practice application.

.75 Special Programs

In some cases the user may wish to contract with the manufacturer to supply specific operational programs (in addition to software packages). In this case, there should be a firm mutual understanding of: the form of documentation of the programs provided; delivery data; acceptance date; how changes and improvements will be made after the program is accepted; how the user can train his own people on the program; and the maximum permissible processing time or other measure of efficiency. The user will have to provide firm specifications for the program early in the schedule and will not have the same flexibility in changing requirements as he might have if his own group was doing the programming. Attention should be given to the acceptance tests for such programs.

.8 SUMMARY

As this Special Report has pointed out, there are many major factors to be considered in contracting for an electronic data processing system. These factors are recapitulated below and may be used as a checklist before negotiating a contract.

- Basic Contract Details
  - Equipment - the manufacturer should provide detailed specifications of the equipment units.
  - Software - specifications should indicate the software to be provided. The user should assure himself that the software provided should operate on the equipment configuration selected.
  - Type of payment - the user should be aware of the various types of payments possible, aside from outright purchases and rental contracts. The user should also investigate the tax implications involved with a particular agreement.
  - Amount of chargeable time - rental agreements should clearly define the amount of chargeable time included in the basic rental fee. In addition, a definition of the "amount of chargeable time" should be stated.
  - Chargeable time - a definition should be provided for the time that is to be counted as chargeable time.
  - Assurance of serviceable time - this time should be specified by the manufacturer, and in the event of a major failure, what back-up facilities are available.

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- Acceptance
  - Shipping and installation - payment for these services should be mutually agreed upon during contract negotiations. Some charges are undertaken by the user while others are absorbed by the manufacturer.
  - Delivery and acceptance dates - these particular dates should be established during contract negotiations. Software packages should be delivered before equipment to allow for familiarization and use.
  - Acceptance tests - these tests should be specified and the test procedures made explicit. The amount of time that tests should run satisfactorily before the equipment is considered acceptable should be stipulated in the contract.

- Environment - the minimum environmental conditions under which the manufacturer's equipment will perform satisfactorily should be stated.

- Maintenance
  - Reliability - the minimum level of reliability and methods of maintaining reliable operation should be agreed upon at contract negotiation.
  - Maintenance responsibility - maintenance of equipment responsibility and the types of maintenance provided should be specified.

- Additional Factors
  - System design - support from manufacturer may be desirable in detailing system design and system concept.
  - Training - training courses should be provided by the manufacturer and the location of the training center be specified.
  - Program testing - initial programs should be pre-tested, perhaps, on equipment provided by the manufacturer at another site.
  - Special programs - the user may contract with the manufacturer to supply specific operational programs other than the software packages provided.

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STANDARD EDP REPORTS

SPECIAL REPORT

A SURVEY OF THE CHARACTER RECOGNITION FIELD

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SPECIAL REPORT
A SURVEY OF THE CHARACTER RECOGNITION FIELD

.1 INTRODUCTION

In the early days of electronic data processing, when the amounts of information being handled in most computer applications were relatively small, the need to manually keypunch the information in a machine-readable code caused no particular concern. Today, when vastly more sophisticated machines are being used to store, retrieve, and process large amounts of information, this manual operation has come to be viewed as a fundamental weak point in computer-based information systems — too slow, expensive, and unreliable to be tolerated in applications involving large volumes of input information. The one solution to this problem is the automatic character reader — a device that has been developed to the point where it has replaced manual keypunching in selected application areas, although it still lacks certain functional refinements that will be necessary to make it suitable for the full spectrum of computer input operations.

Character readers are machines for directly converting alphanumeric characters or symbols into a machine-readable form. The output of the readers may be in the form of punched cards, punched paper tape, or magnetic tape — or the readers may be operated on-line (directly connected) to a computer.

Most current readers are severely limited in the type fonts they can read, and, in some cases, in the size of the character set (alphanumeric vocabulary) they can handle. On the other hand, character readers are in effective and economically efficient use in several major industries. Banking is probably the largest current application area for character readers. The credit-card industry, led by the oil companies, and utility bill processing are other major application areas. In addition, some retail merchandising firms are now using character readers, and the United States Post Office Department (which is already using optical ZIP-code reader/sorters) has expressed interest in seeing a character reader developed to read hand-written addresses.

Character readers offer the advantages of being faster and more accurate than manual keypunching, since they permit printed data to be entered directly into data-processing systems without any additional human action. The present purchase prices of commercial magnetic character readers average around $80,000. The prices for optical character readers range from $75,000 upward, depending upon the speed and sophistication of the machine (rentals run between $3,000 and $15,000 per month).

.2 CHARACTER READER TYPES AND FUNCTIONS

There are two basic types of character readers: magnetic and optical. Magnetic character readers are used almost exclusively within the banking industry. They can handle only special type fonts printed in magnetic ink. The font most widely used in the United States, and adopted as a standard by the American Bankers Association, is Font E-13B — a highly stylized font that can be used to represent only 10 numeric digits and 4 special symbols (Figure 2). Another font, which was developed by Compagnie des Machines Bull-General Electric, is capable of representing all the characters in the alphabet as well as all the numeric symbols (Figure 3). However, the Bull font, which has been adopted as a standard by the European banking community, can at present be read only by the Bull CMC-7 and Olivetti 7750 magnetic character readers.

Since magnetic readers detect only magnetic marks, non-magnetic dirt or other marks will not cause reading errors. However, considerable care must be taken with the quality of the printing on the documents. Ink densities and character image are both critical. Relatively high quality-control standards must be maintained in the printing process to prevent character deterioration and extraneous ink spots.

Optical character readers are used in nearly all the major application areas other than banking. They work on the principle of recognizing the difference in contrast between the characters and the background on which they are printed. Some optical readers do not require special fonts and are theoretically capable of reading most type fonts (with suitable adjustments). So far, however, this theoretical capability is too expensive to realize for commercial use, although there are several optical character readers that can read more than one type font. The least expensive units are restricted to one font, which is usually

.2 CHARACTER READER TYPES AND FUNCTIONS (Contd.)

specially designed for low error rates and is often restricted to numerics plus a few special symbols. Also, optical readers tend to be somewhat less reliable than magnetic readers because of their greater sensitivity to dirt, document creases, and poor paper quality. Despite these drawbacks, optical readers seem to offer the most promise for the future, and new techniques are being explored and developed to overcome the major functional problems.

All existing commercial character readers, whether magnetic or optical, consist of three basic functional units:

- Document transport,
- Scanner, and
- Recognition unit.

A functional block diagram of a typical character reader is shown in Figure 1.

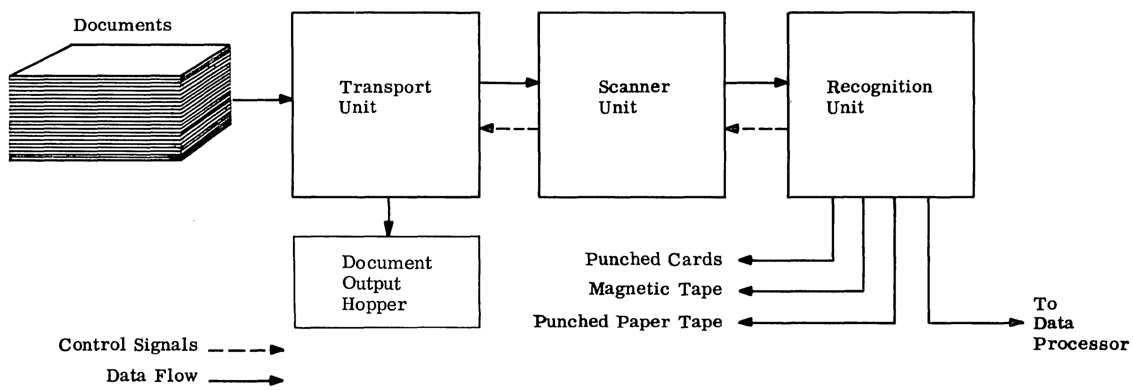

Figure 1. Functional Diagram of a Character Reader

The function of a character reader's document transport is to move each document to the reading station, position it properly, and move it into an "out" hopper. Transport mechanisms can be divided into two basic types: one for handling individual documents (paper sheets or cards) and the other for handling continuous rolls (cash register or adding machine tapes).

The function of a character reader's scanner is to convert the alphanumeric characters and symbols on a document into some analog or digital representation that can be analyzed by the recognition unit. There are two basic methods for accomplishing this: magnetic and optical.

The recognition unit is the heart of the character reader. This unit matches patterns from the scanner against reference patterns stored in the machine and either identifies the patterns as specific characters or rejects them as being unidentifiable.

.3 DOCUMENT TRANSPORTS

Document transports in character readers designed to handle adding machine or cash register tapes consist of a tape well in which the paper roll is loaded, paper guides, and a paper drive control. Once the tape has been manually threaded, the paper is automatically moved past the read head in a manner similar to the movement of a film reel in a movie projector. A vacuum system is frequently used to keep the paper flat. The maximum length of the paper roll that can be handled ranges from 100 feet for the National Cash Register Optical Journal Reader (4) (5) to "any reasonable length" for the Recognition Equipment Journal Tape Reader. The paper-roll mechanisms are usually designed so that the roll can be backed up any time rereading is required. A special feature of the feeder mechanism used in the Recognition Equipment Journal Tape Reader (6) is an automatic tape advance, which speeds up tape movement when there are large spaces between print lines. In most other readers, tape speed is constant at all times.

(Contd.)

.3 DOCUMENT TRANSPORTS (Contd.)

In character readers designed to handle individual sheets or cards, the document-transport function is divided into two phases: (1) feeding the documents from the input hopper, and (2) transporting the documents past the reading station. A common device for document feeding is called a friction feeder. This consists of a belt wound around capstans and partially resting on the document stack. Constant pressure is exerted against the belt by the document stack. As the belt moves across the top of the stack, it pushes the top documents into a separator station, where a combination of rollers and another belt separates the top document from all documents below it. This technique is used in the IBM 1419 Magnetic Character Reader. [2]

Vacuum or suction feeders are also used to lift documents off the input stack. One example of a vacuum feeder is used in the Philco General-Purpose Character Reader, [1] which employs a pair of vacuum belts to lift the document from the stack and carry it forward to the transport unit.

Both the friction and vacuum devices, however, have problems in handling documents of thin paper and may occasionally feed more than one document at a time. A new type of feeder, which has been designed by Rabinow Electronics (a subsidiary of Control Data Corporation) [3] uses a set of cone-shaped rollers to feed the documents. The rolling cones engage a corner of the top-most document and roll the corner away from the pile up into paper rollers, which carry the document to the transport unit. This unit is said to eliminate the possibility of feeding two sheets at a time.

A popular method for transporting the document to the reading station is a vacuum-drive conveyor belt. [1] [3] [7] Some character readers, such as the IBM 1428 and the Rabinow RUR model, use the conveyor belt to place the document on a rotating drum, which moves the document past the read head. The paper is held to the drum by means of a vacuum.

One of the basic disadvantages of the above mechanical techniques is that they cannot move the document as fast as it can be read. One approach to this problem has been the use of a high-resolution CRT scanner, developed by Philco Corporation, [8] which can scan the entire document without requiring any mechanical movement. Another method, used by UNIVAC Division of Sperry Rand Corporation, uses a vidicon scanner which takes a picture of the entire document at once. [9] Both of these systems will be discussed later in this report.

.4 MAGNETIC SCANNER UNITS

Scanner units, as previously mentioned, are divided into two basic categories: magnetic and optical — and these designations are used to characterize the readers themselves.

Since the banking field represents the major application area for magnetic character readers, all of the magnetic readers produced in the United States have scanning units designed to handle the E-13B font shown in Figure 2.

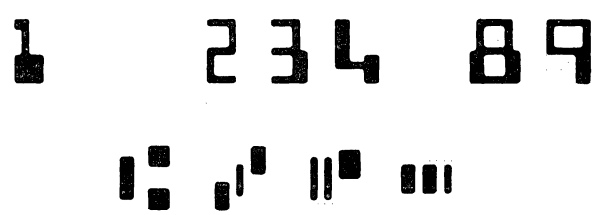

Figure 2. Sample of E-13B Font Characters

Most scanning units convert the magnetic characters into an analog voltage waveform for subsequent identification. The principle used is based on the electrical signals that are generated by moving the characters past the read head. Each character generates a signal that has a unique waveform, which the recognition unit matches against reference waveforms. The companies presently using this technique are Burroughs, General Electric, and National Cash Register.

IBM uses a digital scanning technique, which is exemplified by the IBM 1419 Magnetic Character Reader. [2] In this machine, each character is scanned by 30 magnetic heads stacked vertically and interconnected to give 10 outputs. The outputs are transmitted to a 70-bit shift register in the recognition unit, where they are matched against stored reference patterns.

.4 MAGNETIC SCANNER UNITS (Contd.)

Another type of digital scanning technique is used in the Compagnie des Machines Bull-General Electric CMC-7 and Olivetti-General Electric 7750 magnetic readers, which are designed for the special Bull magnetic font shown in Figure 3. This font, which has been adopted by the European banking community, can be used to represent 26 alphabetical characters, 10 numerals, and 5 special symbols. Also, it is easy for human beings to read. Each character is composed of seven vertical strokes, which define six intervals of short and long durations (i.e., gap widths between strokes). The reader scans each character from left to right and records the variations in magnetic flux, which indicate the width of the gap between the strokes. Each character is then identified by the number and sequence of narrow and wide gap widths.

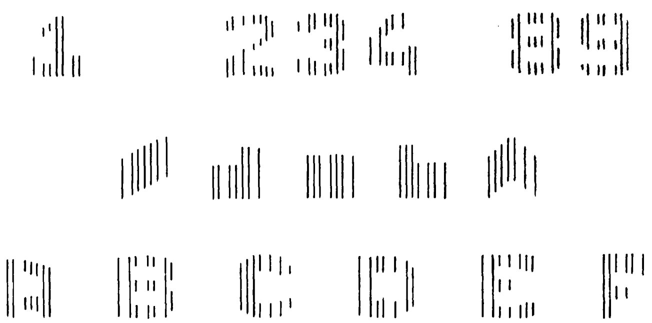

Figure 3. Sample of Bull Magnetic Reader Type Font Characters

.5 OPTICAL SCANNER UNITS

Optical scanning methods are based on the differences in contrast between the characters and the background on which they appear. The function of the scanner is to sample either portions of a character or a complete character to determine the relationships between light and dark areas. The common types of scanners used are mechanical discs, flying-spot scanners, parallel photocells and vidicon scanners.

.51 Mechanical-Disc Scanner

The mechanical-disc scanner consists of a lens system, a rotating disc, a fixed aperture plate, and a photomultiplier, as shown in Figure 4. The characters to be read are flooded with light, which is reflected from the surface of the document into a rotating disc via the lens system. The disc has apertures extending from its center toward its periphery. As the disc rotates, the apertures pick up light samples. A fixed aperture plate regulates the amount of light and directs the light to a photomultiplier. The photomultiplier tube converts the light samples into signal pulses. By varying the voltage threshold, the photocell outputs can be adjusted for different background colors.

The mechanical-disc scanner senses a character of data at a time. Movement between characters and lines is accomplished either by moving the document, as in the NCR Optical Journal Reader, (5) or by repositioning the lens system, as in the IBM 1428 Alphameric Optical Reader. (13) Consequently, this type of scanner is relatively slow by comparison with the other scanners mentioned.

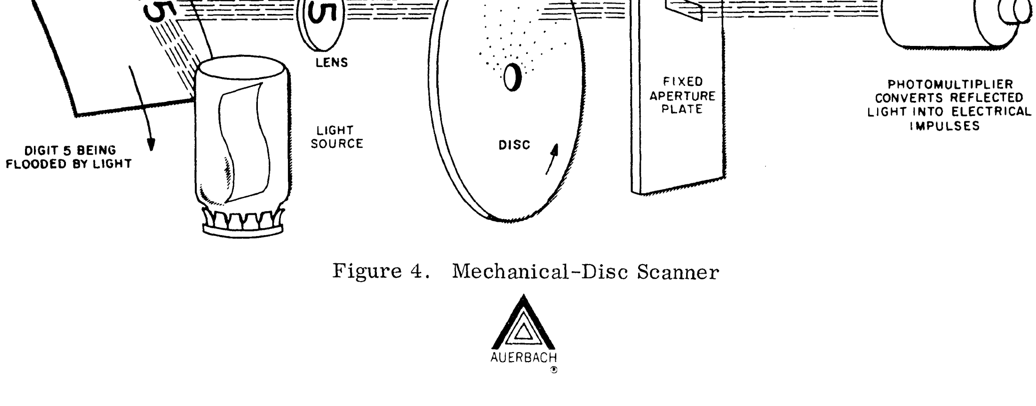

Figure 4. Mechanical-Disc Scanner

(Contd.)

.52 Flying-Spot Scanner

The flying-spot scanner consists of a cathode-ray tube, a projection lens, a phototube, and a control unit. A beam of light is generated in the cathode-ray tube and deflected across the tube in a scan pattern. The lens system projects this scanning light spot onto the document, from which it is reflected into a phototube. The phototube generates a voltage signal whose level is proportional in each instant to the amount of reflected light, thus indicating light and dark areas. The resulting signals are then either fed directly to the recognition unit in analog form or first transformed into digital form.

The flying-spot scanner offers more flexibility than the mechanical disc, since its scanning pattern can be automatically adjusted by the control unit. This permits the use of different scanning modes (i.e., scanning certain character fields, scanning specified portions of the document). Also, being completely electronic, it is faster than the mechanical disc and is generally classified as a medium-speed device.

The introduction of high-resolution cathode-ray tubes (2000 optical lines) has made manufacturers look to the development of a reader in which a complete document can be scanned without any document motion other than that required to position it under the read station. A scanner of this type is now being manufactured by Philco Corporation. (8) Sylvania Corporation has worked on the development of a similar device, which was expected to achieve very high reading speeds of up to 6,000 characters per second. (14)

.53 Parallel Photocells

The use of a vertical grouping of photocells (13) speeds up scanning operations by simultaneously sampling a number of points which, when combined, add up to a complete vertical slice of the character. The electrical signals generated by the photocells are then quantitized into either black, white, or gray levels. This data is fed into a shift register and stored until data on the entire character has been accumulated. Due to the parallel sampling, this type of scanner can achieve higher speeds than the flying-spot scanner.

A variation of this method that eliminates the need for shift registers uses a full "retina" of photocells to sample an entire character rather than just one vertical slice. Besides eliminating the shift register, this method also increases reading speed to approximately 2,400 characters per second. Rabinow Electronics (a subsidiary of Control Data Corporation) (3) and Recognition Equipment (6) are two of the companies currently using a retina of photocells for sampling. This sampling technique has the present capability for achieving a higher speed than any of the previously-mentioned techniques.

.54 Vidicon Scanner

So far, we have discussed scanning methods that read characters by reflecting light from the document to one or more photocells. A totally different method being used is to project the characters onto a vidicon television camera tube and scan the active surface with an electron beam. The resulting video signals are quantitized to digitally indicate black or white.

This type of scanner is currently being used by the UNIVAC Division of Sperry Rand Corporation. (9) (15) By storing a group of characters on the tube (the NDP vidicon scanner can store 45 characters), the need for document movement during the scanning operation is eliminated in cases where the document contains a reasonably small number of characters. The advent of high-resolution vidicon tubes could permit the character capacity to be increased to the point where document movement during scanning will be eliminated on most documents.

Another advantage of the vidicon scanner is speed. Since it takes only 30 milliseconds for the beam to scan the entire tube, a full grouping of stored characters can be read in that time. At present, due to the limited number of characters that can be stored on the tube, the scanner is only medium-speed (i.e., 500 characters per second). However, once this limitation no longer exists, vidicon scanners should be as fast as or faster than the flying-spot type.

.6 RECOGNITION UNITS

Recognition units probably represent the area of greatest technical development in the character reader field. Because of the rapidity of the progress being made, we will limit our discussion to the five most common types of recognition units now available commercially.

.61 Optical Matching

Optical matching was one of the earliest recognition methods to be used. It is based on the use of two photographic masks for each character. One mask is a positive transparency of the character and the other is a negative transparency. The positive transparency shows all the significant areas that should be covered by the character, and the negative transparency shows those areas that should be left blank.

The negative and positive images of the unknown character are projected onto their opposite masks; i.e., the positive image is projected onto the negative mask, and the negative image onto the positive mask.

Phototubes behind each mask detect any light passing through. A character is identified by first measuring the total light passing through each of the reference masks and selecting the one that passes the smallest amount. Character identification or rejection is then made by comparing the amount of light passed through the selected mask with a threshold value. Ideally, no light should pass through the reference mask if it matches the character being identified. In practice, however, the match is seldom precise enough to completely blank out all light, which is the reason for establishing the threshold value as a tolerance.

The RCA multi-font reading machine, [16] which employs an optical-matching technique, can read up to 500 characters per second.

Although most readers using this technique do so in conjunction with a conventional scanning unit, a scanner is not required. For example, an optical character reader being designed by Rabinow Electronics uses a mirror beam splitter to project the character onto the optical masks. If developed, this should result in a significant increase in reading speed.

The advantages of the optical-matching technique are its ability to identify a full alphanumeric character set and its relative simplicity, which makes it less expensive than some of the other techniques. Also, the masks can be manually changed to enable the reader to handle different character fonts. The major disadvantage is that errors are easily caused by characters that do not meet strict standards of shape and registration. Also, there may be problems in distinguishing between such similar letters as "Q" and "O" or between different punctuation marks.

.62 Analog Waveform Matching

Analog waveform matching is another recognition method that has been in use for some time, particularly in the magnetic character readers used by the banking industry. It is based on the principle that each of certain characters passing under a read head will produce a unique voltage waveform as a function of time; that is, the waveform of each character will differ either in shape or length with respect to time. Characters are identified by matching their waveforms against reference waveforms.

Machines using this technique have reading speeds of approximately 500 characters per second. The principal disadvantage of this system is that only a limited number of characters have unique waveforms. Consequently, this technique is found mainly in systems dealing with a limited character set.

.63 Frequency Analysis

Frequency analysis is a digital recognition method developed for fonts consisting of closely-spaced vertical lines. The outstanding example of this kind of font is the Bull magnetic-ink font shown in Figure 3. Naturally, the Bull CMC-7 and Olivetti 7750 magnetic character readers use this recognition technique. The widths of the gaps between the vertical lines of each character are measured by variations in magnetic flux. An unknown character is identified by comparing the sequence and number of its narrow and wide gaps with stored codes for each of the alphanumeric characters. An analog version of this technique is undergoing investigation at General Electric. [10]

The advantage of the frequency-analysis technique is that it can accommodate a full character set. Speed is another advantage; the Bull CMC-7 magnetic reader, which uses this technique, has a maximum speed of 1,3000 characters per second.

.64 Matrix Matching

This technique, one of the more widely-used, stores the scanner signals in a digital register that is connected to a series of resistor matrices. Each matrix represents a single reference character. The other end of each matrix is connected to a second digital register,

(Contd.)

.64 Matrix Matching (Contd.)

whose voltage outputs are representative of what should be obtained if the reference character were present. Recognition is based upon the resultant output voltage obtained from each matrix.

The advantage of the matrix-matching technique is that the resistor matrices can be modified easily, making it easy to change character fonts. In addition, a full alphanumeric character set can be read. The technique also has the advantage of being quite fast, since the matching is done by resistor matrices. Reading speeds of up to 2,400 characters per second have been obtained. The technique is similar in theory to the optical-matching technique described earlier, but it can handle misregistered characters much more effectively. The numerous machines using this technique are listed in the comparison chart.

.65 Stroke Analysis

This technique, used by Farrington Electronics, (7) is based on the stroke or line formation of each character. The characters are differentiated from each other by the number and position of vertical and horizontal strokes. The formation of the unknown character is matched by a special-purpose computer against a character truth table, which indicates the stroke formation for each reference character. At present, this technique is limited to identifying only a special character font called the Selfchek font, which emphasizes straight lines. Work is being done to generalize the technique so that it can be applied to any character font.

Stroke analysis has the advantage of being able to handle a full alphanumeric character set, but the maximum speeds obtainable by the Farrington character readers are about 300 characters per second, which is low compared to the 2,400 characters per second obtained by machines using the matrix-matching technique. Also, the stroke-analysis method does not have the font flexibility of the matrix-matching technique because of the need to change the wired recognition program in the special-purpose computer every time it is necessary to switch to a different character font.

.7 ECONOMICS AND SELECTION CRITERIA

The question of whether it pays to replace a manual keypunching operation with an automatic character reader cannot be answered in any general way. The answer depends upon the characteristics of the specific application — particularly upon the volume of input data that must be regularly handled, the accuracy requirements of the input operation, and the speed of the computer. A rule of thumb that can be helpful in reaching a preliminary decision on whether to seriously investigate the use of a character reader is that an installation preparing 10,000 input documents per day or requiring 8 to 12 keypunch operators is about the smallest that might gain from using character-recognition equipment. As the daily input volume approaches 30,000 documents, character readers tend to cost less to operate than keypunch devices. (19) The final criterion for making the decision is, of course, the number of characters produced per dollar. A simple formula for determining this cost is to determine:

$$F = \frac{a}{b + c}$$

Where

F = number of characters produced per dollar.

a = total characters produced per month.

b = monthly equipment rental cost.

c = monthly employee salary.

For example, assuming an operator's salary of $350 per month and a typical 200-character-per-second character reader renting at $2,000 per month, then if the character reader is run 7 hours per day, 20 days per month, it will produce 42,893 characters per dollar. This characters-per-dollar figure is roughly 17 times larger than could be achieved by a typical manual keypunching operation without verification.

There are four major criteria for evaluating character readers. Cost, of course, is the most obvious one, but it must be carefully related to the functional capabilities of reading speed, flexibility, and reliability. Naturally, all three of these capabilities directly influence the cost of character-reading equipment; but, as is the case with all equipment, the initial cost is only part of the story.

.7 ECONOMICS AND SELECTION CRITERIA (Contd.)

The reading speeds of character readers currently on the market range from about 70 to 2,400 characters per second. You will find, when comparing machines of different speeds and prices, that the number of characters read per dollar tends to increase at a much faster rate than machine costs.

Better performance in terms of flexibility and reliability might also save you money over the long run despite the higher initial equipment cost incurred. Flexibility pertains to a reader's ability to read a variety of character fonts, including handwritten characters, as well as its rescan ability (i.e., ability to re-read a line of characters), paper-handling capability, and special format features. The ability to read only selected fields and to skip over crossed-out characters are two format features that are very useful in some applications.

Reader reliability is, of course, a fundamental criterion. The reliability of a character reader is measured by its reject and error rates. The "reject rate" is generally defined as the percentage of the total documents read which the reader rejects because it is unable to recognize one or more characters. The "error rate" refers to the percentage of documents containing one or more characters which were incorrectly identified by the reader. The reject rates of present readers range from 2% to 15%, while the error rates generally do not exceed 1%. The best way of judging the reliability of a character reader is to compare it with the error rate of the current keypunch operation which the machine is being considered to replace.

.8 TRENDS AND FUTURE DEVELOPMENTS

The scope of applications for character readers is currently limited primarily by their inability to read a variety of different fonts and by their poor performance on handwritten documents. Consequently, considerable development effort is being put into both these areas, as well as into improvements in reliability and speed.

.81 Multi-Font Capabilities

The work being done on the development of multi-font character readers is taking the form of three basic approaches: manual, semi-automatic, and fully automatic.

The manual method consists of altering the recognition logic by manually replacing such machine parts as plugboards and optical masks. This method is low in cost but is clearly inadequate for reading a stack of documents in which the character fonts are mixed.

The semi-automatic approach consists of effecting changes in the recognition logic by means of operator controls. This means that either the machine must store all the different reference patterns that can occur, or the recognition parameters must be modified by means of a special-purpose control unit. The latter technique is used in the presently-available Philco General Purpose Print Reader. (1) Although it has the advantage of being flexible, it is expensive. The monthly rental for the Philco character reader is approximately $15,000, as compared with the typical rental charges of around $3,000 for first-generation character readers.

The automatic technique demands a recognition unit that can automatically sense a change in the character style and adjust itself to the change. This is really a self-adaptive or learning machine, a type of device that is still in the early experimental stages.

.82 Recognition of Handwriting

Since each individual has his own style of handwriting, it is difficult to set any recognition standards for handwritten characters that will not lead to a high reject rate. Consequently, this problem is even more perplexing than the multi-font recognition problem, because the recognition logic of the machine can never be set for a particular style.

The work being done on the recognition of handwritten characters can be divided into two classes: hand-printed characters and script. Some of the techniques currently being investigated in connection with handwritten documents are curve tracing, detection of selected features, and context recognition (which is discussed below). Although a number of companies are working on the problem, most of the work has been kept confidential. The primary customer for a reader capable of handling handwritten documents appears to be the U. S. Post Office Department.

(Contd.)

.83 Improvements in Reliability

Naturally, reliability in the form of low error and reject rates is a prime consideration in all the development work being done on character readers. One approach that is being followed to reduce these rates is to improve the resolution of the scanning units and thereby increase the number of sample points from which the equipment can make an identification. As previously mentioned, Philco Corporation is using a cathode-ray tube that has a resolution of 2,000 optical lines. Even better resolution can be expected in the near future.

A longer-range approach to the reliability problem is the work being done on "context recognition." This is an attempt to simulate a human being's ability to read by context. When a person reads, the legibility of individual letters or even individual words is usually not critical. This is because human beings read letters within the context of the entire word and words within the context of the entire sentence. Consequently, the word "Ouic" in the phrase "Ouic and dirty" would easily be identified in context by most human readers as the word "Quick," even though the first letter of the word is an "O" and the last letter is missing.

The first thing needed to automate this process of context recognition is a group of fundamental rules that will aid the machine in identifying the characters on the basis of the context in which they are used. These context rules must be chosen to agree with the type of material being read. If a new application is added, then new rules should be instituted. Changes of these rules can be accomplished by utilizing either hardware (e.g., plugboards) or programming techniques.

Although context recognition is not yet sophisticated enough to become the major element of a recognition scheme, it can be used as a backup method for identifying illegible characters. The most obvious advantage is the ability to identify a complete word even if one or two characters present recognition difficulties. Context recognition will certainly involve an enormous increase in the storage capacity and logical capabilities of character readers, but this may be justified by the increase in efficiency that can be attained. However, the economics of context-recognition readers will remain highly speculative until considerably more development work has been undertaken.

Context recognition also promises to be useful in the problem of reading handwriting. It could be the basis of a technique for reading complete words rather than a character at a time. Again, it would radically increase the storage requirements and the cost for a reader, but the results might well be worth it. Again, the economics will remain unclear, pending additional development work.

.84 Improvement in Speed

Another, though less critical, area of development emphasis in character-reader engineering is speed. The major limitation on reading speed is the amount of time it takes to mechanically move the document past the reading station. Work now under way indicates that this limitation will be removed by overlapping the two functions of transporting and scanning documents. This is already being done in the UNIVAC Readatron through the use of a vidicon scanner, which photographs an entire card-type document and performs the scanning function within the cathode-ray tube. This allows a new document to be moved into place while the previous one is being scanned. Speed can be further increased by the use of control logic that permits selective scanning; i.e., scanning only those areas of the document that contain pertinent information.

.85 Summary

The character recognition field is still relatively new, and much work remains to be done in improving equipment performance and developing more flexible character readers at lower cost. Consequently, the field is in an active state of developmental flux that can be expected to continue for several years. In the near future, we can expect to see multi-font capabilities in many commercially-available character readers. Further away, possibly in five years, character readers able to read handwriting should be commercially available, and reliability should be greatly improved. By that time, we can expect to see character readers replacing punched cards as the primary computer input medium.

.9 THE COMPARISON CHART

The accompanying comparison chart (page 23:020.910) summarizes the significant characteristics of representative optical and magnetic character readers in terms of the type of document feed and transport unit, document size, document speed (documents/minute), types of scanners and recognition units, type font, character set, and reading speed. It should be noted that the indicated reading speed usually represents a maximum or potential speed; the actual speed is dependent on the size and number of documents being read.

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COMPARISON CHART: OPTICAL AND MAGNETIC CHARACTER READERS

MANUFACTURER	EQUIPMENT MODEL	DOCUMENT FEED TYPE	DOCUMENT TRANSPORT TYPE	DOCUMENT SIZE (INCHES)	DOCUMENTS PER MINUTE	SCANNER TYPE	RECOGNITION TYPE	TYPE FONT	CHARACTER SET	READING SPEED (CHARACTERS/SEC.)
Burroughs Corp.	Typed Page Reader	Vacuum	Drum	8-1/2 x 11	Not specified	Optical — flying spot scanner	Matrix Matching	Upper case standard Elite type	Alphanumerics, punctuation marks	75
	B102 & B103 Sorter-Readers	Friction	Conveyer belt	Length: 5.94 to 9.06 Width: 2.69 to 4.06	1,000 to 1,565	Magnetic	Analog waveform matching	E-13B	Numerals, four special characters	Max. 1,300
Control Data Corp.	915 Page Reader	Vacuum	Conveyer belt	Length: 2.5 to 14 Width: 4 to 12	Max. 180 for 8-1/2 x 11 documents	Optical — parallel photocells	Matrix matching	A.S.A. Font	Alphanumerics, punctuation marks, special symbols	Max. 370
Farrington Electronics, Inc.	Selected Data Page Scanner	Vacuum	Drive rollers	From: 4.5 x 5.5 To: 8.5 x 13.5	Depends upon number of lines and fields	Optical — mechanical disc	Stroke analysis	Selfchek 12F and/or Selfchek 12L	Alphanumerics, punctuation marks, special symbols	Max. 200
	1P Page Reader	Vacuum	Drive rollers	From: 4.5 x 5.5 To: 8.5 x 13.5	150 to 300 lines per minute	Optical — mechanical disc	Stroke analysis	Selfchek 12F and/or Selchek 12H or 12L, A.S.A. Font, IBM 1428	Alphanumerics, punctuation marks, special symbols	Max. 280
	1D Document Reader	Vacuum	Drive rollers	Card stock: From: 2.2 x 2.75 To: 8.5 x 6.0 Documents: From: 2.625 x 2.75 To: 8.5 x 6.0	Max. 440	Optical — mechanical disc	Stroke analysis	Selfchek 7B, 12F and/or Selfchek 12H, IBM 403, IBM 1428	Alphanumerics, punctuation marks, special symbols	Max. 330
	9SP Model Series	Vacuum	Drive rollers	Standard tab cards; 51 or 80 columns	Max. 180	Optical — mechanical disc	Stroke analysis	Selfchek 12F and/or 7B	Numerals	Max. 330
	2J3M Journal Tape Reader	Tape spool	Vacuum, conveyer belt	Length: to 350 ft. Width: 1-5/16 to 4-1/2 inches	2,880 lines per minute maximum	Optical — flying spot scanner	Stroke analysis	Selfchek 9B or 12F, IBM 1428, NCR Optical Font, A.S.A. Font	Alphanumerics, special symbols, limited punctuation	Max. 1,000
	2S3C Self-Punch	Vacuum	Drive rollers	Standard tab cards; 51 or 80 columns	Max. 550	Optical — mechanical disc	Stroke analysis	Selfchek 7B, 7BR, 9B, 12F and 12L	Alphanumerics, special symbols, punctuation	Max. 600
General Electric Company	MR-20 S-12D	Vacuum	Conveyer belt	Length: 4.75 to 9.0 Width: 2.5 to 4.1	1,200	Magnetic	Analog waveform matching	E-13B	Numerals, special symbols	Max. 1,800
Compagnie des Machines Bull-General Electric	LD-1 (CMC-7 Reader)	Friction	Conveyer belt	Length: 2.36 to 8.75 Width: 2.75 to 4.50	330 to 620	Magnetic	Frequency analysis	Bull Font (CMC-7)	Alphanumerics	Max. 700
Olivetti-General Electric	7750	Friction	Conveyer belt	Length: 5-3/4 to 8-3/4 Width: 2-3/4 to 4-1/8	Max. 750	Magnetic	Frequency analysis	Bull Font (CMC-7)	Alphanumerics	Max. 1,888
International Business Machines Corp.	IBM 1428 I, II, & III	Friction	Vacuum drum and conveyer belt	From: 3-1/2 x 2-1/4 To: 8-3/4 x 4-1/4	Max. 400	Optical — mechanical disc	Matrix matching	IBM 1428	Alphanumerics, symbols	Max. 480
	IBM 1412	Friction	Drum	Length: 6 to 8-3/4 Width: 2-3/4 to 3-2/3	Max. 950	Magnetic	Matrix matching	E-13B	Numerals, 4 special symbols	Max. 1,600
	IBM 1282	Friction	Clutch	Standard tab cards: 50 to 80 columns	Max. 200	Optical	Matrix matching	1428-Farrington Optical Code	Numerals, 3 symbols	?
	IBM 1419 Model I	Friction	Conveyer belt	Length: 6 to 8.75 Width: 2.75 to 3.67	Max. 1,600	Magnetic	Matrix matching	E-13B	Numerals, 4 special symbols	Max. 2,112
	IBM 1418 I and II	Friction	Vacuum drum and conveyer belt	Length: 5.875 to 8.75 Width: 2.75 to 3.67	Max. 420	Optical — mechanical disc	Matrix matching	IBM 407-1 or 407-E-1 Font	Numerals, special symbols	Max. 500
	IBM 1285	Vacuum	Conveyer belt	Journal rolls — Width: 1-5/16 to 3-1/2 Length: 36 to 200 feet	Max. 2,190 cards/min.	Optical	Matrix matching	1428-NCR Optical code	Numerals, 7 symbols	Max. 365

COMPARISON CHART: OPTICAL AND MAGNETIC CHARACTER READERS (Contd.)

MANUFACTURER	EQUIPMENT MODEL	DOCUMENT FEED TYPE	DOCUMENT TRANSPORT TYPE	DOCUMENT SIZE (INCHES)	DOCUMENTS PER MINUTE	SCANNER TYPE	RECOGNITION TYPE	TYPE FONT	CHARACTER SET	READING SPEED (CHARACTERS/SEC.)
National Cash Register Co.	420-1 Optical Reader	Automatic cash register tape spooling device	Journal tape reader	From: 1.31 x 10 To: 3.25 x 1200	26 lines per second	Optical — mechanical disc	Matrix matching	NCR Selfchek (NOF)	Numerals, special symbols	Max. 832
	420-2 Optical Reader	Automatic cash register tape spooling device	Journal tape reader	From: 1.31 x 10 To: 3.25 x 1200	52 lines per second	Optical — mechanical disc	Matrix matching	NCR Selfchek (NOF)	Numerals, special symbols	Max. 1,664
	402-3 MICR Sorter-Reader	Friction	Conveyer belt	Length: 5.25 to 10 Width: 2.5 to 4.5	Max. 750	Magnetic	Analog waveform matching	E-13B	Numerals, 4 special symbols	Max. 1,200
	407-1 MICR Sorter-Reader	Friction	Conveyer belt	Length: 4 to 8.75 Width: 2.75 to 4.5	Max. 1,200	Magnetic	Analog waveform matching	E-13B	Numerals, 4 special symbols	Max. 3,200
Univac Division, Sperry Rand Corp.	Readatron	Picker belt	Card	Credit card size	Max. 200 credit cards	Optical — vidicon scanner	Matrix matching	No. 281	Numerals	Max. 580
Philco Corp. (Div. of Ford Motor Company)	General Purpose Print Reader	Vacuum	Conveyer belt	From 3 x 5 To: 8-1/2 x 11	180 for 8-1/2 x 11 documents; 360 for 3 x 5 cards	Optical — flying spot scanner	Matrix matching	Multiple type fonts	Alphanumerics, punctuation, special symbols	Max. 2,000
Rabinow Electronics (Subsidiary of Control Data Corp.)	RUR 3200-1	Vacuum	Conveyer belt	5.5 x 8.63	Max. 400	Optical — parallel photocells	Matrix matching	Billing open type	Numerals	Max. 1,000
	RUR 4100-1	Tape spooling device	Continuous tape	--	--	Optical — parallel photocells (retina)	Matrix matching	Cash register type	10 numerals and 14 alphabetic characters	Max. 110
Radio Corp. of America	5820	Vacuum	Conveyer belt	Max. 4 x 8-1/2 Min. 2-1/2 x 2-1/2	Max. 1500 Min. 750	Optical — vidicon scanner	Stroke analysis	RCA N-2	10 numerals, 5 symbols	Max. 1,500
	70/251	Vacuum	Conveyer belt and drum	Max. 4 x 8-1/2 Min. 2-1/2 x 2-1/2	Max. 1800	Optical — vidicon scanner	Stroke analysis	RCA N-2	10 numerals, 5 symbols	Max. 1,500
Recognition Equipment, Inc.	Electronic Retina Document Carrier	Vacuum	Conveyer belt	From: 2.00 x 2.00 To: 5.00 x 8.75	1,200	Optical — parallel photocells (retina)	Matrix matching	Multiple type fonts	Alphanumerics, punctuation marks, special symbols, mark sense	Max. 2,400
	Journal Tape Carriage Reader	Tape roll	Journal	Width: 1-5/16 to 6	Max. 1,800 lines per minute	Optical — parallel photocells (retina)	Matrix matching	Multiple type fonts	Alphanumerics, punctuation marks, special symbols, mark sense	Max. 2,400
	Electronic Retina Rapid Index Page Reader	?	Conveyer belt and drum	From: 3.25 x 4.88 To: 10.00 x 14.00	Max. 30	Optical — parallel photocells (retina)	Matrix matching	Multiple type fonts	Alphanumerics, punctuation marks, special symbols, mark sense	Max. 2,400

SPECIAL REPORT

DECISION TABLES SYMPOSIUM

prepared by

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.1 INTRODUCTION

The Decision Tables Symposium discussed decision tables as a tool of system analysis and as a programming tool.

The ACM Joint Users Group and the CODASYL Systems Development Group, which sponsored the symposium, described what decision tables were, presented various users' experience with decision tables, and defined DETAB-X (DEcision TABle eXperimental), a language that makes use of COBOL-61 in decision table format. The Systems Group has spent considerable time investigating the potential of decision tables for problem definition, and in defining DETAB-X, so that many others may actually experiment with this valuable tool. It is anticipated that DETAB-X will be recommended as an addition to COBOL-61. At this stage it is premature to speculate whether any manufacturers intend to include DETAB-X in their COBOL compiler package.

If the claims presented by users at the symposium are borne out by others, the decision table technique promises to be yet another major tool in system analysis and programming methodology.

.2 DECISION TABLES

Constructing Decision Tables is a method of stating conditions which must be met in order to draw conclusions and decide what action to take. The tables provide a tabular representation of complex procedures in a way that is easy to visualize and understand.

For example, consider the statement: "If credit is OK, approve order; if credit is not OK, but pay experience is favorable, approve order; otherwise return order to sales." Normally, the next step in formalizing this statement is to draw a flow chart:

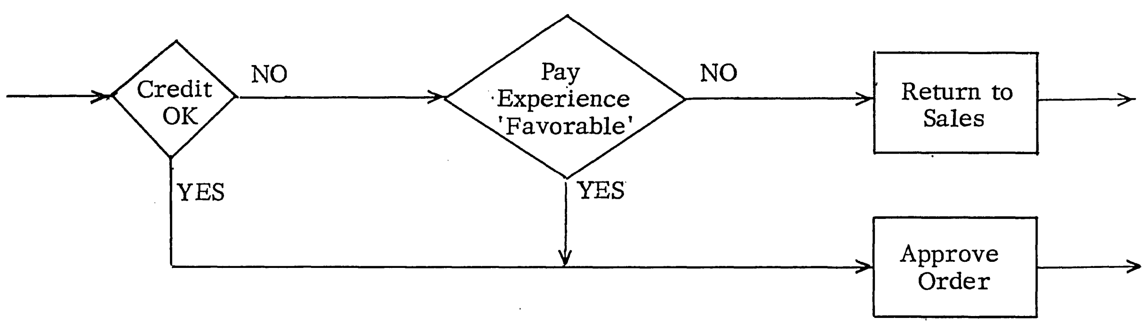

Figure 1. Credit Approval Flow Chart

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A Decision Table for this situation would appear as follows:

TABLE 1. CREDIT APPROVAL DECISION TABLE

Credit OK	Y	N	N
Pay Experience 'Favorable'	-	Y	N
Approve Order	X	X	-
Return to Sales	-	-	X

The basic difference between a flow chart presentation of a decision-making process and its presentation in decision table form is that in a decision table the sets of conditions and their related sets of actions are presented as vertical "rules, " side by side. The decision table organization is particularly advantageous in presenting complex logical processes which would result in a complex, difficult-to-follow chart.

Flow charts depict decision processes sequentially; decision tables depict the same processes in parallel.

A decision table technique is neither particularly new nor revolutionary. As a concept, it is very easy to understand. The interest lies in the technique being developed for the systematic exploitation of decision tables in system analysis, and in development of techniques which permit completed decision tables to serve directly as source programs ready for direct compiling into object computer programs.

The basic elements of a decision table are:

(1) Condition stub.

(2) Condition entry.

(3) Action stub.

(4) Action entry.

TABLE 2. DECISION TABLE ELEMENTS

CONDITION STUB	CONDITION ENTRY
ACTION STUB	ACTION ENTRY

Descriptions of conditions on which decisions are to be based are entered in the condition stub; descriptions of actions which may result from the various combinations of decisions, based on the conditions, are entered in the action stub.

A decision is a specific answer to a question posed by a condition. For example, the first entry in the condition stub of Table 1 reads "Credit OK." This entry can be interpreted as "Is Credit OK, or is Credit not OK?" By examining the item of data which records the state of the credit, the decision is made: YES (Credit OK), or NO (Credit not OK).

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In the action entry part of the table, a set of actions to be carried out for each rule whose conditions have been met is entered. The resulting actions may be a computation, data transfer, initiation of an input or output process, or transfer of control to another decision table, as discussed in the paragraphs which follow. Table 3 is a typical table for a simple problem. (It is an expanded version of Table 1.)

TABLE 3. EXAMPLE OF LIMITED ENTRY TABLE
CREDIT APPROVAL TABLE

	RULE 1	RULE 2	RULE 3	RULE 4
CREDIT OK	Y	N	N	N
PAY EXPERIENCE 'FAVORABLE'	-	Y	N	N
SPECIAL CLEARANCE OBTAINED	-	-	Y	N
APPROVE ORDER	X	X	X	-
RETURN ORDER TO SALES	-	-	-	X

Decision tables may be of one of three forms:

(1) Limited entry table.

(2) Extended entry table.

(3) Mixed entry table.

In limited entry form, the entire condition is stated in the condition stub and the entry portion is limited to a single character per rule per condition. The entry will be "Y" (yes), "N" (no), or "-" (irrelevant). Similarly, the entire action is written in the action stub, and the action entry per rule per action is limited to an "X" (execute), or "-" (irrelevant).

In an extended entry form, part of the condition or action extends directly into the entry portion of the table.

Both forms may be used within one table; however, within any one row of a table, either limited entry or extended entry form must be used exclusively. Such a table is called a mixed entry table.

The DETAB-X experimental language extension to COBOL is designed to handle all three forms of decision tables. Table 3 was an example of a limited entry table; Table 4 is an extended entry table. Table 5 has essentially the same contents as Table 4, presented in limited entry form. Table 6 is a mixed entry table.

TABLE 4. EXAMPLE OF EXTENDED ENTRY TABLE
RATE DETERMINATION TABLE

	RULE 1	RULE 2	RULE 3	RULE 4
AGE	LE 25	LE 25	GR 25	GR 25
SEX	"M"	"F"	-	-
ACCIDENTS	-	-	EQ 0	GR 0
SEX RATE EQ RATE	+ RISKFACTOR	-	- SPECIAL-RATE	-
SET NEWRATE EQ	RATE	RATE	RATE	RATE

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The qualifiers such as "LE 25," "GR 25," "F," "EQ 0" are "extended" from the condition stub to the condition entry part of the table. Action descriptors, such as "+ RISK FACTOR" are extended from the action stub to the action entry part of the table.

Table 4, if designed as a limited entry table, would appear as shown in Table 5. Obviously, the extended entry form of a decision table requires fewer entries to describe the same logic when dealing with multianswer conditions.

TABLE 5. LIMITED ENTRY FORM OF TABLE 4
RATE DETERMINATION TABLE

	RULE 1	RULE 2	RULE 3	RULE 4
AGE LE 25	Y	Y	N	N
AGE GR 25	-	-	Y	Y
SEX "M"	Y	N	-	-
SEX "F"	-	Y	-	-
ACCIDENTS EQ 0	-	-	Y	N
ACCIDENTS GR 0	-	-	-	Y
SET RATE EQ RATE + RISK FACTOR	X	-	-	-
SET RATE EQ RATE - SPECIAL-RATE	-	-	X	-
SET NEW RATE EQ RATE	X	X	X	X

TABLE 6. EXAMPLE OF MIXED ENTRY TABLE: WHAT IS IT?

	RULE 1	RULE 2	RULE 3	RULE 4	ELSE
IS IT AN ANIMAL	Y	Y	Y	N	-
NUMBER OF LEGS	4	4	4	2	-
HAS IT FEATHERS	N	N	Y	Y	-
NOSE	LONG	SHORT	LONG	-	-
NECK	SHORT	LONG	LONG	-	-
IT IS	ELEPHANT	GIRAFFE	HALLUCINATION	BIRD	-
GO TO	TABLE E	TABLE G	PSYCHIATRIST	TABLE B	TABLE X

When used as system analysis and programming tools, the tables must provide for sequencing of operations. Appropriate action entries, such as the last two lines of Table 7, provide such sequencing. An action entry controlling sequence will either pass control to another table unconditionally, or provide for entry into another table and a return to the entry in the original table following the one from which the exit was originally made. In DETAB-X Language this facility is provided by the DO statement and the GO TO statement. Table 7 illustrates the procedure.

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TABLE 7. EXAMPLE OF TRANSFER OF CONTROL
CODE TEST TABLE

	RULE 1	RULE 2	RULE 3	ELSE
JOB-CODE EQ	"A"	"B"	"C"	-
ADD 1 TO	A-COUNT	B-COUNT	C-COUNT	-
DO AB-PROCESS	X	X	-	-
DO AC-PROCESS	X	-	X	-
DO	A-EDIT	B-EDIT	C-EDIT	ERRORS
GO TO NEXT-JOB	X	X	X	X

Table 7 implies the existence of seven other tables. These tables are: AB-Process, AC-Process, A-Edit, B-Edit, C-Edit, Errors, and Next Job. In Rule 1, for example, "DO AB-Process" will cause table "AB-Process" to be entered, and, on completion of that table, control will be returned to DO AC-Process in Rule 1 of Table 7.

A table to which temporary control is transferred with a DO statement should have no rules terminating with a GO TO statement, since this would contradict the return of control that is indicated by the DO action.

While the transfer of control terminology used here applies to the proposed DETAB-X language extension to COBOL, any other equivalent terminology may be used where the tables are not to be compiled by COBOL.

The final example given below illustrates the use of a limited entry table in defining the logic of a simplified file maintenance application. Starting and ending procedures are excluded, and would be normally found in other tables.

The file names and data fields are:

	File Names	Data Fields
Input:	1. Master file	1. STOCK-NR-A
		2. ON-HAND-A
	2. Change file	1. STOCK-NR-C
		2. QUANTITY
		3. CHANGE-CODE
Outputs:	1. New-Master file (same as master file)	
	2. Ship-Order file (same as change file)	

The work to be done is as follows:

When an item from the master file does not have a change record to apply against it, write the master file record into the new master file.

When an item from the change file does not correspond to a master file record, it must be a "NEW ITEM." In this case, create a new master file record from the change file record.

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When the stock number of the master file agrees with the stock number of the change file, update the master file record as follows:

(1) If the change-code is equal to "REC," adjust quantity on hand.

(2) If the change-code is equal to "SHIP," and the quantity requested is available, adjust "ON-HAND-A" and write shipping order. If the quantity requested is not available, modify the change-code to read "BACK-ORDER" and write shipping order.

(3) If the change-code is equal to "ADJUST," apply quantity in change file to ON-HAND in master file.

Table 8 shows this specification in tabular form. It seems obvious that the tabular presentation, when compared to the text description, is more concise and permits ready checking of the logic involved.

TABLE 8. FILE UPDATING ROUTINE
FILE MAINTENANCE TABLE TAB-001

	RULE 1	RULE 2	RULE 3	RULE 4	RULE 5	RULE 6	ELSE
STOCK-NR-A EQ STOCK-NR-C	Y	Y	Y	Y	N	N	-
STOCK-NR-A LR STOCK-NR-C	-	-	-	-	Y	N	-
STOCK-NR-A GR STOCK-NR-C	-	-	-	-	-	Y	-
CHANGE-CODE EQ "REC"	N	N	Y	N	-	-	-
CHANGE-CODE EQ "SHIP"	Y	Y	-	N	-	-	-
CHANGE-CODE EQ "ADJUST"	-	-	-	Y	-	-	-
CHANGE-CODE EQ "NEW-ITEM"	-	-	-	-	-	Y	-
QUANTITY LR ON-HAND-A	N	Y	-	-	-	-	-
MOVE (ON-HAND-A+QUANTITY) TO ON-HAND-A	-	-	X	X	-	-	-
MOVE (ON-HAND-A-QUANTITY) TO ON-HAND-A	X	-	-	-	-	-	-
SET CHANGE CODE EQ "BACK-ORDER"	-	X	-	-	-	-	-
WRITE SHIP-ORDER FROM CHANGE	X	X	-	-	-	-	-
WRITE NEW-MASTER FROM MASTER	-	-	-	-	X	-	-
WRITE NEW-MASTER FROM CHANGE	-	-	-	-	-	X	-
READ CHANGE	X	X	X	X	-	X	-
READ MASTER	-	-	-	-	X	-	-
DO ERROR ROUTINE	-	-	-	-	-	-	X
GO TO TAB-006	X	X	X	X	X	X	X

While each rule is independent of the others, it is important to consider, within each table, the frequency with which each rule will be carried out, and the order in which actions are listed in order to minimize the number of instructions to be carried out when the coding resulting from the table is used. Analysis of each specific problem should show which of the rules contained in the table will be satisfied most frequently. Those rules should be entered first. When such a table is being executed, the most common path through the table will be preceded by a minimum number of condition tests.

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.3 USERS' EXPERIENCE

The companies which presented papers on their experience with the use of decision tables were:

General Electric (2 papers)

Insurance Company of North America

RAND Corporation

Sutherland Corporation

.31 General Electric

Reports on experience gained by GE in its Large Steam Turbine-Generator Department and in the area of manufacturing were presented. The Turbine Department has used computers for ten years, an IBM 704 for five years. GE now has approximately 200 active programs, half of them commercial and half engineering applications.

Decision tables were initially applied to develop specifications for manufacturing planning work. Once the decision to apply decision table techniques had been made, a decision table compiler was developed. In the process, it was discovered that decision tables are excellent for expressing compiler logic.

The first decision table application was the development of a program to produce control instructions for three-dimensional contouring on a milling machine. The whole job was done by one man in 4 months. The program was then completely debugged in 3 weeks by another engineer while the author was taking a vacation. The completion of the job in that time was entirely unexpected by management because it was estimated that it would take much longer.

Now there are forty active programs which were developed using decision table techniques and the decision table compiler.

In the manufacturing area, two major jobs were cited. The first one, static rotor manufacturing planning, was developed using both decision table and charting techniques to obtain a measure of comparison.

Using decision table techniques and the compiler, the rotor program was designed and completed in 6 weeks. Using charting techniques, 14 weeks were required to design and complete the same program. The charted program, when compiled, was 50 percent larger than the compiled decision table program. However, the decision table program ran 30 percent longer.

The second major program design was for planning the manufacture of gears. The output of that program provided detailed instructions on manufacturing each type of gear. Some 100,000 gear variations are possible. To manufacture a gear takes about thirty separate machine operations.

To design and debug the program using decision tables took 2.5 man-years. Approximately 3,000 decision tables were generated, resulting in 60,000 object instructions. The planning cycle for a specific gear manufacture run was cut from 4 weeks to 25 minutes by using the computer.

In addition, decision tables were used to design a simulator program for real-time models of inventory management. The program was designed and debugged in 6 man-months. Approximately 100 decision tables and 8,000 object instructions were generated. The use of the program has already indicated reduction of inventories by 20 to 30 percent.

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.32 Sutherland Corporation

The major achievement cited by Sutherland was the successful design of a highly complex file maintenance specification.

Eight months of conventional effort, using charting techniques to define the logic of the system, were abortive. Using decision tables, the system was completely specified in 3 weeks.

.33 Insurance Company of North America

The experience of INA has been similar to that of the Sutherland Corporation. A complex casualty file system defied all attempts at successful definitions using charting techniques. INA succeeded in programming the system using decision table techniques. In the course of this project, they developed a preprocessor which accepts cards punched with decision table codes, converts them into COBOL-like statements for permanent documentation, and produces a source program tape for assembly by IBM 7080 AUTOCODER.

Since their system is expected to be in operation for many years, one of the main requirements of the system was facility to incorporate changes. INA claims that use of the decision tables makes this relatively easy because the logical implications of each change are clearly shown on the tables. The tables themselves form the main documentation of the system. (EDITORS NOTE: These are two of the main benefits of decision tables.)

.34 RAND Corporation

RAND Corporation developed a FORTRAN decision table preprocessor called FORTAB, which operates under the control of the FORTRAN monitor. The preprocessor accepts decision table statements and translates them into a FORTRAN source program, which is then compiled.

RAND's work has been experimental, and has had encouraging results. The program in decision table form is its own documentation, and it was found to be easy to prepare. The decision table program took twice as long to compile as its normal FORTRAN version and used one third more memory, but ran almost as fast. On the other hand, the program ran successfully on the first try and saved much debugging time.

The FORTAB preprocessor will be released through SHARE. It is easy to learn, and the FORTAB manual is only 16 double-spaced pages.

.4 CONCLUSIONS DRAWN BY USERS

All decision table users represented at the symposium claimed a number of advantages for the technique in most system analysis and programming areas:

(1) It forces a clear problem statement and shows where information is missing.

(2) It forces a complete logical description of the problem.

(3) It completely defines, at system level, decisions to be implemented.

(4) It leads to low-cost translation of a defined system into a working computer program.

(5) It permits development and orderly presentation of systems too complex for effective charting.

(6) It provides extreme subroutinization by forcing the segmentation of the overall system into logically manageable tables.

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(7) It is suitable for documentation, and for communication of system and program design between people.

(8) It assists in implementing system changes, and quickly points out consequences of any one change, even in complex systems.

(9) It permits system definition and description divorced from procedural content.

(10) It is a technique which is easily learned.

(11) Decision table language and presentation are suitable for direct translation into machine language; i.e., it lends itself to direct compiling.

(12) It is helpful in designing compilers themselves.

(13) It is useful for presenting management policies and rules, and for communicating system design to management for evaluation.

.5 COMMENTS

The potential value of decision tables as a system analysis and programming tool appears to have been demonstrated during the symposium. Promise lies particularly in the direction of using decision tables as a source programming language. The logically clear presentation which decision tables permit should ultimately permit the compiling of object programs almost as efficient as those coded by skilled machine language programmers. This could be achieved by having the compiler analyze each table as a whole prior to generating an object code. While this would increase compiling time, it would provide object program efficiency, which is most important in repetitive program runs. Further development work is required to increase the sophistication with which tables may be used. In particular, studies are required to evaluate and develop techniques for application of decision tables to the design and programming of large real-time systems because it is there that the inadequacy of present methodology is most obvious.

The CODASYL Systems Development Group invites comments and criticisms of DETAB-X, and any suggestions on its improvements.

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SPECIAL REPORT

U.S. MANUFACTURED MAGNETIC TAPE HANDLERS A STATE OF THE ART REPORT

prepared by
the Technical Staff of
AUERBACH Corporation

AUERBACH/BNA SPECIAL REPORT: U. S. MANUFACTURED MAGNETIC TAPE HANDLERS A STATE-OF-THE-ART REPORT

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.1 INTRODUCTION

The classification of computer programs into two types, computer-limited and input-output-limited, is evidence of the problem of getting information to and from a computer fast enough to utilize the internal speed and efficiency of the computer. One of the most important types of computer devices is the magnetic tape handler functioning both as external memory to the central processor and as the primary communications medium to other computers and to peripheral equipments. Ever since the introduction of the high-speed digital computer, manufacturers of tape handlers have been plagued with the problem of keeping the speed of their units abreast of the ever-increasing speeds of central processors.

This report presents the characteristics of contemporary American computer magnetic tape handlers available both as integral parts of computer systems and as separate components. (For additional reference to technical terms, see Glossary, 7:194 and :195.)

One must be careful not to confuse systems characteristics such as data block load size, effective character transfer rate, checking features, and in some special cases, inter-block gap, with the physical characteristics detailed in the accompanying chart. Also, to eliminate confusion, no attempt has been made to include price data. Such data would be meaningless, particularly in the case of those tape handler manufacturers who sell their tape equipment for connection to any number of different computer systems. For such cases, it is the type of connection or "interface" which governs the overall package price.

The chart form of presentation has been chosen because it is a most convenient way to compress data for easy comparison of the parameters of the various units. The charted data is discussed, and finally, observations are made on the status and future of developments in the magnetic tape field.

.2 COMPARISON CHART GUIDE

The detailed characteristics and performance of the tape handlers are presented in the chart. The categories of information presented are:

Identity	- Manufacturer - Model Number
Physical Form	- Drive Method - Head Arrangement - Tape Buffer Reservoir Type
Storage Characteristics	- Total Number of Tracks - Number of Data Tracks - Data Rows per Inch (i.e., Packing Density) - Data Rows per Block - Interblock Gap (Inches) - Tape Width (Inches) - Tape Length (Feet)

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.2 COMPARISON CHART GUIDE (Contd.)

Performance	- Peak Speed (Data Rows Per Second) - Peak Speed (Characters Per Second) - Peak Speed (Digits Per Second) - Tape Speed (Inches Per Second) - Start Time (Milliseconds) - Stop Time (Milliseconds) - Rewind Time (Minutes)
Application	- Representative Computer Systems Using This Unit

Observations on the Comparison Chart

Twelve manufacturers of tape handlers are listed on the chart; of these, six are also manufacturers of lines of computers. These companies (Burroughs, Control Data, IBM, Honeywell, RCA, and UNIVAC) normally supply tape handlers as components of a complete system, but most will also sell their tape handlers as separate components.

The remaining manufacturers (Ampex, Consolidated Electrodynamics, Datamec, Information Storage Systems, Midwestern, and Potter) carry on significant marketing effort. Their primary markets are the special-purpose system builders and those computer manufacturers who do not make their own units. Of the independent group, Ampex and Potter are best established in the field. Ampex is broadly based in all aspects of magnetic tape technology and in magnetic core memories, while Potter concentrates on computer peripheral equipment, including printers and paper tape readers. The remaining independent companies are newer in the field and have not yet had a major effect on the market.

.21 Physical Form Characteristics

Two major mechanical elements characterize the physical form of all of the existing tape handlers: the tape drive method, and the means for buffering (isolating) the tape drive from the inertia of the storage reels. Tape is advanced (or driven) by a pinch roller that holds the tape against a drive roller, by a magnetic clutch driven capstan, or by a vacuum capstan that uses external air pressure to hold the tape against the capstan. The portion of the tape to be accelerated is isolated from the storage reels by vacuum columns, by tension arms, by a combination of vacuum and arms, or by storage bins. The physical form of all available tape handlers can be shown by a simple tree diagram:

PHYSICAL FORM

Drive Method			Buffer Type		
Pinch Roller	Vacuum Capstan	Clutched Capstan	Vacuum Columns	Tension Arms	Storage Bins

Each of these methods is highly developed today; obtaining further improvement in mechanical performance may require new methods of solving the drive and buffer problems.

Great flexibility in the physical arrangement of the read/write and erase heads is provided by the independent tape equipment manufacturers in order to satisfy a variety of customer requirements. All of the independent companies will provide for compatibility with the tapes and data structures of the computer manufacturers, while generally each computer manufacturer is most concerned with his own particular data characteristics.

However, it is to be noted that the concept of "IBM-compatibility" is gaining more favor, primarily as a marketing tactic. IBM-compatibility is the concept of producing a tape unit which will read and record the binary data structures used in the IBM 7090 series computers.

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.21 Physical Form Characteristics (Contd.)

The most important storage characteristic of magnetic tape is its packing density. Early tapes typically had packing densities of 100 to 200 rows per inch, but existing tapes permit densities ranging from 400 to more than 1,500 rows per inch. Such high densities depend critically upon tape material quality, good dimensional stability*, high uniformity of read-write heads, and sophisticated electronic circuitry. The packing densities in the 800 to 1,500 rows per inch range generally use either more than one clock track or self-clocking of each track to compensate electronically for the effects of tape skew and variations between heads. In this type of self-clocking, each track is so recorded that a clock signal can be extracted electronically without reference to other tracks. Thus, it is possible to overcome the effect of timing variations between tracks. Another factor in achieving high packing density is the degree of resolution of information that can be recorded on the tape. This factor depends on intimate contact between the read-write head and the tape, a small head-gap, the thickness and quality of the tape coating, and good control over the amplitude and duration of the drive current in order to limit magnetic saturation of the tape. The full potential of achievable tape resolution has not yet been exploited. (In actual practice, achieving specified densities is not always as easy as manufacturer sales literature implies.)

The length of the interblock gap has an important effect on total storage capacity, because in most systems the blank space that constitutes the gap is unavailable for storage of information. A limited number of designs have made use of the interblock gaps for information storage, but the practice is not common. The effect of interblock gaps can be minimized in most systems by the use of longer blocks. Because the size of the recorded block has a critical effect on the total capacity of a tape and on the overall speed of processing the data recorded on it, the total tape capacity must be considered as a system characteristic rather than a tape handler characteristic.

Other important storage parameters are tape length and tape width. These parameters and the number of tracks determine the number of digits or characters that can be recorded in a single tape row. The majority of tape handlers are designed to use 1/2-inch wide tape and record one character at a time. A minority use 3/4- or 1-inch wide tape, and some of these can record two digits or characters side by side. Standard size reels used in most computer installations are either 2,400 or 3,600 feet long. No standard tape units are available for use with reels larger than 3,600 feet, and few units are specially designed for short reels.

Because of the length of tapes normally used and the permissible maximum physical tape movement velocities, full-reel rewind times range from approximately one to more than 3 minutes. The fastest rewind times are obtained when the tape can be unloaded from the buffer reservoirs and the entire tape path cleared. Obtaining significantly faster rewind times will require substantially improved reel drive systems.

Tape life depends chiefly on wear caused by friction against read/write heads. Mechanical damage caused by the action of pinch rollers and tape guides is also important. Tape life is presently said to range from 20,000 to 50,000 passes; however, it is doubtful whether many users attempt such extended use in normal practice. More extensive use of pneumatic techniques, including air film lubrication at the heads, might increase potential tape life even more.

.22 Performance Characteristics

The data rate of a tape unit depends upon the packing density and the tape velocity. Tape speeds range from 30 to 150 inches per second. Because of the basic mechanical limitations, tape speed is one of the parameters that has changed least with the advance in the state of the art, as demonstrated by the Uniservo I models, which in 1951 moved tape at 100 inches per second. Another important performance factor is the ability of the tape drive to accelerate and decelerate the tape between the stationary condition and the constant running velocity. Improvements in start and stop times reduce the length of the

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§ 040.

.22 Performance Characteristics (Contd.)

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Among the most important characteristics of a magnetic tape system are the checking features it uses. The checking system embraces the tape, the recording and reading operation, and the processing of the data; hence, checking is only partly related to features of the tape handler. The most common checking technique is the transverse parity check (either odd or even parity), which uses one of the tracks to establish a constant parity condition, and thus serves to signal a reading or recording error in any single bit position of a character. Odd parity is sometimes used to eliminate the need for a separate clock track by ensuring that between successive rows at least one of the tracks will always show a change in magnetic state.

In many cases the system also provides for a longitudinal parity check, with the parity bit for each track forming a longitudinal parity check character located at the end of each block. By means of the central processor, a single error within a block can be corrected through the use of both transverse and longitudinal parity data. Generally, however, more than one error will occur, since errors are usually due to dirt, dust, or flaws. Some systems take advantage of the frequently transient nature of errors by using programmed or automatic reread operations, sometimes at varying amplifier settings. The most sophisticated checking systems use many check characters which are computed from the contents of the block and recorded at the end of the block. Such systems (e.g., Honeywell's Orthotronic error-correcting) allow detection and correction of several simultaneous errors.

A major aid in checking is the use of dual, or two-gap, heads that permit the information to be checked (usually only for transverse parity) after it has been written, so that a recording error can be corrected.

.3 SUMMARY OF THE STATE OF THE ART

At present, the commercially available tape handlers use pinch roller, clutched capstan, or vacuum capstan tape drives and vacuum-column, tension arms, or storage-bin tape buffers.

Tape packing densities range from 125 to more than 1,500 characters per inch. The most common tape width is 1/2-inch, and tape reel length is usually 2,400 or 3,600 feet. Tape movement speeds of 30 to 150 inches per second, and start and stop times of 1.5 to 5.0 milliseconds, are common.

We believe that with the presently used techniques, the potential for further improvements in performance is limited. On the other hand, there is still considerable room for reductions in cost, and improvements in reliability and simplicity of operation. We expect further developments in low-cost tape handlers of moderate performance and in cartridge-loaded units (such as those used in the IBM Hypertape Drive). It may even be possible to develop a low-cost, cartridge-loaded magnetic tape device that will be competitive with paper tape reader and punch units for keyboard and business machine applications.

For radically improved performance in terms of higher capacities, shorter access times, and higher information transfer rates, we expect that other devices, including disc files, will become more important than tape in the largest systems. This is particularly true for the on-line applications. Magnetic tape equipment will, on the other hand, continue to be improved and will, we feel, continue to be the primary input-output medium for all classes of computers.

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COMPARISON OF MAGNETIC TAPE HANDLERS
(COMMERCIALLY USED IN THE UNITED STATES – 1963)

IDENTITY		PHYSICAL FORM			STORAGE CHARACTERISTICS						PERFORMANCE								APPLICATION
											Peak Speeds								
Manufacturer	Model Number	Drive Method	Head Arrangement	Buffer Type	Total Tracks	Data Tracks	Data Rows Per Inch	Interblock Gap, in.	Tape Width, inches	Tape Length, feet	Data Rows per Second	Characters per Second	Digits per Second	Tape Speed, in./sec.	Start Time, msec.	Stop Time, msec.	Rewind Time, minutes	Representative Computer Systems Using This Unit
Ampex Corp.	TM-2	Pinch rollers	V	Vacuum columns	V	V	800 max.	V	1.0, 0.50	3,600 max.	120,000 max.	V	V	112.5, 120, or 150	2.0	1.5 max.	3.0 max.	NCR 315, Philco 2000
Ampex Corp.	TM-4	Pinch rollers	V	Tension arms & vacuum columns	V	V	800 max.	V	0.50	3,600 max.	60,000 max.	V	V	30/60 or 37.5/75	3.3	1.8 max.	4.5 max.	CDC 1604, GE 225, SDS 920
Burroughs Corp.	B 421	Pinch rollers	1 two-gap	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	50,000	50,000	50,000	90	6.7	7.1	1.5	B 270, B 280
Burroughs Corp.	B 422	Pinch rollers	1 two-gap	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	66,600	66,600	66,600	90 or 120	5.0	5.0	1.5	B 5000
Consolidated Electro-dynamics Corp.	DR-2700	Pinch rollers	V	Tension arms & vacuum columns	7 to 16	V	556	V	0.50, 0.75 or 1.0	3,600 max.	83,400	V	V	30 to 150	3.0	2.5	3.0 max.	
Control Data Corp.	CDC 603	Vacuum capstans	1 erase, 1 read, 1 write	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	41,700	41,700	41,700	75	3.0	3.0	1.3	CDC 160, 160-A
Control Data Corp.	CDC 606	Vacuum capstans	1 erase, 1 read, 1 write	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	83,400	83,400	83,400	150	4.0 max.	4.0 max.	1.3	All CDC systems
Datamec Corp.	D 2020	Pinch rollers	V	Vacuum columns	7	6	556 max.	0.75	0.50	2,400 max.	16,667	16,667	16,667	10 to 30	5.0 max.	1.5 max.	4.0 max.	
Information Storage Systems, Inc.	DK-1 Models A-E	Pinch rollers	V	Tape bins	32	V	1,250 max.	0.50	1.00	3,600	250,000 max.	500,000 max.	750,000 max.	100 or 200	1.5	1.5	3.6	
Information Storage Systems, Inc.	DK-1 Models F, G, H	Pinch rollers	V	Tape bins	7	6	800 max.	0.75	0.50	2,400	90,000	90,000	90,000	112.5	1.5	1.5	2.4	
IBM Corp.	729 II	Pinch rollers	1 two-gap	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	41,667	41,667	41,667	75	Read 10.5 Write 7.5	Read 2.1 Write 5.1	1.2	IBM 1401, 1410, 7040, 7070, 7080, 7090, etc.
IBM Corp.	729 IV	Pinch rollers	1 two-gap	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	62,500	62,500	62,500	112.5	Read 6.7 Write 5.0	Read 2.1 Write 3.8	0.9	IBM 1401, 1410, 7040, 7070, 7080, 7090, etc.
IBM Corp.	729 V	Pinch rollers	1 two-gap	Vacuum columns	7	6	200, 556, or 800	0.75	0.50	2,400	60,000	60,000	60,000	75	Read 10.5 Write 7.5	Read 2.1 Write 5.1	1.2	IBM 1401, 1410, 7040, 7070, 7080, 7090, etc.
IBM Corp.	729 VI	Pinch rollers	1 two-gap	Vacuum columns	7	6	200, 556, or 800	0.75	0.50	2,400	90,000	90,000	90,000	112.5	Read 6.7 Write 5.0	Read 2.1 Write 5.8	0.9	IBM 1410, 7040, 7070, 7080, 7090, etc.
IBM Corp.	7330	Pinch rollers	1 two-gap	Vacuum columns	7	6	200 or 556	0.75	0.50	2,400	20,016	20,016	20,016	36	Read 7.6 Write 5.0	Read 12.9 Write 15.3	2.2 or 13.3	IBM 1401, 1410, 7040, 7044, 7072
IBM Corp.	7340 Hypertape	Single capstan	1 two-gap	Vacuum columns	10	8	1,511	0.45	1.00	1,800	170,000	170,000	340,000	112.5	3.0 max.	3.0 max.	1.5	IBM 7074, 7080, 7090, 7094
Midwestern Instruments	M 3000	Pinch rollers	V	Vacuum columns	V	V	V	V	0.50 or 1.0	2,400	V	V	V	60 to 150	6.0 max.	3.5 max.	1.5 max.	
Minneapolis-Honeywell Regulator Co.	404-3 & 804-3	Vacuum capstan	1 erase, 1 read/write	Vacuum columns	10	8	400	0.67	0.75	2,400	24,000	32,000	48,000	60	3.5	5.0	2.7	H-400, H-800
Minneapolis-Honeywell Regulator Co.	404-1 & 804-1	Vacuum capstan	1 erase, 1 read/write	Vacuum columns	10	8	400	0.67	0.75	2,400	48,000	64,000	96,000	120	2.7	3.5	1.3	H-400, H-800
Minneapolis-Honeywell Regulator Co.	804-2	Vacuum capstan	1 erase, 1 read/write	Vacuum columns	10	8	556	0.67	0.75	2,400	66,700	88,900	133,300	120	2.7	3.5	1.3	H-800, H-1800
Minneapolis-Honeywell Regulator Co.	804-4	Vacuum capstan	1 erase, 1 read/write	Vacuum columns	10	8	777	0.67	0.75	2,400	93,000	124,000	186,000	120	2.7	3.5	1.3	H-800, H-1800
Potter Instrument Co., Inc.	MT-36	Pinch rollers	V	Vacuum columns	V	V	NS	V	0.50, 0.75 or 1.0	3,600 max.	NS	86,000 max.	NS	36	3.0 max.	1.5 max.	3.0 max.	Recomp II
Potter Instrument Co., Inc.	MT-120	Pinch rollers	V	Tension arms & vacuum columns	V	V	NS	V	0.50 or 1.0	3,600 max.	NS	240,000 max.	NS	75 to 120	3.5 max.	1.5 max.	3.0 max.	
Potter Instrument Co., Inc.	906 II	Pinch rollers	1 two-gap	Tension arms & vacuum columns	Up to 20/inch	V	2,000 max.	0.3 min.	0.50 to 1.25	3,600 max.	NS	500,000 max.	NS	150 max.	3.0 max.	1.5 max.	2.6 max.	Bendix G-20
Radio Corp. of America	381	Pinch rollers	Single head	Tension arms	7	6	333	0.34 avg.	0.50	1,230	10,000	10,000	10,000	30	7.0	NS	3.0	RCA 301
Radio Corp. of America	581	Pinch rollers	Single head	Weight-sensing bins	16	12	333	0.46 avg.	0.75	2,400	33,333	33,333	33,333	100	3.5	NS	5.0	RCA 301, 501, 601
Radio Corp. of America	582	Pinch rollers	1 two-gap	Weight-sensing bins	16	12	667	0.66 avg.	0.75	2,400	66,667	66,667	66,667	100	3.5	2.0	3.2	RCA 301, 501, 601
Radio Corp. of America	681	Pinch rollers	1 two-gap	Weight-sensing bins	16	12	800	1.1 nom.	0.75	2,400	120,000	120,000	180,000	150	6.0	1.3	2.1	RCA 601
UNIVAC Division, Sperry Rand Corp.	Uniservo II	Clutched capstan	1 erase, 1 read/write	Vacuum columns	8	6	125 or 250	2.4 or 1.05	0.50	2,400	25,000	25,000	25,000	100	12.0 to 18.8	9.2 to 17.8		UNIVAC II, SS-80, SS-90
UNIVAC Division, Sperry Rand Corp.	Uniservo III A	Vacuum capstan	1 erase, 1 read/write	Vacuum columns	9	V	1,000	0.4 to 0.6	0.50	3,600	100,000	133,000	200,000	100	4.0 max.	4.0 max.	2.1	UNIVAC III, 490, 1107
UNIVAC Division, Sperry Rand Corp.	Uniservo II A	Clutched capstan	1 erase, 1 read/write	Vacuum columns	8	6	125 or 250	1.05	0.50	2,400	25,000	25,000	25,000	100	5.0	5.0		UNIVAC III, 490, 1107

V — Variable
NS — Not specified

SPECIAL REPORT

HIGH-SPEED PRINTERS
STATE OF THE ART REPORT

prepared by
the Technical Staff of
AUERBACH Corporation

AUEBACH/BNA SPECIAL REPORT
STATE OF THE ART OF HIGH-SPEED PRINTERS

§ 050.

.1 BACKGROUND

Since its inception over a decade ago, the computer industry has witnessed the development of faster and faster computers through a number of advances in the technology of electronic and electromechanical applications. The rapidly developing industry has also been continually faced with the problem of getting information into and out of the central processors at speeds compatible with the ever-increasing speeds of internal storage media.

In the early days of the industry, computers were utilized mostly in scientific and mathematical applications. For such applications, the single-action character printers were fast enough to cope with the limited amount of input-output data that they were required to print. These applications involved large amounts of computation with relatively limited amounts of input and output. With the advent of commercial or business applications for electronic computers, circumstances changed drastically. Large volumes of data were fed into the computer and a relatively small amount of computation was performed on each data record. In some cases the data output was voluminous, causing problems in producing usable output fast enough.

A temporary solution reached in the mid-1950's was to record data at high speeds on magnetic tapes and then, in separate "off-line" operations, transmit this data to various types of line printers, most of them impact or "line-at-a-time" types. The speeds of these printers ranged from 5 lines per minute up to 1,800 lines per minute.

.2 THE DEVELOPMENT OF HIGH-SPEED PRINTERS

The development of high-speed printers has followed two basic paths:

(a) Impact Printers - which print by means of some kind of mechanically driven typebar or type-generating device. The basic principle of operation, similar to that employed in the ordinary typewriter or adding machine, has many variations.

(b) Non-Impact Printers - which form an image on some medium, generally by electrical charges. The image is then developed, fixed, or rendered opaque by a suitable means. The medium can be some form of paper, a special transfer material (e.g., a Xerox drum or plate), or a cathode ray tube.

Almost all existing high-speed printers used in data processing installations today are impact printers, and this report is concerned only with this type. The accompanying chart summarizes the operating features of the major impact printers used with today's electronic data processing systems.

Most of the printers operate in the range of 600 to 1,000 lines per minute, but the operating range extends from 150 to 1,200 lines per minute. It is significant that the Burroughs High-Speed Printer System, which operated at 1,500 lines per minute and had more flexibility in format control and record selection than most printers available today, is no longer available as a standard product item from the Burroughs Corporation.

The entire concept concerning the use of high-speed printers in commercial data processing installations has changed in emphasis from using printers for off-line applications to employing small computing systems as controllers for high-speed

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on-line printers. With the increased use of on-line printing, the throughput of the entire computer system becomes limited by its slowest component, whether that component be the magnetic tape unit, the card reader, the central processor, or the line printer. In most cases, the card reading and magnetic tape data transfer rates are sufficiently fast to make the line printers the slowest factor. It can be readily seen from the system performance graphs throughout Standard EDP Reports that in the smaller system configurations the printer speed is the limiting factor in those systems which use on-line printers. Where paired configurations are shown, the input-output data transfer rates for the detail and report files are much faster. Where the printing is done off-line, the tape unit or central processor time is more likely to be the limiting factor.

.3 METHOD OF PRINTING

With the exception of the IBM 370 and the Soroban MT series "stick" printers, line printers are characterized by the printing of an entire line essentially with one stroke. The need for a moving carriage is therefore obviated, and much greater speeds are achieved than are possible with single-character printers. Line printers utilize continuous pin feed forms. All incorporate some form of high-speed skipping function in which multiple lines can be skipped at several times the normal printing speed.

.31 Stick Printers (See Soroban, IBM 370.)

Intermediate-speed printing for computers is offered by the single-element stick printer. The printing element is normally an eight-sided metal element embossed with eight characters on each face to provide sixty-four print characters. The character to be printed is selected by the decoding logic which actuates a rotation and/or an in-out movement of the stick. At the time of the "dwell" (no movement) of the stick, a single hammer is struck against the paper from the rear. The paper is usually moved into contact with an inked ribbon against the printing stick to produce the printed character.

Horizontal positioning and carriage return result from the motion of the entire printing assembly across the platen in a manner somewhat similar to the action of typewriters.

The general characteristics of stick printers are:

- Relatively low speed (30 to 60 lines per minute).
- Ribbon motion across the paper, as in a conventional typewriter.

.32 Hammer-Actuated Type Bar or Wheel Printers (See IBM 407)

Many line printers, especially the earlier and slower ones, employ a series of type bars or wheels. Each printing position has a separate bar or wheel containing all characters of the print set. All positions are printed simultaneously, after the entire line has been decoded and each bar or wheel has been independently positioned. The actual printing occurs when hammers, driven by electronic triggers, strike the paper into contact with an inked ribbon against the type face.

The general characteristics of wheel or bar type printers are:

- Relatively low speed (50 to 150 lines per minute).
- Ribbon motion across the paper, as in a conventional typewriter.

.33 Matrix Printers (See IBM 720, 730)

Since the physical positioning and recoil movement of individual hammers against the embossed characters is the primary limiting factor in the design of faster printers,

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a number of high-speed printers have been designed which employ matrix-type print heads. Each head consists of a small rectangle of fine wires. Characters are formed by electromechanically actuating selected individual wires in each print head and, with these wires, striking the ribbon against the paper. Matrix printers can employ either a stationary head assembly or a moving head assembly. The stationary assembly has one head for each printing position, while the moving assembly has one-half or one-fourth as many individual heads spaced farther apart. Each head of the moving assembly prints in two or four positions in turn after the entire head assembly has been shifted laterally a slight distance.

In general, experience with matrix printers has been characterized by frequent and troublesome mechanical maintenance and service problems. Currently, no high-speed impact type matrix printers are produced in the United States. It may reasonably be stated that the mechanical matrix printer has been displaced by other types.

The general characteristics of matrix printers are:

- High speed (500 to 1,000 lines per minute).
- A hidden flat metal platen.
- Ribbon motion across the paper, as in a conventional typewriter.
- A relatively poor printed image.

.34 "On-the-Fly" Printers (See UNIVAC, Anelex, Shepard.)

High print speeds are achieved in "on-the-fly" printers by extremely rapid hammer action against continuously moving type elements. Although such machines can be either solid-drum, multiple-wheel, or chain types, their printing methods are similar. The majority of printing units included in the chart fall into this category.

During each print cycle (normally the time allocated to load the print buffer; decode its contents; print one line, including hammer action and recoil; and space the paper), all characters rotate past the print hammers at each printing position. The character to be printed is selected by decoding, and a fast-action hammer, controlled by an actuator, presses the paper against the type slug at the exact moment the required character is in position. If the machine is printing at 600 lines per minute, each total printing cycle is one six-hundredth of a minute. This interval is in turn divided into discrete timing units for each character which is available, plus several units for paper advance. In some drum printers, if all hammers are fired at, say, time "3", a "C" might be printed in every position across the page.

In the asynchronous mode of printing, such as is used in the Anelex 4-1000 printers, the firing of the hammers does not commence at any fixed point during the rotation of the drum. Rather, firing commences whenever a signal is received to indicate that line spacing has been completed and the print buffer loading is finished. Firing terminates when a counter indicates that all characters have rotated past the hammers or when the buffer holding the line of characters to be printed has been sensed and found empty. Skipping is controlled by a special control tape or by the central processor.

In the chain printers (only the IBM 1403 printers), hammers are individually timed, because each character travels horizontally across many printing positions during the print cycle. Five identical sets of 48 characters are assembled serially on a horizontally moving chain which resembles a bicycle chain. At each print position, the paper is forced into contact with the ribbon against the chain by a solenoid-activated hammer fired as the appropriate character on the chain passes the printing position. In the 1403 Model 3, the chain has been replaced by a train mechanism in which type slugs move in the same horizontal plane as in the chain at more than twice the speed. If all hammers were fired simultaneously, several sets of sequential characters rather than a line of identical characters would be printed.

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Printers designed for only numeric printing are equipped with drums or chains on which numeric type faces are repeated several times, often with blank print segments between the groups for spacing. Such an arrangement (generally with two sets of print characters) permits two lines to be printed for each drum revolution. Thus, at 1,000 revolutions per minute, 2,000 lines of numeric print per minute are produced.

Hammer action in "on-the-fly" printers is either by: (1) free flight, or "ballistic," hammers (movement stopped by contact with the paper and the drum), or (2) "controlled flight" hammers (fixed spatial movement). The most important advantage claimed for the latter design principle is positive control over the depth of penetration of hammer action. When such a printer is operated without paper in the tractor feed, the hammers are prevented from striking the print drum by "end of paper" safety switches.

Vertical format control is generally effected by an 8- or 12-channel paper tape loop. The vertical spacing of the punches controls the actual spacing on the printed sheet. In some printers it is necessary to use a loop the exact vertical size of the printed page; in others it is possible to use loops representing only the vertical area to be imprinted.

The general characteristics of "on-the-fly" printers are:

- High speeds (600 to 1,200 lines per minute).
- The absence of a platen.
- Ribbon movement parallel with paper motion; ribbon width at least equal to maximum line length.
- Hammers which strike the paper from behind.
- Printing often recognizable by a light box framing the characters (chain printers) or lack of horizontal alignment (drum printers).

.4 FUTURE OUTLOOK

While certain new models and variations of present models of impact printers will appear, it does not seem likely that any dramatic change in the performance of mechanical printers can be expected. Perhaps, a two-fold increase in speed can reasonably be expected, but speed increase of a greater order of magnitude appears very unlikely. The problems which tend to limit the speed of mechanical printers are associated with paper handling and movement in the printing plane, as well as the problems caused by stresses on the paper itself (particularly multi-part forms) when it is being moved and imprinted upon at high speeds.

It can be safely assumed that new mechanical printers appearing on the market will have either cost or performance advantages, or both, over those presently available. Continuation of the general trend to increased accuracy of registration can be expected and, hopefully, the cost of the printing mechanisms and associated paper-handling mechanisms will be reduced. With the present price range of high speed printers ($30,000 to more than $70,000) * moving down during the last 3 years, continual reduction in price can be expected, if for no other reason, from improvement in production methods. Nevertheless, this downward price trend will not be a marked one.

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* Exclusive of associated buffer storage and controllers. Prices are not shown on the comparison chart because of the near-impossibility of obtaining prices that are truly comparable with respect to the amount of control circuitry included.

§ 050.

a number of high-speed printers have been designed which employ matrix-type print heads. Each head consists of a small rectangle of fine wires. Characters are formed by electromechanically actuating selected individual wires in each print head and, with these wires, striking the ribbon against the paper. Matrix printers can employ either a stationary head assembly or a moving head assembly. The stationary assembly has one head for each printing position, while the moving assembly has one-half or one-fourth as many individual heads spaced farther apart. Each head of the moving assembly prints in two or four positions in turn after the entire head assembly has been shifted laterally a slight distance.

In general, experience with matrix printers has been characterized by frequent and troublesome mechanical maintenance and service problems. Currently, no high-speed impact type matrix printers are produced in the United States. It may reasonably be stated that the mechanical matrix printer has been displaced by other types.

The general characteristics of matrix printers are:

- High speed (500 to 1,000 lines per minute).
- A hidden flat metal platen.
- Ribbon motion across the paper, as in a conventional typewriter.
- A relatively poor printed image.

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§ 050.

Any significant increases in over-all printer unit output will probably have to come through a shift in emphasis from mechanical printers to non-impact printers. Within the last 5 years, non-impact printers have been developed which are designed to produce copy at rates of 5,000 lines per minute or faster, using various electrical and chemical processes to imprint the paper copy. One limitation on the development and eventual use of the non-impact printers has been the problem of developing a convenient process to produce simultaneous multiple copies and copy of sufficiently high print quality to serve as routine business documents, such as bills, checks, and receipts.

At present, these devices are significantly more costly and do not generally produce printed documents of the highest quality. Use of improved treated papers and new chemical and physical processes should enhance development in this area. However, as far as general commercial computer installations are concerned, the penetration of non-impact printers upon the market should not be expected for at least two to three years. During this period, the relatively special uses of these printers will probably prove economical, and these developments will promote the general acceptance of non-impact printers.

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APPENDIX

Data Processing Terms Commonly Used in Connection with Line Printers

Carriage

That portion of a printing device which serves to hold and transport the paper being printed.

Control Character

A coded character which is part of a computer program or some common language medium. Instead of being printed, a control character initiates some kind of mechanical activity on the part of the device being used for printing.

Counter

A mechanical or electromagnetic device capable of numeric accumulation; an accumulator. Within a computer program, a storage location used to total numeric information.

Drum

With reference to printing, the imprinting device in an on-the-fly printer consisting of a constantly revolving shaft, drum, or series of interlocked wheels, embossed with the characters which are to be imprinted.

Edit

To rearrange information. Editing may involve the deletion of unwanted data; the selection of pertinent data; the insertion of various symbols, such as page number and typewriter characters; and the application of standard processes such as zero suppression.

Font

A particular style and size of the type faces for a set of characters.

Frame

Total area of a single print position.

Hard Copy

A visible record on a permanent medium readable by the human eye.

Pitch

The horizontal spacing of type characters; e.g., 12-pitch (12 characters per inch) is "elite" pitch, 10-pitch is "pica" pitch, and 8-pitch is "billing" pitch.

Platen

An element of the carriage in a typing or printing device which is usually (but not necessarily) a hard rubber cylinder. The function of the platen is to support the paper as it is struck by the type face, and to guide the paper as it is spaced.

Plugboard

A wired control panel.

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Position

With reference to a printing or typing device, one position is equivalent to a potentially printable or printed character for that space. The number of "positions" available determines the maximum length of the printed line.

Registration

The physical positioning of a print line or character (vertical or horizontal registration) with relation to a form set or the machine itself.

Tractor

A device used on printers which controls the vertical movement of paper through the carriage, normally by means of pinion wheels which engage pinfeed or punched-hole margins.

Skip

Accelerated vertical motion of a form through a printing device.

Solenoid

An electro-mechanical actuator, used to convert electrical energy into physical movement.

VFU

Vertical Format Unit - A device used to control the skipping of a high-speed printer.

Vernier

A printer control, normally rotational in nature, used for fine vertical or horizontal carriage adjustments to align the form being printed while the printer is operating.

COMPARISON CHART: HIGH SPEED PRINTERS

IDENTITY		PHYSICAL FORM							PRINTING CHARACTERISTICS				PERFORMANCE CHARACTERISTICS				APPLICATION
Manufacturer	Model	Paper Feed Mechanism	Recording System	Plug-board	Vertical Spacing Control Tape	Printable Characters	Prints Serially by:	Print Positions	Hori-zontal Spacing (char/inch)	Vertical Spacing (lines/inch)	Form Width (inches) Maxi-mum	Form Width (inches) Mini-mum	Maxi-mum Copies	Speed (alphameric lines/minute) Peak	Speed (alphameric lines/minute) 1-inch Spacing	Skipping Speed (inches/sec)	Representative Computer Systems Using This Unit
Anelex Corp.	300	Sprocket	Drum	No	8 Channels	48	Line	120 to 160	10	6/8	19	3	6	300	257	25	
Anelex Corp.	580	Sprocket	Drum	No		48 to 64	Line	80	10	6	9.50	9.50	6	1,000	643	25	
Anelex Corp.	4-1000	Sprocket	Drum	No	8 Channels	48 to 64	Line	120 to 160	10	6	19	4	6	667 or 1,000	643 or 487	25	Bendix G-20; GE 225; Philco 1000, 2000, 4000; RCA 301
Burroughs Corp.	B-231	Sprocket	Drum	No	12 Channels	64	Line	120	10	6/8	20	5	6	700	518	25	Burroughs B 200 Series, B 5000
Data Products Corp.	P-3300	Sprocket	Drum	No	No	64	Line	132	10	6	19		6	300	244	18	
Data Systems Devices of Boston, Inc.	1-132	Sprocket	Drum	No		64	Line	132	10	6	22	3		1,200	720	25/50	
Holley Computer Products Co.	H-207	Sprocket	Drum	No	8 Channels	10 to 64	Line	120	10	6/8	22		6	150 or 300 (600 or 1,010*)	133 or 238	16	CDC 160, 160-A, 924-A
IBM Corp.	370	Sprocket	Octagonal print stick	Yes	7 or 12 Channels	47	Character	80	10	6	16.75		7	29		25	IBM 305
IBM Corp.	407**	Sprocket	120 Wheels	Yes	12 Channels	47	Line	120	10	4/6 or 6/8	16.75	4.75	6	150	150	6 to 7	Burroughs B 205
IBM Corp.	720	Sprocket	Matrix printer	No	12 Channels	49	Line	120	10	6/8	20.38	4		500	400	30/70	IBM 705, 7080
IBM Corp.	730	Sprocket	Matrix printer	No	12 Channels	49	Line	120	10	6/8	20.38	4		1,000	667	30/70	IBM 705, 7080
IBM Corp.	1403 Model 1, 2	Sprocket	Horizontal chain	No	12 Channels	48	Line	100 or 132	10	6/8	18.75	3.50	6	600 (1,285*)	480	33/75	IBM 1401, 1410, 1460, 7010, 7040, 7044
IBM Corp.	1403 Model 3	Sprocket	Horizontal "train"	No	12 Channels	48	Line	132	10	6/8	18.75	3.50	6	1,100	750	33/75	IBM 1410, 1460, 7010, 7040, 7044
IBM Corp.	1443	Sprocket	Horizontal bar	No	12 Channels	52 (13, 39, or 63 optional)	Line	120	10	6/8	16.75	4		150 or 240 (430 or 600*)	132 or 196	15	IBM 1440
Minneapolis-Honeywell Regulator Co.	422-3, 822-3	Sprocket	Drum	Yes	2 Channels	56	Line	120	10	6/8	22	3.50	10	900	560	20	H-400, H-800
Minneapolis-Honeywell Regulator Co.	422-4, 822-4	Sprocket	Drum	Yes	2 Channels	56	Line	160	10	6/8	22	3.50	10	900	560	20	H-400, H-800
Potter Instrument Co., Inc.	LP 600	Sprocket	Drum	No	8 Channels	64	Line	80 to 160	10	6	17.78	4.19	5	600 (1,200*)	450	25	
Potter Instrument Co., Inc.	LP 1200	Sprocket	Drum	No	8 Channels	64	Line	160 max.	10	6	17.78	4.19	5	1,000 (1,200*)	570	18.5	Bendix G-20
Shepard Laboratories Inc.	190	Sprocket	Drum	Yes	6 Channels	64	Line	120	10	6	22	3	6	680 (900*)	407	14	NCR 315, 304; RCA 501
Soroban Engineering, Inc.	MT-1	Sprocket or friction	Octagonal print stick	No	No	56	Character	97	10	6	11		7	57 (100 char/sec)		4	
Soroban Engineering, Inc.	MT-50	Sprocket or friction	Print stick	No	No	Up to 128	Character	97	10	6	11		5	24 (40 char/sec)		?	
UNIVAC Division, Sperry Rand Corp.	4152	Sprocket	Drum	No	No	51	Line	128	10	6/8	22	4	5	700 (922*)	475	22	UNIVAC III
UNIVAC Division, Sperry Sperry Rand Corp.	7912	Sprocket	Drum	No	No	51	Line	100 to 130	10	6/8	21	4	5	600	430	20	UNIVAC SS-80, SS-90, 1107, 490

* Peak speed for all-numeric data (may require special character set).

** IBM printer models 716, 717 and 7400 are variations of this model which are no longer in production. They were used as on-line printers for the 709, 705 and 7070 series computer systems.

SPECIAL REPORT

RANDOM ACCESS STORAGE:
A STATE-OF-THE-ART REPORT

Prepared by

The Technical Staff of
AUERBACH Corporation

AUERBACH SPECIAL REPORT
RANDOM ACCESS STORAGE: A STATE-OF-THE-ART REPORT

.1 INTRODUCTION

The increasingly widespread use of automated techniques to improve order processing, inventory and production control, and various types of management information systems has sparked a strong interest in the capabilities and application of random access storage devices. These systems generally must employ equipment of the "on-line" type, in which the storage files are electrically connected to the main frame of the computer so that data storage and retrieval can be both immediate and automatic. The on-line file concept calls for some kind of random access storage medium, which, as the name implies, permits data to be retrieved from it on a random basis.

Mass random access storage devices are also desirable for the utilization of modern multiprogrammed computer systems (in which utilization of the equipment is maximized by processing several independent programs concurrently) and high-performance software systems (compilers, operating systems, sorting routines, etc.). The importance of this type of equipment in the current computer market is illustrated by the fact that IBM's new System/360 line includes six different types of random access storage devices (described in report sections 420:042 through 420:047) with a wide range of data capacities, access times, and data transfer rates.

The functional meaning of the term "random access" is best understood by comparing random access storage with magnetic tape storage. Data is stored on magnetic tape in serial form, and the time required to retrieve a certain piece of data is dependent upon its location on the tape. Retrieval time, therefore, can vary widely according to the location of the data within the storage medium. In contrast, the time to retrieve data from random access storage is not related to its location in the medium. The retrieval time for any one given item of data is, in the ideal case, the same as for any other item of data.

This idealized definition of random access storage does not strictly apply to most of the existing mass random access storage devices. In these devices the access times to retrieve two different items of data may differ slightly according to the locations of the data. Time is required to move the section of the storage medium containing the desired data into position under the read/write head. This is called "latency" or "rotational delay." Latency is directly dependent upon the relationship between the locations of the desired data and the data currently under the read/write head; to bring the new data into position under the read-write head may require a quarter, half, or full turn of the storage medium.

An additional period of time, called "head positioning time," may be required to position the read/write head over the proper track of the storage medium. In any case, the variance in access times is measured in milliseconds, an insignificant amount as compared to the minutes required to run through several thousand feet of magnetic tape.

One storage medium that does meet the strict definition of random access is the computer's internal core memory. All data contained in it literally can be accessed in equal time, regardless of its physical location. Although functionally ideal, core memory is economically impractical for most mass-storage purposes because of the high cost per character stored.

A highly significant recent development in this area is IBM's Model 2361 Core Storage (see Section 420:042), which makes up to 8.4 million characters of 8-microsecond random access storage available to the larger central processor models in the System/360 line. Its cost, however, is still too high to justify its use for master-file storage in most applications. Current development work in this area indicates that within a few years it probably will be possible to store hundreds of millions of characters in this kind of medium and access them within a few microseconds — and at a reasonable cost.

.2 HARDWARE TYPES

The most commonly used mass random access storage devices at the present time are magnetic drums, magnetic disc files, and cartridge-loaded units. These three basic types of devices differ functionally in a number of ways that can be important from an applications viewpoint.

.21 Drums

Magnetic drum devices consist of a revolving drum with a magnetizable surface on which information is arranged in tracks. Read/write heads pick up and record data as the desired items pass beneath them. This means that there may be a rotational delay of up to one drum revolution when accessing a given record. In practice, the delay averages out to one-half a revolution. Most magnetic drum devices employ an individual, fixed read/write head for each track, so that this rotational delay is the only time factor that must be considered in the accessing operation.

High data transfer rates are frequently achieved by recording data simultaneously (in parallel) in two or more adjacent tracks. IBM's new 2301 Drum Storage unit reads and records four bits in parallel and transfers 1,200,000 characters per second. Control Data's 861 and 862 Drum Storage units read and record 13 bits (2 characters plus a parity bit) in parallel and can transfer up to 2,000,000 characters per second.

When compared to the other types of random access storage devices, drums have relatively fast access times and transfer rates, relatively low storage capacities, and a relatively high cost per character stored. The type of drum memory with a fixed read/write head serving each data track is particularly well suited to the storage of systems programs, address directories for larger-capacity random access units, and for on-line applications where short response time is more important than large storage capacity.

Though most magnetic drum units use multiple fixed read/write heads, there are some exceptions. Two units available for use with UNIVAC systems use movable access mechanisms to decrease the number of read/write heads necessary to serve large data stores. In both these units access time is significantly increased by the need to move the heads from one data track to another. The Randex drum unit used in the UNIVAC Solid State 80/90 systems offers a choice of one or two drums in a single cabinet and has a single access mechanism with one read/write head per drum. The average time required to position the read/write head over the selected data track is 333 milliseconds. The newer Fastrand unit, used with the UNIVAC III, 490, 1050, and 1107 computer systems, also offers two drums in one cabinet and has a single access mechanism. It differs from the Randex unit, however, by using 32 read/write heads per drum. Each head serves 96 data tracks in a Fastrand I unit and 192 data tracks in a Fastrand II unit. All 64 heads are moved horizontally as a single unit, and the average head-positioning time is only 57 milliseconds. The multiple-head arrangement makes it possible to access up to 688,128 characters at any given position of the access mechanism.

.22 Disc Files

Magnetic disc devices are a variation on the drum concept. They consist of multiple discs mounted on a single shaft to provide larger and considerably less expensive storage capacity than fixed-head drums. Data is recorded on concentric circular tracks, usually on both faces of the discs.

In the first generation of disc file equipment, exemplified by the IBM 1405 Disc Storage Unit and the IBM 305 RAMAC, a single access arm serves all the discs. In these units, the arm moves vertically to the selected disc, then horizontally across the disc to the appropriate data track. This extensive mechanical movement of the head, plus the time it takes for the desired record to rotate past the head, makes these initial disc file units significantly slower than drum devices. The average access time of these early units is more than one-half second.

Access time has been improved in later equipment models. Most of the second-generation disc file units, as exemplified by the Bryant 4000 (used in Honeywell and other computers) and the IBM 1301, have a separate access arm for each disc. The multiple access arms form a comb that moves as a single unit. The elimination of the need for vertical positioning reduces the average head-positioning time by a factor of 4 to 6 as compared with the early IBM 1405 unit. In the Bryant 4000 disc files, each access arm has six read/write heads, each of which services 128 data tracks. The IBM 1301 uses a single read/write head on each access arm to service all 250 data tracks on each disc.

A later IBM unit, the 1302, uses the same principle as the 1301 but offers more characters per track and more tracks per disc through an increase in the recording density. This approximately quadruples the capacity, doubles the peak data transfer rate, and significantly lowers the cost per character stored.

Anelex Corporation produces two disc file units. Both models use comb-type access mechanisms. Model 800 consists of one to eight discs, with a total storage capacity of up to 23 million characters. Each of its access arms has eight read/write heads (four per disc face), and the average time for head positioning is 100 milliseconds. Model 4800 is a similar unit, but with larger storage capacity and faster head-positioning time. It consists of from 8 to 24 discs, capable of storing up to 95 million characters, and has an average head-positioning time of 50 to 65 milliseconds.

(Contd.)

.22 Disc Files (Contd.)

A subtle but significant variation on the comb-type access mechanism is provided in the disc storage units manufactured by Data Products Corp. and General Electric. These units feature a separate, individually-positioned access arm for each disc. Each arm has eight read/write heads (four per disc face). This arrangement is more flexible than the comb-type access mechanism, but it has the drawback that only one or two of the 16 or more access arms can be positioned at a time. (A new, larger GE disc storage unit will permit any or all of its access arms to be positioned at the same time.)

Burroughs, in its On-Line Disc System, uses another variation of the comb-type access mechanism. All movement of the read/write heads is eliminated by providing an individual head for each data track. Consequently, the total access time is limited, as in fixed-head drum devices, to the rotational-delay time, which ranges from 0 to 40 milliseconds. This is less than one-fifth of the time required by most of the disc files, in which a comb of access arms has to be moved horizontally across the disc surfaces. Despite the large number of read/write heads used in the Burroughs unit, the cost per character of storage is still competitive.

Disc-file development has been hampered by two major mechanical problems: positioning movable read/write heads with the desired speed and precision, and preventing physical contact between the heads and the disc surfaces. A number of complex electro-mechanical techniques have been developed to position the heads quickly and accurately, but their uncertain reliability is still causing headaches for both manufacturers and users.

The read/write heads must be kept within a few ten-thousandths of an inch of the magnetic recording surface in order to achieve the high recording densities required for high data transfer rates and large storage capacities. To avoid damaging physical contact between the heads and the rapidly revolving disc surface, many units use the principle of "floating" the read/write heads on a layer of air generated by the rotational friction of the discs. Some units also employ solenoids as a fail-safe device that retracts the heads in case of power failure. Although these solutions are obviously workable, they are mechanically complex and expensive.

.23 Cartridge-Loaded Units

The third basic type of random access storage device is the cartridge-loaded units, which utilize a variety of different types of magnetic media. NCR's CRAM, RCA's Model 3488, and IBM's 2321 Data Cell Drive all use magnetic cards, which are extracted from a replaceable cartridge and wrapped around a revolving drum that carries them past the read/write heads. The IBM 1311 and 2311 Disk Storage Drives and the Anelex Model 80 all use interchangeable stacks of discs. Potter's new RAM unit uses continuous loops of magnetic tape. Each of these units represents an attempt to combine the rapid-access capabilities of random access devices with the practically unlimited total storage capacity (on-line plus off-line) of magnetic tape. From an applications point of view, the total storage capacity and flexibility of operation gained by having interchangeable cartridge units must be measured against the relatively long delays that occur whenever cartridges must be manually interchanged to make new information available on-line.

The trail-blazing NCR CRAM (Card Random Access Memory) unit uses flexible magnetic cards. A cartridge contains 128 or 256 cards. For a read/write operation, the selected card is dropped from the cartridge and held by vacuum against the revolving drum, which carries it under the read/write heads. A fixed read/write head serves each track. After the card has been read and/or recorded upon, it is stripped from the drum, and its momentum carries it up through a return chute and back into the cartridge. There is no need for the cards to be replaced in any particular sequence; the eight selector rods can cause the selected card to drop, regardless of its position in the cartridge, through the use of eight binary-coded notches in the top of each card.

In the NCR Model 353-1 CRAM, each cartridge can store over 5.5 million alphanumeric characters. Each card in the cartridge has seven 3100-character data tracks, all of which can be read or recorded upon when the card is wrapped around the revolving drum. The recording mode is similar to that of many magnetic tape systems; there are 8 bit channels per track, and a "read-after-write" check is performed upon recording.

The newer Model 353-2 and 353-3 CRAM units use bit-serial recording, one bit channel per 1120-character data track. This change in the recording mode reduces the equipment cost and increases cartridge capacity to 8 million characters in Model 353-2 and 16 million characters in Model 353-3, but it also results in a lower data transfer rate than that of the Model 353-1.

RCA's Model 3488 Random Access Computer Equipment uses the same basic principles as CRAM, but each Model 3488 unit can hold 8 or 16 interchangeable card magazines at a

23 Cartridge-Loaded Units (Contd.)

time. Each magazine holds 256 cards and up to 42 million characters of data. Each card contains 64 bands of two tracks each, and each band holds four 650-character blocks of data. Four pairs of read/write heads are moved, in unison, to one of 16 possible positions so that they can serve all of the 64 bands. Access time to data on a particular card is normally between 290 and 465 milliseconds, depending upon the position of the addressed magazine. Model 3488 storage is clearly intended for applications where a large volume of relatively inexpensive random-access storage is needed, rather than where fast access is important. The Model 70/568 Mass Storage Unit in RCA's new Spectra 70 line is physically similar to Model 3488, but each band holds one 1900-byte record and each magazine holds 31 million eight-bit bytes in the 70/568 unit.

IBM's new 2321 Data Cell Drive, like RCA's Model 3488, provides economical storage for extremely large volumes of data in applications where relatively slow access times can be tolerated. Each 2321 drive stores up to 400 million characters (or 800 million packed decimal digits) in 10 removable, interchangeable "data cells" with a capacity of 40 million characters each.

Data in the 2321 is recorded on magnetic strips, 13 inches long and 2.25 inches wide, which are arranged in data cells mounted vertically around the circumference of a cylinder or "tub file" that can be rotated. Each of the 10 data cells is divided into 20 subcells, and each subcell contains 10 magnetic strips. There are 100 recording tracks on each strip, and each track can hold a maximum of 2,000 characters. A bidirectional rotary positioning system positions the selected subcell beneath an access station. The selected strip is withdrawn from the cell, placed on a separate rotating drum, and moved past the read/write heads, where reading and/or recording take place. Then the strip is returned to its original location in the cell. When a previously-addressed strip is on the drum, time to access data on a different strip varies from 375 to 600 milliseconds.

The IBM 1311 and 2311 Disc Storage Drives are patterned after the larger IBM 1301 and 1302 Disc Storage Units. They use the comb-type access mechanism with interchangeable "Disc Pack" cartridges consisting of a stack of 6 discs. A cartridge has a total storage capacity of 2,980,000 characters in the 1311 and 7,250,000 characters in the 2311, and it can be replaced in one minute. Compared with the IBM 1301, the 1311 and 2311 cartridge units have much lower on-line storage capacities, which may be offset by the advantages of cartridge loading and the lower price tags.

Anelex offers a functionally similar unit, the Model 80, which utilizes interchangeable cartridges called "Disc Kits." Each kit contains six discs and can store up to 3,900,000 characters. A constant head-positioning time of 75 milliseconds is achieved as a result of the superimposed operations of seven binary-clutch motions. The comb-type access mechanism contains two heads per disc surface. Provision is made for mechanically coding the Disc Kits to provide for read-only operations by sector for data protection.

Potter's RAM unit, a new addition to the cartridge-loaded class of equipment, offers a number of interesting features. Data is recorded on 30-inch-long loops of standard computer-grade magnetic tape held in interchangeable cartridges. Each tape loop is 2 inches wide and contains 112 recording tracks. Bit-serial recording is used, at a density of 1000 bits per inch. A single cartridge contains 16 tape loops and can store up to 7.2 million characters. Vacuum capstans and "air bearings" are used to reduce wear and contamination of the tape. Any tape loop not engaged in a data transfer process remains stationary and is drawn away from both the drive capstan and the read/write heads.

Seven reading heads and seven writing heads serve each of the 16 RAM tape loops. All of the heads move in unison to any one of 16 discrete positions. Average head positioning time is 62.5 milliseconds, and average rotational delay is 25 milliseconds. Data transfer rate is 86,000 characters per second.

.3 THE COMPARISON CHART

The accompanying comparison chart (page 23:060.800) summarizes the significant characteristics of a number of representative random access storage devices. The entries have been selected to pinpoint specific advantages or disadvantages of each device from a user's point of view. An explanation of the meaning and significance of each comparison chart entry follows.

- Category — The storage devices included in this chart can be grouped into three major categories: Magnetic Drums, Magnetic Disc Files, and Cartridge-Loaded Units (in which the storage medium is conveniently replaceable).

(Contd.)

.3 THE COMPARISON CHART (Contd.)

- Device — Identifies each device by manufacturer, model number, and the name by which it is commonly known.

- Representative Computer System — It is difficult (if not meaningless) to evaluate a random access storage device independently of the computer system to which it is connected. A single, representative computer system has been selected to serve as a basis for all the comparison-chart entries for each storage device. The capacity and performance characteristics of some storage devices can be significantly different when they are associated with other computer systems.

- Report Reference — Indicates the section of AUERBACH Standard EDP Reports where you will find a more detailed description of each random access storage device (or a closely related unit).

- Storage Medium — The physical medium upon which data is recorded.

- Storage Capacity — The five entries in this general category define data storage capacity in terms of:

  (1) The number of data discs or drums per physical unit of random access storage (often a variable quantity, in which case the range is indicated).

  (2) The number of tracks on each disc surface or drum upon which data can be recorded. Where a logical track (or "band") is composed of two or more parallel bit channels, which are always read and recorded at the same time, the fact is noted under "Features and Comments."

  (3) The maximum number of alphanumeric characters that can be recorded on a single track.

  (4) The maximum number of characters that can be read or recorded without any repositioning of the read/write heads.

  (5) The maximum number of alphanumeric characters (usually 6 data bits per character) that can be stored in each physical random-access storage unit. The characters are assumed to be in the code and format most commonly used to represent alphanumeric information in the particular system. It should be noted that in many random access devices, the number of decimal digits of all-numeric information that can be stored is substantially higher than the number of alphanumeric characters. Capacity and performance of the IBM System/360 random access units are indicated in terms of 8-bit bytes; each byte can hold one alphanumeric character or two decimal digits.

- Head Positioning Time — For storage devices with movable read/write heads, the time required to reposition these heads is reported in terms of:

  (1) The minimum time required to move the heads to the next adjacent track position.

  (2) The average time required to position the heads to read a randomly-placed record.

  (3) The maximum (worst-case) positioning time.

  For the cartridge units that use magnetic cards, what the indicated "head positioning times" actually represent are the times required to withdraw a card from the cartridge and position it on the read/write drum.

.3 THE COMPARISON CHART (Contd.)

- Average Rotational Delay — The average time (in milliseconds) required for the first character of the selected data record to reach the read/write heads after the heads have been properly positioned (usually one-half a revolution in the case of magnetic disc and drum storage devices). The total average "access time" for a randomly-placed record is, of course, the sum of "Average Head Positioning Time" and "Average Rotational Delay."

- Peak Data Transfer Rate — The maximum rate at which data is read from or recorded upon the random access storage medium after the desired record has been located, expressed in characters per second. When large blocks of data must be read from or recorded in consecutive storage locations, the overall effective data transfer rate, in some cases, will be significantly lower than the peak rate, due to rotational delays between records and/or the need for repositioning.

- Transfer Load Size — The number of alphanumeric characters that can be transferred to or from the random access storage device in a single read/write operation. The load size is fixed in some cases and variable in others. Where the minimum increment for a variable-length load is greater than one word, the increment is stated; e.g., "100 to 20,000 by 100."

- Read/Write Checking — The type of checking performed upon the accuracy of data recording and/or reading. The most commonly-employed method is to generate and record a parity bit for each character, word, or record, and to check the recorded data for correct parity when it is reread. "Check characters" usually implies a similar but somewhat more powerful system for detecting errors (and, in some cases, correcting them). "Read after write" parity checking or separate (and time-consuming) "write check" operations permit detection of most recording errors at the time of occurrence — a highly desirable feature.

- Representative Cost — To complete the picture, a purchase cost figure, expressed in dollars per character, is listed for each type of random access storage. This cost is based upon the price of a single physical storage unit of the largest available capacity, together with any control units that are required to connect it to the specific computer system shown in the chart. (The costs of general-purpose computer data channels and multiplexors are not included.) It is important to note that the cost per character for a particular type of random access storage may vary significantly when it is associated with a different computer system, or when more or less storage capacity is required.

.4 THE ECONOMICS

The economics of using random access devices involves considerably more than simply comparing their cost with that of magnetic tape transports. To achieve any sort of valid economic measurement, you must make a comparison between the two fundamentally different methods of processing: on-line and batch. On-line processing implies that all transactions are processed in essentially the order in which they are presented to the data processing system, so random access to the stored files is a prerequisite. In the more conventional batch-processing approach, the transaction data must be arranged in the same sequence as the master file before processing. The major economic differences between the two methods can be determined by comparing their access times, storage costs, and overall throughput costs.

.41 Access Times

A comparison between the access times of on-line and batch processing really necessitates a comparison between the access time of the random access device and the times for the transaction-file sorting required for batch processing. Once the transaction record is matched or merged with the master-file record in batch processing, the remaining processing time required will be about the same as that required for the on-line processing

(Contd.)

.41 Access Time (Contd.)

operation. In making such a comparison, keep in mind that in a well-designed on-line system, most of the access time can probably be overlapped with computer processing; only the non-overlapped access time needs to be measured against the sorting time for the batch processing case.

These timing factors will vary with the file size, record size, computer system configuration, and type of random access device used. Each case will therefore need to be considered separately, and no generalized conclusion can be drawn.

.42 Storage Costs

Here we must consider the cost of: (1) the storage units themselves, (2) all control units necessary to connect the storage units to the central processor, and (3) the storage media (cartridges, tape reels, etc.) required to hold all of the necessary information, both on-line and off-line. Using currently-available equipment, disc files (and large-capacity drum files) tend to compare favorably in cost with cartridge and tape units for storage requirements of up to around 100 million characters. For storing files of over one billion characters, they tend to become unwieldy because of the large number of physical units required and their space and maintenance requirements.

When properly used, the best cartridge units appear to offer significant advantages in storage cost over both magnetic tape and disc units for storage requirements up to several billion characters. When total storage requirements exceed this level, tape systems are unmistakably the cheapest, due to the very low cost of the tape itself.

On the basis of relative cost, it would seem that a combination of both serial and random access storage is likely to become standard practice in many of the EDP installations of the future. Discs, drums, or future nonmechanical random-access stores would be used for smaller files of up to about 100 million characters, and magnetic tape would be used for the very large-volume files. Normally, the more active records would be held in random access storage for faster accessibility, while the rest would be stored on magnetic tape for economy.

.43 Throughput Costs

In determining the effect that random access storage will have on the number of transactions your EDP system can process per dollar, you are getting close to the crux of whether or not random access storage is practical for your own particular installation. In attempting to make this decision, you must begin considering some of the broader systems implications of using random access storage.

It is obvious that a well-designed on-line system is greatly superior to a batch-type system with respect to the total response time required to process a given transaction and update the necessary files. The advantage might be as much as seconds versus hours or even days. However, in order to handle high peak loads without excessive delays, an on-line system may require significantly more throughput capacity (computer power) than a batch-type system designed to handle the same total workload. With currently-available computer hardware, a system configuration designed for efficient batch processing generally will be able to process more records per day at a lower cost than a corresponding random access configuration of the same computer system. This is due not only to the cost of the random access units themselves, but also to the added core storage and communications equipment that is usually required for on-line processing.

On the basis of the number of transactions processed per dollar, therefore, batch processing usually shows a significant advantage over on-line processing with currently-available equipment. This advantage may be more than offset, however, by a number of system performance considerations centered around a significant expansion of the data processing system's utility to an organization.

.5 SYSTEMS CONSIDERATIONS

The use of random access storage can rarely be justified solely on the basis of the economic comparisons described above. The decision is really one of whether an on-line system will provide enough added user advantages over a batch-type system to justify the added expense. These advantages take the form of faster response, more timely management information, and the economies of integrated operations.

.51 Faster Response

On-line random access files can, of course, provide immediate responses to requests for information. Because data can be entered into the system on a random basis and filed immediately, as contrasted with the batch processing techniques used in punched-card or magnetic-tape systems, answers to queries are not only rapid but based on completely up-to-the-minute information. In cases where different types of data must be supplied to a system user, data retrieval can usually be accomplished in one pass, whereas a batch-processing system might require a number of separate passes through the different files. The more diverse the data requirements of an organization and the greater the need for up-to-date information, the more practical an on-line system becomes.

.52 Timely Management Information

The on-line system's ability to respond quickly to diverse queries with up-to-date information is extremely attractive to management. Not only can the system provide the type of information needed to tighten the administration and control of operations, but it can provide more pertinent inputs to the management decision-making process.

The ability of an on-line system to process transactions as they occur also simplifies the scheduling problems within the computer facility. Tradeoffs no longer need to be made between regular daily tasks and the occasional tasks such as end-of-month closings and weekly reports. This tends to reduce peak-load buildups and even out the data processing workload so that more consistent and efficient use is made of the computational equipment.

.53 Integrated Operations

Mass random access storage devices are a vital element in the development of modern integrated information systems. By permitting rapid access to all of the pertinent information in the organization's files, random access devices open the door to a total-systems concept in which each individual transaction can immediately trigger the appropriate entries in all of the affected files. For example, a single sales order might cause changes in inventory, production scheduling, material control, dispatching, billing, accounts receivable, credit, commission, and other records. Integrated systems will make it possible for large modern corporations to enjoy the same degree of centralized control and flexibility of operation as small single-proprietor businesses.

CHARACTERISTICS OF RANDOM ACCESS STORAGE DEVICES

Category		MAGNETIC DRUMS				
Device		Control Data 861 Drum Storage	IBM 2301 Drum Storage	Univac Fastrand I Drum	Univac FH-880 Drum	Univac Randex Drum
Representative Computer System		CDC 3200	IBM System/360	Univac 1107	Univac 1107	Univac SS-80/90 Model II
Report Reference		245:045	420:047	(777:043)	784:043	772:043
Storage Medium		Drum	Drum	Drum	Drum	Drum
Storage Capacity	Data Discs or Drums per Physical Unit	1	1	2	1	1 or 2
	Data Tracks per Disc Surface or Drum	64	200	3,072	128	2,000
	Maximum Characters per Track	65,536	20,486**	10,752	36,864	3,840
	Maximum Characters Accessible Without Head Repositioning	Total Capacity	Total Capacity	688,128	Total Capacity	7,680
	Maximum Character Capacity per Physical Unit	4,194,304	4,097,200**	66,060,288	4,718,592	15,360,000
Head Positioning Time, msec.	Minimum	0	0	30	0	125
	Average (Random)	0	0	57	0	333
	Maximum	0	0	86	0	540
Average Rotational Delay, msec.		17.2	8.6	35	16.7	35
Peak Data Transfer Rate, Characters/sec.		2,000,000	1,200,000**	150,900	368,760	9,280
Transfer Load Size, Characters		1 to 131,072	1 to 20,486**	6 to 344,064	6 to 393,216	320
Read/Write Checking		Parity	Cyclic check characters	Parity	Parity, character count	Parity
Representative Cost, $ per Character		0.029	0.080**	0.0044	0.0348	0.0091
Features and Comments		Fixed heads; 13 bit channels per track	Fixed heads; 4 bit channels per track	Movable access mechanism has 64 read/write heads	Fixed heads; 6 bit channels per track	Movable access mechanism has 1 head per drum

Category		MAGNETIC DISC FILES						
Device		Bryant 4000 (Honeywell 460)	Burroughs B 472 On-Line Disc System	Data Products 5024 Discfile (CDC 818)	GE M640A Disc Storage Unit	IBM 1301 Disc Storage	IBM 1302 Disc Storage	IBM 1405 Disc Storage
Representative Computer System		Honeywell 400	Burroughs B5500	CDC 1604-A	GE 225	IBM 7074	IBM 7080	IBM 1401
Report Reference		501:042	201:042	(245:042)	321:042	403:043	417:043	401:042
Storage Medium		Discs	Discs	Discs	Discs	Discs	Discs	Discs
Storage Capacity	Data Discs or Drums per Physical Unit	3, 6, 12, 18, or 24	4, 8, 12, 16, or 20	16	4, 8, 12, or 16	20 or 40	20 or 40	25 or 50
	Data Tracks per Disc Surface or Drum	768	50	256	256	250	500	200
	Maximum Characters per Track	4,096	24,000	5,120	3,072	2,780	5,850	1,000
	Maximum Characters Accessible Without Head Repositioning	786,432	Total Capacity	524,288	294,912	222,400	936,000	2,000 or 4,000*
	Maximum Character Capacity per Physical Unit	100,663,296	48,000,000	33,554,432	18,874,368	55,600,000	234,000,000	20,000,000
Head Positioning Time, msec.	Minimum	60	0	35	70	50	50	90
	Average (Random)	95	0	120	199	160	165	600
	Maximum	130	0	200	305	180	180	800
Average Rotational Delay, msec.		33.5	20	26	26	17	17	25
Peak Data Transfer Rate, Characters/sec.		27,500 to 75,000	100,000	58,800 or 98,000	35,500 or 71,000	90,000	184,000	22,500
Transfer Load Size, Characters		512	96 to 30,240 by 96, 240, or 480	8 to 32,768	192 to 3,072 by 192	1 to 111,200	1 to 234,000	200 or 1,000
Read/Write Checking		Parity	Check chars., write check	Check chars.	Word & record parity, write check	Check chars., write check	Check chars., write check	Parity, write check
Representative Cost, $ per Character		0.0026	0.0053	0.0062	0.0065	0.0041	0.0018	0.0030
Features and Comments		All read/write heads (6 per disc surface) move in unison	Fixed heads, 1 per track	Individually positionable access arm for each disc	Individually positionable access arm for each disc	Variable record lengths, defined by format disc	Two access "combs" serve 250 track positions each; variable record lengths	Single access arm serves all discs (second arm is optional)

Category		CARTRIDGE-LOADED UNITS					
Device		IBM 1311 Disc Storage Drive	IBM 2311 Disc Storage Drive	IBM 2321 Data Cell Drive	NCR 353-1 CRAM Unit	NCR 353-3 CRAM Unit	RCA 3488 Random Access Computer Equip.
Representative Computer System		IBM 1401 and 1440	IBM System/360	IBM System/360	NCR 315	NCR 315	RCA 3301
Report Reference		401:043	420:044	420:045	601:042	601:043	703:044
Storage Medium		Magnetic discs	Magnetic discs	Magnetic strips	Magnetic cards	Magnetic cards	Magnetic cards
Storage Capacity	Data Discs or Drums per Physical Unit	6 (10 sides)	6 (10 sides)	Ten 200-strip cartridges	One 256-card cartridge	One 256-card cartridge	Up to sixteen 256-card cartridges
	Data Tracks per Disc Surface or Drum	100	200	100 per strip	7 per card	56 per card	64 per card
	Maximum Characters per Track	2,000 or 2,980*	3,625**	2,000**	3,100	1,120	2,600
	Maximum Characters Accessible Without Head Repositioning	20,000 or 29,800*	36,250**	40,000**	21,700 (1 card)	62,720 (1 card)	10,400
	Maximum Character Capacity per Physical Unit	2,000,000 or 2,980,000*	7,250,000**	400,000,000**	5,555,200	16,056,320	681,574,400
Head Positioning Time, msec.	Minimum	75 or 54*	30	375	235	235	290
	Average (Random)	250 or 154*	85	550	235	235	378
	Maximum	392 or 248*	145	600	235	235	465
Average Rotational Delay, msec.		20	12.5	25	23	23	30
Peak Data Transfer Rate, Characters/sec.		77,000	156,000**	64,700**	100,000	38,000	80,000
Transfer Load Size, Characters		100 to 20,000 by 100	1 to 36,250**	1 to 40,000**	2 to 3,100	2 to 120	1 to 166,400
Read/Write Checking		Parity, write check	Cyclic check characters	Cyclic check characters	Two-way parity, read after write	Two-way parity, read after write	Parity, read after write
Representative Cost, $ per Character		0.0234 or 0.0163*	0.0074**	0.00043**	0.0068	0.0022	0.00034
Features and Comments		Changeable "Disc Pack" cartridges	Changeable "Disc Pack" cartridges	Changeable "Data Cell" cartridges hold 200 strips each	Changeable CRAM cartridges of 256 cards each; 8 bit channels per track	Changeable CRAM cartridges of 256 cards each; 1 bit channel per track	Changeable cartridges of 256 cards each; 2 bit channels per track

* Denotes that an optional feature is required to achieve the indicated figure.
** Expressed in terms of 8-bit bytes.

SPECIAL REPORT

DIGITAL PLOTTERS:
A STATE-OF-THE-ART REPORT

Prepared by

The Technical Staff of
AUERBACH Corporation

AUERBACH SPECIAL REPORT
DIGITAL PLOTTERS: A STATE-OF-THE-ART REPORT

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.1 INTRODUCTION

Graphic display recorders have been a principal form of output in analog computing systems for a number of years. The growing use of these devices in digital systems, however, is a relatively recent development, and present trends indicate a widening range of applications for plotting equipment in both the scientific and non-scientific fields. The chief value in a plotter lies in the fact that large amounts of digital computer data can be reduced and converted to graphical form for easier study and interpretation. This type of output has proven valuable in such applications as the plotting of missile trajectories and orbits, the checking and comparing of engineering design calculations, in speeding up final analysis of scientific evaluation studies, and in automatic weather map plotting.

In the non-scientific areas, plotters are being used to generate business progress, sales inventory, and production charts that give management a graphic tool to help forecast future trends. Other uses include the checking and charting of automatic machine tool performance, the production of traffic density pattern data for computer-controlled highway studies, and the plotting of earth moving and fill problems which are more easily dealt with in graphical form.

Digital plotters can be used in more general application areas than their analog counterparts, in the same sense that a digital computer can be used as a general purpose system whereas an analog system is usually designed for relatively specialized applications. Digital plotters also eliminate the problems of drift, dynamic response, and changing gain settings which are inherent in analog operations.

The possibility of using your existing high-speed printer for certain point plotting applications should not be overlooked. Standard character printers such as the IBM 1403 and the Anelex 4-1000 have been found quite useful in applications where high precision is not required, as in the graphical representation of business trends. Several computer manufacturers offer printers which are specially modified for more precise plotting and standard subroutines to facilitate their use. This report, however, is devoted to equipment designed specifically for digital plotting.

.2 TYPES OF DIGITAL PLOTTERS

There are currently two general types of digital plotters, which are characterized by whether or not the plotting surface remains stationary. In the "table" type plotter, a flat plotting board is fixed in some position and all plotting movements are performed by the plotting (writing) mechanism. The writing mechanism consists of a carriage and pen assembly that moves along one axis of the plotting surface. The pen unit is free to move along the other axis either independently or in unison with the carriage. Motion in the X or Y direction, or in both directions simultaneously, is thus obtained, permitting the pen to reach any co-ordinate value contained within the plotting area.

The second basic type is the so-called "drum" plotter that uses a movable plotting surface in conjunction with a writing carriage to provide the required two-dimensional motion. In these units, the writing element moves along one axis while rotation of the drum supplies the other coordinate. At the present time, California Computer Products is the only major manufacturer that builds plotters of the drum type. All of their units employ an incremental plotting technique wherein the graph or curve is produced by a series of fixed incremental steps of the drum and/or carriage. Bi-directional motors are used to control motion along both the X and Y axes so that each input digital signal causes a small incremental step (1/100 inch or less) of the carriage, the drum, or both. A third (Z axis) input signal is used to control the raising and lowering of the pen from the surface of the paper.

Other techniques have been developed for digital plotting applications, such as the all-electronic plotting-board currently under development by the Ford Instrument Company of Long Island City, N. Y. This design is capable of high speeds since all limiting physical aspects of mechanical plotting systems are eliminated. A sheet of sensitized paper is sandwiched between two X-Y conductive grids consisting of fine wires. When the appropriate

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X and Y coordinates are chosen and the wires energized, a voltage potential exists at the crossing point of the two wires. The sensitized paper reacts to this voltage potential to produce a mark at that one point. To produce the next point, a new pair of grid lines is chosen and energized. At present, the Ford Instrument system is capable of handling about 50 points per second.

Radiation Incorporated of Orlando, Florida, has produced a plotting device called the Radicorder which also employs electrosensitive paper as the recording medium. This unit moves the paper at a selected rate of speed while a special multistylus recording transducer "marks" the paper in one or more places across the width of the chart. In this way, three distinct forms of binary input data (graph, character, and on-off event data) can be recorded simultaneously. Although this device, as well as the Ford Instrument unit described above, may find wider applications in the future, they are not being commercially marketed at the present time and are only mentioned here to give some indication of advanced developments in the plotter field.

In comparing the relative merits of the drum type to the more common table-type plotters, it is evident that more programming control is required for the drum type because of its incremental stepping nature (e.g., many commands may have to be given just to reach an initial starting point). In most table types, the plotter can accept two sets of coordinates and plot a line between them. This can result in generally faster plotting times, except where many short-line segments are required. In addition, errors in individual points tend to become cumulative in the incremental method.

The table-type plotters are generally more versatile in that they can be built to meet high precision or large size requirements, and can incorporate many supplemental features such as interchangeable recording heads for inking, punching, or scribing, and the ability to plot more than one curve at a time. All of these advantages are accompanied by proportionately higher costs. Comparative prices of digital plotters alone (no peripheral units included), range from $4,500 to $9,600 for the drum type, while prices of table-type plotters range from about $6,500 to $50,000.

Ability to operate on-line with a digital computer is another criterion for classifying digital plotters. The drum-type plotters produced by California Computer Products are all adaptable to on-line operation, and interface units are available from them for such widely-used computer systems as the IBM 1401, IBM 1620, NCR 315, and LGP-30. Some manufacturers offer on-line operation as an optional input mode and state that the required interface units can be supplied by them or by the computer manufacturer. In contrast to the on-line mode, all digital plotters on the market today can operate off-line, using either punched cards, punched tape, or magnetic tape as the chief source of input data. Off-line plotters using input from magnetic tape are particularly suitable for use with large, expensive computers, since they make it unnecessary to slow the computer down to the relatively low speed of the plotter.

.3 THE COMPARISON CHART

The accompanying comparison chart (Page 23:070.900) summarizes the significant characteristics of representative digital plotting devices. The entries have been selected to describe specific operational criteria for each device from a user's point of view.

- Type — Almost all the plotters included in this chart are of either the table type or drum type as described in the preceding paragraphs. Horizontal positioning of the plotting table or drum is implied unless otherwise noted.
- On-line Operation — This entry simply specifies whether or not a plotter can be connected to a digital computer data channel for direct, on-line output. At the present time, only a few computer manufacturers offer digital plotters as part of their standard line of peripheral equipment, but several plotter manufacturers are prepared to supply interfaces that will adapt their equipment for on-line use with most digital computers.
- Input Device Supplied — A few plotters are marketed as integrated systems which include either a magnetic tape transport or a paper tape reader as a standard part of the equipment. Some also have rather elaborate operating panels and provisions for manually entering data through a keyboard.
- Input Medium — The physical medium upon which the data to be plotted can be stored is listed here. This is generally magnetic tape, paper tape, or punched cards. When they are provided, facilities for manual input are also indicated here.

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- Input Code — The majority of plotters can receive input data in pure binary or in some binary-coded-decimal (BCD) form, depending upon the types of input media employed. For example, most table-type plotting boards require four decimal digits to specify each coordinate value, since the matrix range usually extends from -9999 to +9999. Some drum-type incremental units utilize three successive 2-bit characters to specify three of the six possible operating movements (+X or -X, +Y or -Y, Pen Up or Pen Down) for each point. In the case of magnetic tape units, all manufacturers state provisions for accepting data from IBM-compatible tapes recorded at a density of 200 bits per inch. A few models also have the ability to handle tape recorded at 556 bits per inch.

- Chart Size — The actual plotting area available is stated in inches. Only the width dimension is listed for drum-type units, since rolls of 120 feet are standard with these plotters.

- Plotting Mode — All plotters are capable of operating in a "point" mode wherein a single point is plotted for each pair of input coordinates. This is a relatively simple operation for the table-type plotters, but a series of commands (including the pen-up, pen-down control) usually must be given for each point to be plotted by the drum type. An extension of the point mode is the "continuous" mode, which allows significantly higher curve-plotting speeds to be attained. However, the input data must be supplied to the plotter as a continuous train of closely-spaced points. The incremental stepping nature of the drum-type units makes them particularly well suited for this type of operation.

  As defined for table-type plotters, the "line" or "line-drawing" mode results in constructing a straight line between two consecutive pairs of input data coordinate values. The drum-type plotters cannot operate in this fashion, but they can produce lines of any desired length by plotting the required number of incremental steps with the pen held in the down position.

- Accuracy — Percentage figures are quoted for full-scale accuracy. For example, if a plotter with a 30-inch by 30-inch plotting surface has an accuracy figure of 0.05%, the plotter is capable of moving the pen to within 0.015 inch (0.05% of 30 inches) of the true value of any specified coordinate. Where the accuracy figures vary according to the plotting mode, both figures are listed.

- Speed — For the drum-type plotters, the speed is fixed for each model according to the incremental step size. For table-type units, however, the speed can vary greatly according to the plotting mode and the maximum distance traveled along either axis to move from one coordinate to the next. To keep the chart as orderly as possible, all figures given in this column refer to maximum speeds only, as rated by the manufacturers.

- Symbol Printing — Most plotters offer symbol printing devices as optional equipment, which enable special symbols to be plotted instead of points. Alphanumeric character sets are also available with many plotters so that fully annotated graphs can be produced to further identify and define the output data.

- Comments — This column is used to mention any additional facts about a particular unit that are unusual or of general interest.

.4 REPRESENTATIVE SYSTEMS

Some examples of specific computer-controlled digital plotting systems are presented here to illustrate the overall relationship between the computer output and the plotting operation. In the first case, a drum-type incremental plotter manufactured by California Computer Products is connected on-line to an IBM 1401 system. Either of two methods can be used for making the connection, depending upon whether or not an IBM 1407 Inquiry Station is available as part of the 1401 installation. If the Inquiry Station is available, the plotter can be connected to the computer through a special attachment in the 1407. Alternatively, a J-1401 Adapter can be used in place of the 1407 unit to effect the required interfacing between the plotter and the 1401 Processing Unit. The cost of this particular adapter is $3, 500, and it can be used with any model of incremental plotter. Total cost of the plotter and adapter can range from about $8, 000 for 11-inch plotters to $13, 000 for 30-inch plotters. Regardless of the method used, no modification of the basic computer system is required.

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As described earlier in this report, the principles of operation are the same for each of the models of incremental plotters. The 1401 BCD characters 0 through 9 are the only ones required to control the plot operation. Each of the ten characters will cause a distinct plotter movement, as depicted in Figure 1 and as listed below:

1401 Character:	0	1	2	3	4	5	6	7	8	9
Plotter Operation:	Pen Down	+Y	+Y, +X	+X	-Y, +X	-Y	-Y, -X	-X	+Y, -X	Pen Up

A single output instruction can shift the IBM 1401 to an output plotting operation. The instruction M %X1 BBB W will initiate the plotting of one or more points, as controlled by the data stored in the character locations starting at storage address BBB. The plotting action is terminated upon receipt of a group-mark character from the core storage of the 1401 Processor.

A good example of off-line operation is that performed by the Dymec Magnetic Tape Plotting System (Model DY-6575) using tapes prepared by the large-scale IBM 7090 computer. Here, automatic plotting is achieved by including all necessary plotter commands on binary-coded tapes that have been prepared by appropriate computer subroutines. The tapes are recorded on IBM 729 Magnetic Tape Units at speeds of 75 or 112.5 inches per second, but are read back at much slower rates in order to match the plotter operating speed.

Complete instructions for plotting any given point of a curve are contained in a single 36-bit tape word, as illustrated in Figure 2. Each word contains 12 bits of X-coordinate data, 12 bits of Y-coordinate data, 6 bits of word identification, and 6 command bits. During plotting the tape is run at a speed of 3 inches per second, and the bits read from the tape are shifted through a 6-bit by 6-bit shift register. When a complete word has been read, the instruction portion of the word is interpreted and the plotter is operated accordingly. A typical portion of tape is illustrated in Figure 3.

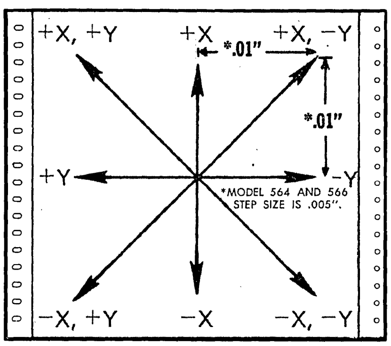


Figure 1 — Drum Plotter Step Directions for IBM 1401.

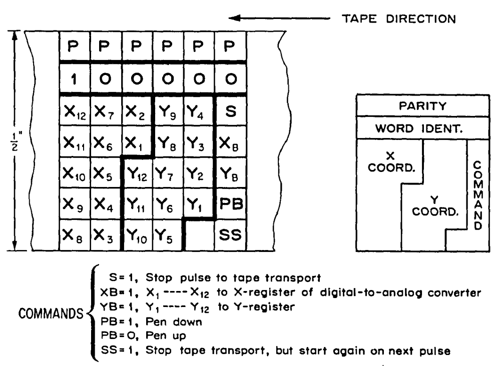
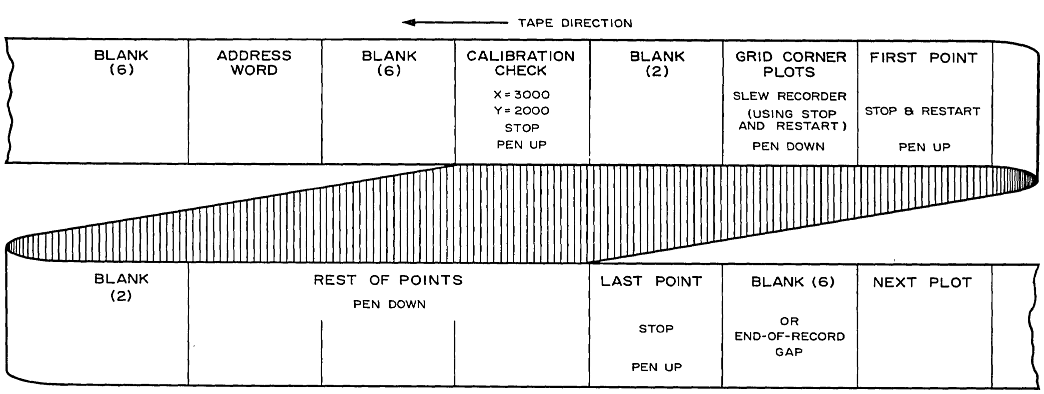


Figure 2 — Word Format for IBM-Dymec Binary Tapes.



NOTE: BLANK IS DEFINED AS TWO OR SIX COMPUTER WORDS WITH 8 TRACK ZEROS (NO IDENTIFICATION BITS).

Figure 3 — Portion of Tape Recording for Dymec System.

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For example, the beginning point of a curve is written with the commands PB = 0 and SS = 1. Thus, the pen is up while the plotter servos are slewing to the position defined by the 12 bits of X and Y coordinate data. On reaching the correct point, a start pulse is sent to the tape transport control unit. The next point is written with PB = 1, so the pen drops and plotting commences. When the plot is completed, the last word has S = 1 and XB, YB = 0. This command will stop the tape transport, leaving the system ready for selection of the next curve by the operator. Alternatively, this combination of command bits can be used to initiate various optional system operations controlled by bits stored in the positions normally occupied by the X-Y coordinate data. Some typical operations which can be added to the standard system are: change paper, change to a different color ink, find next address and continue plot, change plot mode or symbol.

The tape for the Dymec system is recorded at a density of 200 bits per inch, or 33-1/3 IBM 7090 words per inch. Since the tape is read at 3 inches per second, the word rate into the shift register is 100 words per second. Thus, if 25 points define 1 inch of curve under computer control, the plotting rate is 4 inches per second. Since end-of-record gaps, address codes, calibration points, etc., are occasionally needed, the tape length is approximately equal to the final curve length. Thus, a 2,400-foot reel of tape can contain 2,400 feet of curve, equivalent to about 2-2/3 hours of plotting time. The tape writing time (at a speed of 75 inches per second) is about 6-1/2 minutes, so that this system is capable of approximately 25 hours of continuous plotting for each hour of expensive computer time.

The cost of this Dymec system, including plotter, tape transport, and all control circuitry, is $29,450.

Examples of some actual plots reproduced from brochures supplied by plotter manufacturers are shown in Figures 4, 5, and 6. The first of these was produced off-line on the Model 3440 Dataplotter made by Electronics Associates, Inc. The contour plotting illustrated here is a vivid example of a plotter's ability to reduce large volumes of data accurately and rapidly. This system of weather contours was reproduced in less than 3 minutes, whereas it would take a draftsman approximately 3 hours to do the same job. This kind of plotting speed can result in better weather analysis, since charts of this type can be updated much more frequently than heretofore.

In Figure 5, a portion of a fully annotated drawing that was produced by a drum-type plotter (California Computer Products Model 560) connected on-line to an IBM 1401 computer is shown. The Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin, builds a rotary kiln that is a process machine used for the production of cement clinker, lime, iron ore blast furnace charge, and other commercial chemicals. Once the process application is defined and a specific kiln tube is selected, an IBM 704 computer is employed to select, locate, and optimize all design details of the kiln tube and supporting mechanisms (rings and rollers). The 704 then generates a tape for the IBM 1401. The 1401, in turn, prints the output and drives the Model 560 Incremental Plotter. From the original design data, the system generates visual output of what was formerly presented as tables of sizes and stresses. Using the 1401-plotter combination, a fully annotated kiln drawing can be completed in 20 minutes (Figure 5). Each kiln proposal drawing had previously required 20 to 30 hours of manual drafting time. Because of the plotter's speed and relatively low cost, proposal drawings such as these can accompany sales proposals whenever needed.

Our last example, Figure 6, illustrates a set of "curves" produced by the Model 570 Magnetic Tape Plotting System built by California Computer Products. At Thompson Ramo Wooldridge's Space Technology Laboratories, it became apparent that subroutines describing certain standard shapes would be quite useful when developed to allow the programmer to call them out and place them anywhere, and in any size, on a plot or a drawing. To demonstrate the flexibility of such a subroutine, the Las Vegas girl was described in plotter instructions as a subroutine. From it, the chorus line in Figure 6 was plotted. Other, more prosaic standard subroutines have been developed and are currently in use in the production of standard technical plots.

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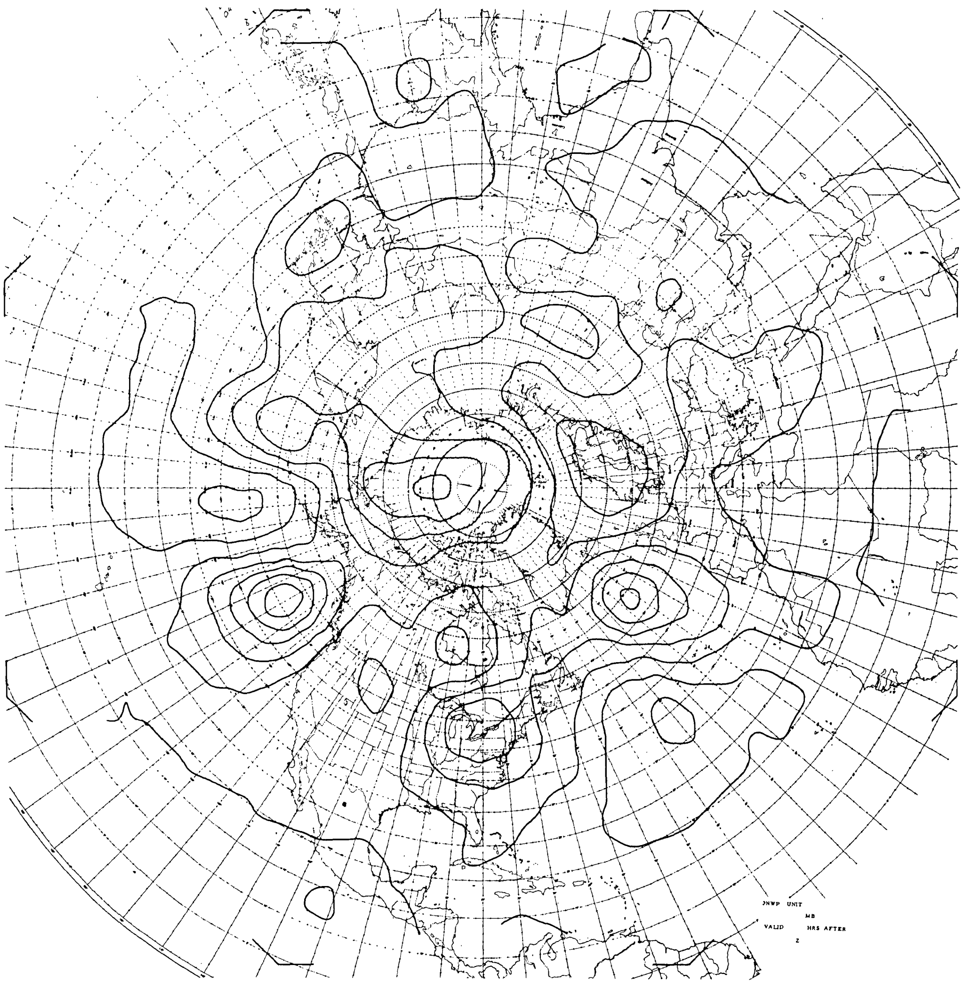

Figure 4 — Weather Contours Plotted by EAI Dataplotter.

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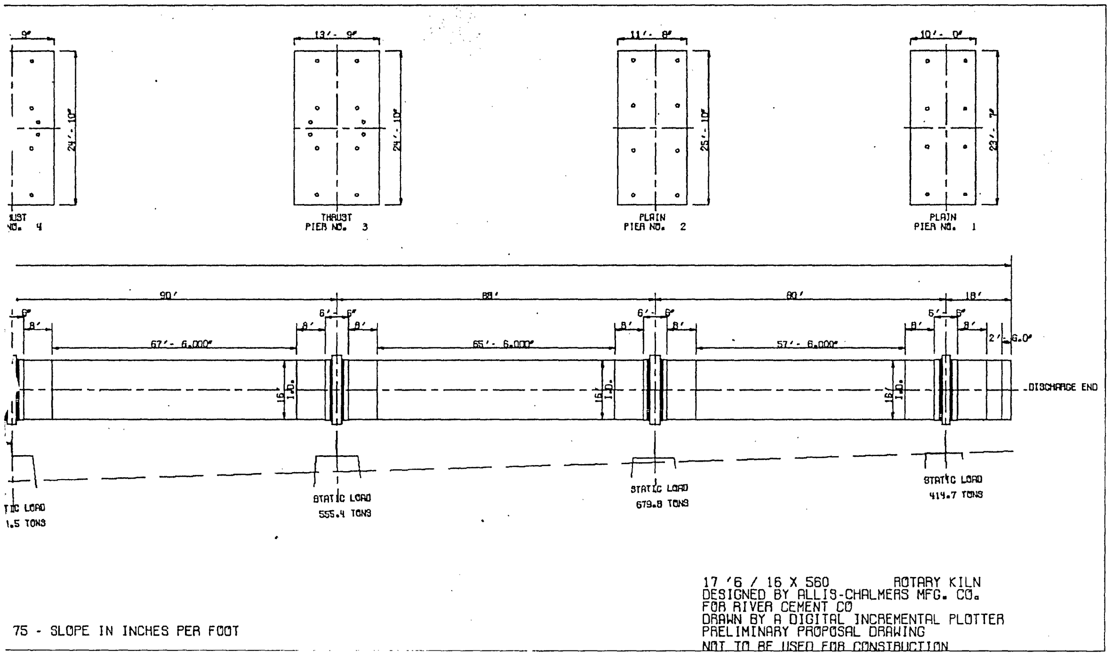

Figure 5 — Annotated Drawing Produced by Calcomp Model 560 Plotter.

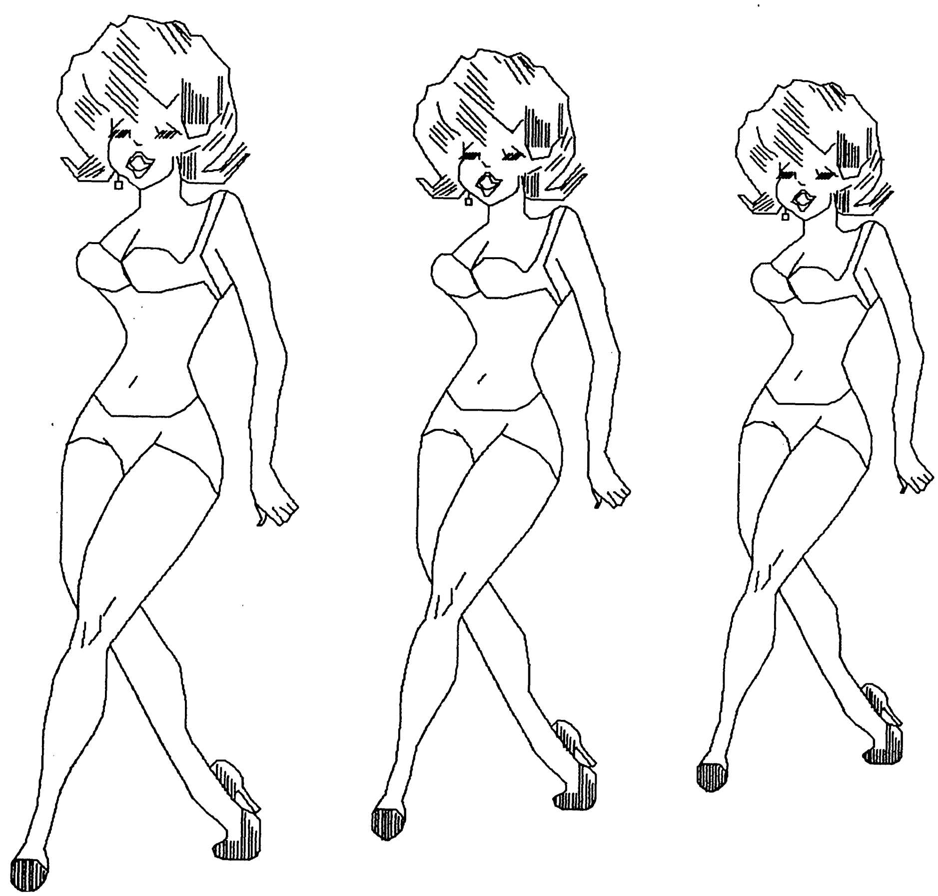

Figure 6 — Curve Plotting by Calcomp Model 570 Plotter.

CHARACTERISTICS OF DIGITAL PLOTTERS

MANUFACTURER	NAME AND/OR MODEL NO.	TYPE	ON-LINE OPERATION	INPUT DEVICE SUPPLIED	INPUT MEDIUM	INPUT CODE	CHART SIZE (INCHES)	PLOTTING MODE	ACCURACY (%)	SPEED (MAX.)	SYMBOL PRINTING	COMMENTS
Aero Service Corp, Division of Litton Industries, 210 E. Courtland St., Philadelphia, Pa.	Aero Automated Coordinatograph, Models A and E	Table	No	None	Magnetic tape Paper tape Punched cards	Binary or BCD	Model A: 47 x 47 Model E: 60 x 120	Line	Model A: 0.005 Model E: 0.03	Model A: 1.8 in/sec Model E: 1.8 in/sec	9 symbols*	Inked or scribed plotting available.
Benson-Lehner, Inc. 14761 Califa Street, Van Nuys, California	Electroplotter, Model J	Table	No	None	Punched cards Manual (keys) Magnetic tape* Paper tape*	BCD or Binary	30 x 30	Point Line* Continuous*	0.05 (point mode) 0.1 (line mode)*	5 points/sec 75 points/sec continuous*	12 symbols*	Manual or automatic control of origin and scale factor.
	Electroplotter II	Table	*	Magnetic tape transport*	Punched cards Manual (switches) Magnetic tape* Paper tape* Computer*	BCD or Binary	30 x 30	Point Line* Continuous*	0.05 (point mode) 0.1 (line mode)*	6.66 points/sec 75 points/sec continuous*	12 symbols or digits. 46-character printing set*	
California Computer Products, Inc. 305 Muller Ave., Anaheim, California	Incremental Plotters, Models 563, 564, 565, 566	Drum	Yes, with small to medium size computers.	Special adapter required for each computer*	Computer	BCD or Binary	Models 563,564: 29.5 Models 565,566: 11	Point Continuous	0.1	Model 563: 2 in/sec Models 564,566: 1.5 in/sec Model 565: 3 in/sec	*	Incremental step size is 0.01 inch for Models 563 and 565; 0.005 inch for 564 and 566.
	Magnetic Tape Plotting System, Models 570, 580	Drum	No	Magnetic tape transport	Magnetic tape	BCD	29.5 or 11	Point Continuous	0.1	1.5, 2, or 3 in/sec	*	Any model incremental plotter can be used as output for either the 570 or 580 Tape System. Model 570 operates from tape densities of 200 bpi; Model 580 — 556 bpi.
Concord Control Inc. 1282 Soldiers Field Road, Boston, Mass.	Concord Coordinatograph	Table	No	None	Magnetic tape Punched cards Paper tape		60 x 60	Point Line	0.005	1 in/sec	Yes	Interchangeable heads for scribing, graving, inking, punching, or printing can be used. High precision machine.
Dymec, Division of Hewlett - Packard Co. 395 Page Mill Road, Palo Alto, California	Magnetic Tape Plotting System Model DY-6575	Table	No	Magnetic tape transport	Magnetic tape	Binary or BCD	15 x 10 30 x 30*	Point Continuous Line*	0.15 (point) 0.2 (continuous)	4 in/sec	*	IBM-compatible tapes are standard. Provisions for multiple plotter outputs.*
	Digital Data Plotting System Model DY-6242	Table	No	Paper tape reader	Paper tape Punched cards Manual keyboard	BCD	11 x 17	Point	0.15	Card input: 0.8 point/sec Paper tape input: 1.3 points/sec	*	Several different card and paper tape codes can be accommodated by factory modification.

* Optional at extra cost.

CHARACTERISTICS OF DIGITAL PLOTTERS (Contd.)

MANUFACTURER	NAME AND/OR MODEL NO.	TYPE	ON-LINE OPERATION	INPUT DEVICE SUPPLIED	INPUT MEDIUM	INPUT CODE	CHART SIZE (INCHES)	PLOTTING MODE	ACCURACY (%)	SPEED (MAX.)	SYMBOL PRINTING	COMMENTS
Electronic Associates, Inc. Long Branch, N. J.	3100 Series Dataplotters	Table	*	Special interface unit required for on-line operation*	Punched cards Paper tape Computer* Manual keyboard	BCD or Binary	11 x 17	Point Line*	0.075	2 points/sec 0.7 in/sec	16 symbols* 48-character printing set*	3100 series accepts 3-digit input coordinates; all other Dataplotters accept 4-digit (-9999 to +9999) inputs. All units have manual input keyboard for selecting one or more sets of scale factor and origin values which can then be changed automatically by the program.
	Models 3200 and 3300 Dataplotters	Table	No	None	Punched cards Paper tape Manual keyboard	BCD or Binary	30 x 30 45 x 60*	Point Continuous (model 3300 only)	0.05 - point 0.1 - line	Point: 1.33 points/sec Continuous: 0.417 point/sec	same as 3100	
	Model 3440 Dataplotter	Table	No	Magnetic tape transport	Magnetic tape Punched cards* Paper tape* Manual keyboard	BCD or Binary	30 x 30 45 x 60*	Point Line Continuous	0.05 - point 0.1 - line	5.8 points/sec 1.9 in/sec	same as 3100	
	Model 3500 Dataplotter	Table	*	Special interface unit required for on-line operation*	Punched cards Paper tape Manual keyboard Computer*	BCD or Binary	30 x 30 45 x 60*	Point Line	0.05 - point 0.1 - line	5.8 points/sec 2 in/sec	same as 3100	
Ford Instrument Co. 31-10 Thomson Ave., Long Island City, N. Y.	Electronic Plotter	Special chart	Yes	None	Punched cards Magnetic tape		15 x 15	Point		50 points/sec	No	This is a developmental model that features all-electronic operation.
Gerber Scientific Instrument Co. P. O. Box 305, Hartford, Conn.	Model 30-D Plotter	Table	No	None	Punched cards Paper tape Magnetic tape* Manual keyboard	Binary or BCD	30 x 30	Point	0.01	1.5 points/sec	24 symbols	All Gerber plotters accept 4-digit (-9999 to +9999) inputs, and each has an extensive manual control console. A 72-character print head is available for all models.
	Model 30-DV	Vertical table	*	Paper tape reader	Paper tape Manual keyboard	Binary or BCD	30 x 30	Point	0.01	1.7 points/sec	24 symbols*	
	A-6-12	Vertical table	No	Magnetic tape transport	Magnetic tape Manual keyboard	Binary or BCD	78 x 150	Line	0.008	5 in/sec	24 symbols*	
Milgo Electronic Corp. 7620 N.W. 36th Ave., Miami, Florida.	Models 4022D and 4023D Recorders	Table	*	None	Magnetic tape Punched cards Paper tape Keyboard Computer*	Binary or BCD	30 x 30	Point Line Continuous	0.05	50 in/sec	40 character printing set standard with 4022D	Model 4023D has two writing carriages and can plot two curves simultaneously.
Radiation, Inc. 5800 McCoy Road, Orlando, Florida	High-Speed Digital Plotter	Special chart	No	Magnetic tape transport	Magnetic tape		11 x 11	Point	0.5		Yes	This is a multistylus unit that can record three forms of input data simultaneously on special electrosensitive paper.

* Optional at extra cost.

SPECIAL REPORT

DATA COLLECTION SYSTEMS: A STATE-OF-THE-ART REPORT

Prepared by

The Technical Staff of
AUERBACH Corporation

AUERBACH SPECIAL REPORT
DATA COLLECTION SYSTEMS: A STATE-OF-THE-ART REPORT

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.1 INTRODUCTION

Automatic data collection (ADC) implies the recording, in machine-readable form, of the pertinent data about a transaction at the time the transaction occurs. Some data collection systems feed data directly into real-time computer systems to provide up-to-the-minute information for operational decisions; others simply collect and record the transaction data in machine-readable form for later batch processing.

This report summarizes the results of a comprehensive AUERBACH survey of the characteristics and applications of the transmitting automatic data collection equipment that is commercially available in the U.S. today. (Information on the cost and availability of the more detailed 85-page report from which this material has been extracted can be obtained from the publisher, AUERBACH INFO, INC.)

A comparison chart (Page 23:080.900), arranged in a format designed to facilitate objective comparisons, presents the key hardware, performance, and cost characteristics of each of nine different transmitting data collection systems. The meaning, derivation, and significance of the comparison chart entries are explained in Paragraph .6, THE COMPARISON CHART. A brief description of each of the systems included in the comparison chart is presented in Paragraph .7, CHARACTERISTICS OF INDIVIDUAL SYSTEMS.

.2 WHY AUTOMATIC DATA COLLECTION ?

The need for improving the accuracy and reducing the cost of providing the necessary input to automatic data processing systems has long been recognized. Furthermore, modern manufacturing control systems require up-to-the-minute information about what is happening in the plant, so that operating decisions can be based upon current conditions rather than upon statistics covering last week's operations.

Transmitting data collection equipment that can meet both these needs is now available from several major EDP equipment manufacturers. Through the use of such equipment, it is now feasible to design systems that can:

- provide the complete, timely data needed for accurate cost control;
- reduce the number of times and places at which data must be transcribed, thereby cutting clerical costs and error rates;
- make and implement operating decisions of a routine nature; and
- provide information about current plant conditions upon request.

Actual real-time control of manufacturing operations is still quite rare, but the other potential advantages of automatic data collection — reduced clerical costs, increased accuracy, more effective cost control, and sounder operating decisions — have immediate significance for nearly every business.

.3 TYPES OF TRANSACTION RECORDING UNITS

Transaction recording units are devices that can record pertinent data about a transaction in machine-readable form at the time the transaction occurs. The objective of such devices is to collect data accurately and quickly in a form suitable for processing on a computer or tabulating equipment, thus eliminating the need for manual key-punching.

A wide variety of techniques and equipment is currently being employed for transaction recording. While this report is concerned primarily with transmitting data collection systems designed for industrial use, a review of some of the other techniques and representative equipment used in transaction recording will help to establish the proper perspective.

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One of the simplest transaction recording techniques has been widely used by retail outlets: prepunched tags, such as the Dennison and Kimball tags. When an item is sold, the sales clerk is instructed to tear off one section of the tag (which contains the item identification and price) and deposit it in a box near the cash register. These tags are collected periodically, carried to the data processing center, and converted to standard punched cards for use in sales analysis and inventory control applications. Although the method is simple and inexpensive, it generally involves a high error rate because clerks frequently neglect to tear off and deposit the required sections. Furthermore, the prepunched tags are difficult to modify for exceptions. The prepunched tag method is very useful for sales analysis to indicate the fast-moving and slow-moving items, but it has generally been found inadequate for accurate inventory control.

Many organizations employ simple manual devices which record, in machine-readable form, information coded on embossed cards (e.g., credit cards). Imprinters for this purpose are produced by Addressograph-Multigraph, Dashew Business Machines, Farrington Electronics, and others. Usually the coded information is read by an optical character reader to produce input to a computer system. Like the prepunched tags, this system is simple, relatively inexpensive, provides for capturing a record at the source of certain relevant information about each transaction, and requires manual transportation of the recorded data to the processing center. The system is generally suitable only for billing and sales analysis by territory since only the customer's name, identification number, and amount of transaction are currently imprinted. The reject rate has been found to be relatively high because of difficulty in maintaining the required quality of imprinting. Advanced versions of these imprinting devices are electrically powered and can provide accumulators for development of batch control totals.

Other variations of this general type of transaction recorder are represented by IBM Porta-Punches, in which variable data is encoded by pushing partially punched holes out of a card, and the Mek-A-Punch (at one time produced by American Data Machines), in which variable data is set up by lever movements and punched into a card by pulling a handle forward.

Mark-sensing is a widely-used technique that permits data to be recorded at its source on standard punched cards, using no special equipment except a pencil that produces electrically conductive marks. After the cards have been carried to the central processing site, the marked data can be sensed and converted to standard punched-hole form by such machines as the IBM 514 Reproducing Punch or 519 Document Originating Machine.

Another important transaction recording technique is the connection of paper tape punches (or, less frequently, card punches) to cash registers, typewriters, savings bank window machines, and other manually-operated business machines to capture a machine-readable record of each transaction. As an example of this widely-used technique, let us examine the use of a cash register with an integrated tape punch. As each sale is rung up, the clerk records the department number as well as the amount via the register keyboard. Both are punched into the paper tape, which is collected and carried to the data processing center at the end of each day to provide input data for sales analysis. Incorporation of the customer's account number into the paper tape record of each transaction enables billing to be accomplished from the same input. The obvious advantage of this system is that source data is captured in machine-readable form as a byproduct of the normal cash register operation. Serious drawbacks to the use of such systems, however, are the cost of the paper tape punch in each register, the frequency of clerical errors in entering department numbers, and the number of tape rolls that must be collected and spliced for efficient computer processing.

A variation of this basic technique is the use of optical journal tape readers, such as the NCR 420-1 and the new IBM 1285, to read the printed transaction records produced by many standard cash registers, adding machines, and accounting machines.

Industrial data collection systems of the non-transmitting type are similar to the cash registers described above in that they produce a record on punched tape or cards of the pertinent data about each transaction, which must be manually transported to a central location for subsequent processing. The system response time of such equipment is necessarily long, and it is obviously unsuitable for real-time control applications, yet its relatively low cost may make it more suitable than transmitting equipment for many small-scale installations.

A good example of the non-transmitting type of industrial data collection equipment is the Control Data 180 Data Collector. The 180 accepts input data from punched cards and/or dials and converts it directly into 8-level punched tape codes. Fixed alphanumeric data on punched cards of 28 to 80 columns and variable numeric data from up to 16 dials can be read and recorded at the tape punching speed of 17 characters per second. Operation of the Control Data 180 consists simply of setting the appropriate dials and inserting the card(s) into the reader. A "not complete" light remains on until recording of the message has been completed. Time and date information is automatically added to the message by a built-in clock unit. Accuracy checks include a character parity check at the recorder and means for detecting operational errors or equipment malfunctions.

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The highest level of transaction recorders in the field today, and the one that will be of maximum value to most large manufacturing companies, is represented by the transmitting data collection systems that are now being used extensively for employee attendance recording, production control, labor distribution, inventory control, and a variety of other applications. The object of this report is to survey and evaluate the commercially available data collection systems of this type.

.4 TRANSMITTING DATA COLLECTION SYSTEMS

A data collection system of the transmitting type consists of:

- input units which accept and transmit fixed data from prepunched cards or badges and variable data from dial, lever, or slide settings or keyboards;
- output units which record the transmitted data on punched tape or cards or control its direct entry into a computer system; and
- cables or communications facilities to transmit the data from the input units to the output units, which may be located in the same plant or many miles apart.

Transmitting data collection systems can be classified as "on-line" systems, which feed data directly into a computer, or "off-line" systems, which produce punched or printed transaction records that will generally be processed later by a computer. Several of the systems surveyed in this report can be used in either on-line or off-line configurations.

A typical transaction message in a production control and labor distribution application might consist of: employee number (read from the employee's badge); job number (read from a prepunched card traveling with the job); machine operation number, transaction code, and quantity completed (entered by the employee via manually operated dials or levers); input station number (transmitted automatically); and time and date (added automatically at the central recording unit).

.5 FACTORS TO CONSIDER IN PLANNING FOR ADC

Enough successful and unsuccessful installations of transmitting data collection systems have now occurred so that we can list a number of desirable things to do — and to avoid — when planning such an installation.

The first question is: Do you really need automatic data collection? Instead of installing an expensive mechanized system to record actual job hours, for example, it might be better to install a good hourly job standard system and not bother to record actual hours. The reduced time lags between occurrence and reporting of events that automatic data collection makes possible are of no value unless management knows what actions are dictated by the reports it receives and initiates those actions promptly.

The decision to use automatic data collection equipment in connection with conventional batch-type processing should be made only after a detailed systems study. (It is assumed that all real-time information systems will require some form of transaction recording equipment.) The systems study must determine what information management needs and the minimum amount of data that must be collected to satisfy those needs. Then a suitable system must be designed. It is unlikely that straightforward mechanization of existing manual reporting systems will lead to the most efficient use of automatic equipment. Existing systems should be streamlined wherever possible, and the full support of top management is essential.

All potential applications should be carefully considered. For example, an integrated data collection system in a production plant can be used for attendance reporting, inventory control, parts and material requisitioning, shipping, purchasing, billing, inspection, and numerous other functions — all in addition to the primary functions of production control and labor distribution.

Complications will arise from material substitutions, returns, damaged items, obsolete parts, inaccurate counts, unplanned requisitions, reworks, etc. Provisions should be made to handle all such complications without deviating from the cardinal design principle: send all messages relating to a particular application through the mechanized system. Don't plan to mechanize only the high-volume transactions and handle the exceptions manually. Dual systems will create continual problems and additional expense.

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One of the biggest problems in specifying a data collection system is determining system capacity — how many input stations and central recording units will be needed. The peak loads that will be imposed on the system must be determined; these will most commonly occur at clocking-out time in systems used for attendance reporting. Message lengths should be minimized to reduce data entry and data transmission times. Message length and transmission speed will determine the service time per transaction. The service time, in turn, determines the maximum number of input stations that can be adequately serviced by each central recorder. In determining the capacity of individual input stations, the time required to enter the necessary cards, badges, and/or variable data must be added to the data transmission time.

Closely related to system capacity is the question of where to locate the input stations. You will need to consider the maximum distance an employee should have to walk to get to an input station, the maximum waiting times that can be tolerated, and the costs of walking to the station and waiting to use it as compared to the costs of additional input stations and transmission lines.

One of the major disadvantages of transmitting data collection systems is their relatively high cost of installation. The cable cost for systems interconnected by multi-wire cables can represent a significant portion of the total system cost. A reasonable estimate is about $1.00 per foot of cable, with the cost of the cable itself amounting to about one-third of the total and the labor involved in junction box connections accounting for much of the remainder. Input stations in most installations will frequently be moved, and each move will usually require relocation and extension of the existing cables.

Since many commercially available data collection systems can utilize two-wire transmission facilities as an alternative to multi-wire cables, the relative merits of the two transmission modes should be examined. Buildings separated by city streets or plants at locations remote from the central recording point can be handled more easily with two-wire hookups. A two-wire system can utilize existing telephone lines with no additional installation or maintenance costs. But two-wire systems generally require special adapters (usually Data-Phone subsets) to provide for serial transmission of the bits that make up each character. Multi-wire cables eliminate the need for subsets and often permit higher transmission speeds.

Where the published specifications for a particular data collection system do not exactly coincide with your requirements, remember that most manufacturers will be glad to discuss potential modifications of their equipment when a sizable installation seems to require such modifications. It is probable, for example, that most "off-line" systems can be adapted for on-line use with most digital computer systems, though the user will probably have to bear the engineering costs of the necessary modifications.

Another important point to consider is the training and indoctrination that must be given to each employee who will be using a transaction recorder. With at least 30 minutes of well-planned instruction, it should be possible to reduce the rate of human errors to about 1 per cent of the total transactions. To insure acceptance of the mechanized system by the employees, they must be thoroughly briefed in advance. The briefing should explain why the system is needed, how it will operate, and how it will affect each employee. Several data collection installations have failed because the need for pre-installation training and indoctrination was ignored, leading to a strongly rebellious attitude among the workers.

The need for high reliability in a data collection system can hardly be over-emphasized. Therefore, in evaluating specific equipment, it is wise to ask the manufacturer's representative such questions as:

- What happens if a single input station fails? (Does the entire system go down?)
- What happens if a single cable breaks? (Is the entire system incapacitated?)
- What happens if a central recorder fails? (Are all connected input stations incapacitated, or can another recorder pick up the load?)
- Where are the nearest service technicians, and how soon can one be summoned?

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.6 THE COMPARISON CHART

The comparison chart on Page 23:080.900 summarizes the key characteristics of nine commercially available transmitting data collection systems, in a concise format designed to facilitate objective comparisons and pinpoint the specific advantages and disadvantages of each system. The comparison chart entries are explained below, and a brief description of each of the data collection systems included in the comparison chart is presented in Paragraph .7, CHARACTERISTICS OF INDIVIDUAL SYSTEMS.

.61 Input

Probably the most important factor in determining the success of a data collection installation is the speed, convenience, and flexibility of data entry. Input data can be broadly classified as either "fixed" or "variable." Fixed data is defined as data read from previously prepared punched cards, plastic badges, or other semi-permanent, machine-readable data storage media. Variable data is data entered manually at transaction time by means of a keyboard or by dial, slide, or lever settings.

.611 Punched Card Input

All the systems described in this report can accept fixed input data from standard, Hollerith-coded, 80-column punched cards. The method of entry is usually by manual insertion and then removal of one card at a time. The number of columns that can be read from each card and the number of cards that can be read in a single transaction are indicated.

.612 Badge Input

Some systems can accept fixed input data from badges or tokens which are manually inserted into the input device. This capability is particularly valuable for employee attendance recording. The number of columns that can be read from each badge and the number of badges per transaction are indicated.

.613 Variable Input

The type of facilities that permit the user to enter variable data at transaction time, and the number of digits that can be entered in a single transaction, are indicated. The variable data will usually be entered by means of a set of dials, switches, slides, or levers.

.614 Restricted Input

In many applications there will be certain semi-permanent data that is part of all or most messages from a given input station. If the input device includes means for entering variable data and then preventing it from being altered by unauthorized personnel or reset to zero after each transaction, this is called "restricted input." The method of restriction is noted; most commonly this consists of a hinged, lockable cover over some of the dials, levers, or slides used for variable input.

.615 Transaction Codes

Multi-purpose data collection systems usually utilize a transaction code to specify the nature and, in many cases, the message format of each transaction. The number of available codes is specified here. In some systems the transaction code is entered by the same method as the other variable data; in other systems there are special provisions. Certain types of transactions may be restricted, requiring insertion of a supervisor's key or special badge to initiate their transmission.

.616 Automatic Reset

Automatic resetting of the variable dials, levers, or slides to zero after a message has been transmitted is a feature that will increase input speeds and reduce errors in most data collection applications.

.617 Visible Settings

After the variable data for a transaction has been entered, it is important to note whether the settings are visible to the user so that he can verify that the data has been entered correctly before the message is transmitted. Where a 10-digit or typewriter-like keyboard is used, there is usually no visible record of the data that has just been entered. In systems that employ dials, levers, or slides for variable input, the settings will generally be visible, though it may not be easy to read them quickly and reliably. Some input units incorporate a direct, digital display of the data about to be transmitted.

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.62 Output

.621 Medium

Data collection systems of the transmitting type can be broadly classified as "on-line" systems, which feed data directly into a computer, and the more common "off-line" systems, which produce a punched or printed record of each transaction that may or may not be processed later by a computer. Output from an off-line system will generally be on punched tape, punched cards, magnetic tape, or a printer. The basic output media for each system are listed here.

.622 Code

The standard output code (e.g., the number of levels for punched tape output) is briefly described here.

.623 Maximum Input: Output Unit Ratio

Data collection systems of the transmitting type can assume a wide variety of equipment configurations, ranging from a single input unit with cable-connected recorder to a far-flung network with multiple input units transmitting data to multiple recorders or computers by means of both common carrier facilities and direct cable connections. Probably the most important parameter in planning the equipment configuration of a system is the maximum number of input stations that can be connected to a single central recording unit, as indicated in this entry. See Paragraph .7 for configuration details for each system.

.624 Error Checks

Once a data collection system has been installed and accepted, the operations of an industrial firm will tend to become heavily dependent upon it. Therefore, it is extremely important that the data collection hardware be designed to:

(a) minimize the occurrence of errors; and

(b) insure that virtually all errors that do occur will be detected and corrected.

Minimization of the occurrence of errors involves a great many relatively intangible factors such as component reliability, mean time between failures, conservatism in circuit design, transmission line quality, preventive maintenance, proper training of all system users, and availability and quality of service. The prospective user of any data collection system must satisfy himself that the incidence of errors and system down-time can be kept low enough to meet his needs.

Errors will occur, even in the best-engineered and costliest systems. Therefore it is important to detect and correct as many of these errors as possible. The main types of error checking performed by each system are listed here. The most common checks are:

- Input interlocks — checks which verify that the correct types and amounts of data have been inserted, in the correct sequence, for each transaction. Such checks can detect many procedural errors committed by persons entering input data into the system.

- Parity — addition of either a "zero" or "one" bit to each character code so that the total number of "one" bits in every transmitted character code will be either odd or even. Character parity checking can detect most single-bit transmission errors, but it will not detect the loss of two bits or of an entire character.

- Message length — checks which involve a comparison of the number of characters received at the output unit with the correct number of characters as specified for that particular type of transaction. Message length checks can detect many errors arising from both improper data entry and equipment or line malfunctions.

.625 Time and Date Recording

The time of day and/or the day of the week or month form an important part of the record of each transaction in most data collection applications, so special provisions are frequently made to supply this information automatically.

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.626 Feedback Capability

"Feedback" in on-line data collection systems is the capability for the computer to process messages from the input stations and send appropriate replies back to the originating stations, thereby making it possible to "close the loop" in real-time information systems.

.63 Transmission

These entries describe the available means for connecting and transmitting data between the input stations and the central recording units, along with the resulting speeds and maximum ranges.

.631 Speed

This is the normal peak rate of data transmission, in characters per second.

.632 Line Requirements

Where input and output units can be linked by direct cable connections, the number of conductors required is listed here. In cable-connected systems, data will usually be transmitted in a "parallel by character" mode: i.e., all the bits comprising a single character are transmitted simultaneously via multiple conductors, and successive characters are transmitted sequentially. Where 2-wire communication lines are employed, data transmission will necessarily be "serial by bit;" i.e., each bit of each character is transmitted sequentially over the same pair of conductors. A Bell Data-Phone subset is commonly used at each sending and receiving terminal to perform the necessary conversions between the parallel and serial transmission modes. Several systems can utilize either multi-conductor cables or 2-wire communication lines.

.633 Range

The maximum allowable distances between input stations and central recorders in cable-connected systems are listed here. Where common-carrier telephone lines are used, the range is essentially unlimited.

.64 Costs

The approximate single-shift monthly rental prices for each input station, central recorder, and control unit (when required) are listed here. Where there is a choice of two or more models with different capabilities, the price range is shown.

The "Typical 10-Station System" is defined as a small, off-line system providing ten input stations capable of accepting card, badge, and variable input data (where available); one central recorder; and any required central control units. Costs of cables, transmission lines, subsets, and installation are not included in the indicated monthly rentals.

.7 CHARACTERISTICS OF INDIVIDUAL SYSTEMS

.71 Control Data Transacter System

The Transacter System was developed and originally marketed by the Stromberg Division of General Time Corporation, but Control Data Corporation purchased all sales and engineering rights to the system in February, 1964. Control Data announced at that time that it plans to continue marketing the Transacter System without significant changes to its specifications.

The Transacter System consists simply of remotely operated Input Stations and a central Compiler (receiver-recording station). Up to 36 Input Stations can be connected to a single Compiler.

Each input station can perform the following tasks: accept prepunched input data from punched cards or badges; provide dials for setting variable information such as quantities and transaction codes; and emit fixed information such as location codes and programming instructions from a plugboard, as required by the individual application. A system of interlocks requiring correct precomposition of the message prior to transmission helps to reduce input errors.

Activated by a Transmit bar, and without further human intervention, the Input Station transmits the data to the Compiler over a cabling network which can extend up to 2,500 feet in length. The Compiler adds to the message the date, time, and shift information, end of message code, and any needed instructions for subsequent processing equipment. The final message is normally punched on paper tape at a speed of 60 characters per second. Any of the standard sizes and levels of paper tape can be used.

The Compiler verifies the accuracy of the message by comparing its length to a predetermined program, and by performing a parity check on each character transmitted.

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The output tape is in suitable form for use in communications systems, in tape-to-card converters for tabulating equipment, or for direct input into a high-speed page printer. Recent announcements indicate that the Transacter equipment can now provide output on magnetic tape or directly into a computer system.

.72 Control Data 8010 System

The 8010 system was announced by Control Data Corporation in June, 1964. It accepts fixed input data from punched cards and/or variable data from ten 10-position dials. Output is normally on 7-level magnetic tape. Data is transmitted at the rate of 54 characters per second over either 24-wire cables or 2-wire communication lines. Up to 128 input stations can be tied into a single system. The 8010 system can be connected to existing Control Data computers for on-line use.

.73 Digitronics 201/751 Data Collection System

The Digitronics 201/751 system includes input card reading stations with manual entry capability (the D201 and variants) and a message collection and recording center (the D751) which accepts and checks complete messages from any number of input stations. Accepted messages are transferred to magnetic tape or punched tape, or directly into a computer. Both fixed and variable numeric information can be transmitted at a speed of 50 characters per second. Fixed input data is obtained from prepunched cards, while variable input data can be entered manually by means of thumbwheel switches or by a 15-digit keyboard. Restricted input can be obtained on one model by placing a plastic cover over the thumbwheel switches.

The operating procedure consists simply of setting the variable data and inserting a card into the reading station. Messages received at the collection point are checked for correct parity. Should an error occur, the message is rejected and the operator is alerted. If the message is properly received, a positive acknowledgement is returned to the operator, indicating that the next message may be entered into the system.

Transmission is parallel by character, using 10-wire cables at distances up to 2,500 feet. Conventional leased communications lines can be used for greater distances.

Digitronics Corporation states that the 201/751 system is aimed primarily at folder and paper control operations, as opposed to normal industrial uses, and that a high degree of customization is offered to meet specific user requirements.

.74 Friden Collectadata 30 System

The Friden Collectadata 30 System consists of three basic components: Transmitters, Receivers, and a Control Console. Identification Badge Reader Stations are offered as optional equipment. These units can transmit and receive alphanumeric information over an intra-company cabling network up to two miles long, at a maximum speed of 30 characters per second. Fixed input data is obtained from standard prepunched cards or plastic badges. Variable input can be selected manually by means of 10 front-panel dials and a 7-position transaction selector. Restricted entry dials are also available for occasional use. All characters and code groups that make up the Friden Systems code (65 total) can be handled by the system.

The receiving station consists of a central control console and one or more paper tape punch receiving units that produce the system output on 8-channel paper tape. All transmission cables terminate at the control console, which allows an operator to connect or disconnect any receiver to/from any transmitter, as the need arises. A central time recorder is also included in the console to register the time of day for each transaction. Provisions are available for connecting up to 20 transmitters (card readers and/or badge readers) and up to 22 receivers to each central control console.

The general operating procedure consists of inserting the proper card or badge into the transmitter, setting the appropriate dials and transaction selector, and depressing a Start switch. The remainder of the operation is entirely automatic, including the generation of error indicating signals at both the sending and receiving terminals, and the granting of priority to the next transmitter requiring the cable network.

The Collectadata System can be used in conjunction with leased communications lines to provide long distance hook-ups between any desired points. An optional Automatic Program Control feature switches the entire system into an attendance recording mode up to 4 times during a 24-hour day.

.75 General Electric 3101 System

The GE 3101 Data Accumulation System consists of from 1 to 10 Collectors that accept input from punched cards and/or dials, and a single Accumulator that receives and converts the transmitted data into 8-level punched tape codes. The components are connected by 33-wire cables

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whose maximum length is 10,000 feet. Fixed alphanumeric data on punched cards of 24 to 80 columns is read and transmitted at 60 characters per second. Variable numeric data is entered by means of 18 rotary dials and transmitted at 110 characters per second. Use of eight of the dials can be restricted by means of a locked cover plate. There is also a 12-position Message Type dial for transaction code entry.

Messages may consist of data from a single card only, from the dials only, or from a combination of the dials and any number of punched cards. The operator inserts the proper card into the reader on the right side of the collector, sets the appropriate variable dials and Message Type dial, and presses one of three transmission buttons. A Busy light on the Collector remains on until transmission of the message has been completed. Time and date information can be added to the transmitted message by an optional clock in the Accumulator.

Transmission accuracy is checked by a character parity check (standard) and a digit sum check (optional). When the digit sum check is used, each message must consist of an even number of characters.

The GE 3101 system can be connected to a GE 200 series or 400 series computer for on-line operation.

.76 IBM 357 Data Collection System

The IBM 357 Data Collection System is designed primarily as an off-line (intra-plant) system, although facilities are available for connecting the system on-line to an IBM 1440 or 1460 computer. Input can be read from standard 80-column prepunched cards, from 22-column-wide identification badges, or from up to 12 manually set 11-position slides. Designated card columns, badge columns, and/or slides can be read or not read depending upon "instruction codes" in specific card columns.

The off-line output medium in this system is punched cards. A modified version of either the IBM 24 or 26 Card Punch is used to produce output at a rate of up to 20 characters per second. A switching control unit enables up to 20 input stations to be connected to one card punch. Switching is accomplished by sequential scanning of "ready" input lines; from 35 to 700 milliseconds are required to search through all 20 input stations for a waiting station. The output format can be controlled by a combination of program card and patch-panel wiring, and data can be punched into any or all of the 80 columns in each output card.

Transmission of data is automatic upon insertion of a card or badge into the proper reader slot. Variable data can be set up off-line and then transmitted under control of the card reader. Discrepancies in transmitting (either by commission or omission) are indicated by lights, and up to 15 seconds are allowed for making any necessary corrections to the current transaction; otherwise, the entire transmission must be repeated. A transaction can consist of any number of cards in sequence, so that the 15-second wait period is valuable in case an error is made near the end of a long transaction.

The 357 system offers several features that can be incorporated into an installation at the user's option. Among these are:

- Portable manual entry units (Cartridge Readers) which permit off-line composition of variable data.
- Readout Clock for automatic recording of time at end of each transaction.
- Switch control for automatically switching to a back-up punch.

.77 IBM 1001 Data Transmission System

The IBM 1001 Data Transmission System consists of a network of 1001 Data Transmission Terminals transmitting data over leased or toll telephone facilities to one or more centrally located card punches. Input can be read from standard 80-, 51-, or 22-column cards or entered manually on a 10-digit keyboard. The basic system accepts only numeric data and can read only the first 22 columns of a card. The optional alphabetic features permit transmission of the 10 digits, 26 letters, and 3 special characters from the first 36 columns of a card. Data transmission speed is approximately 12 columns per second.

The receiving station consists of an IBM 24 or 26 Card Punch equipped with a data translator, a conventional telephone equipped with an exclusion switch, and a receiving data subset. The output format can be controlled by a program card, and data can be punched into any or all of the 80 columns in each output card.

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Contact is established by dialing the receiving station from the telephone associated with the transmitting 1001 terminal. The sending and receiving operators can speak to each other when data is not being transmitted over the line. An unattended receiving station can "answer" a call and start accepting data automatically. A parity check is performed upon each character at the receiving station, and a record-length check can be programmed.

Unlike most of the other systems described in this survey, the IBM 1001 system is not well suited for in-plant use by production workers. It is intended to be used by specially trained office employees, and is particularly suitable for linking branch offices with the home office.

.78 IBM 1030 Data Collection System

The IBM 1030 Data Collection System is designed primarily for two-way communication between remote plant locations and a central processing area. Input can be from prepunched cards, identification badges, manual entry slides, or preset data cartridges. A variety of input stations are available for handling various combinations of these inputs.

The input stations are also available with two types of line capabilities. A "control" station (model A) operates over two-wire communications lines while a "satellite" station (model B) transmits over multi-wire cable attached to a control station. This flexibility permits a wide variety of system configurations with varying combinations of control and satellite stations. The maximum number of control and satellite stations per communication line is:

- 10 control stations per communication line.
- 8 satellite stations per control station.
- Total of 24 control and satellite stations per 2-wire communication line.

The 1030 system transmits all input data to the central processing area in a serial-by-bit form at 60 characters per second. It can be used on-line with IBM System/360, 1440, or 1460 computers.

Each control station provides for the connection, by an additional multi-wire cable, of up to 9 printers. The printers, in conjunction with an input control station, give the 1030 system on-line inquiry and reply capabilities to and from the computer. Up to 9 printers can be connected to an input control station, but no more than 24 can be connected across any one 2-wire line.

A 1026 or 1448 Transmission Control Unit (at the computer site) controls message reception, character assembly, polling of communication lines, and other related functions. The 1448 can handle as many as 20 lines. Optional automatic time equipment can be included which records the time of day for each transaction.

For off-line applications, punched card output can be produced by connecting one or more 1034 Card Punch units to the transmission line(s). One or two punches can serve as output for any combination of up to 24 input stations. Input station polling, as well as parity and message length checks, are performed at the card punch.

.79 RCA EDGE System

The RCA EDGE System (Electronic Data Gathering Equipment) transmits data from remote points to a central location for recording on punched paper tape or for direct on-line input to an RCA 301 or 3301 computer. In addition to reading input data from pre-punched cards or tokens (badges), the remote input stations can handle manually-selected variable data in numeric or (optionally) alphanumeric form. The data is represented by 6-bit binary-coded characters (plus an odd parity bit) and is transmitted over ordinary two-wire lines in a phase-modulated serial-by-bit mode. Maximum transmission speed is 27.7 characters (250 bits) per second.

Central switching facilities are provided by automatic "Line Concentrators" which are capable of handling fan-in ratios between 25:1 and 25:4 (input stations: recorders or computer terminals). The flexibility of the Line Concentrators enables the total transmission load to be distributed over all available receiving points. In addition, each Line Concentrator can be interconnected by trunk lines to other Line Concentrators so that any input station has access to any receiver.

Each Central Recorder station contains two independent paper tape punches that produce output on 7-channel paper tape. Automatic time equipment is included which registers the time of day for each transaction. A special Central Receiver Terminal unit is used to provide direct input to a computer from a Line Concentrator. Through the use of a Communication Mode Control (CMC), the on-line EDGE System can be used as part of a two-way real-time network with the ability to request information through auxiliary inquiry stations and receive answers from the computer.

Comprehensive error checking is performed by the EDGE system. When a transmission error is detected, the message is automatically retransmitted.

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COMPARISON CHART: TRANSMITTING DATA COLLECTION SYSTEMS

MANUFACTURER SYSTEM	CONTROL DATA TRANSACTER	CONTROL DATA 8010	DIGITRONICS 201/751	FRIDEN COLLECTADATA 30	GE 3101	IBM 357	IBM 1001	IBM 1030	RCA EDGE
INPUT									
Punched Card Input									
Columns/card	15, 22, or 80	28 to 80	up to 50	up to 80	24 to 80	up to 80	up to 36	up to 80	up to 80
Cards/transaction	1, 2, or 3	up to 4	1	1 or 2	unlimited	unlimited	unlimited	1 or 2	1 or 2
Badge Input									
Columns/badge	15 or 22	none	none	10	none	10	none	10	1 to 12
Badges/transaction	1			1		unlimited		1	1
Variable Input									
Type	10-position dials	10-position dials	10-position switches	12-position dials	12-position dials	11-position slides	10-digit keyboard	11-position slides	levers
Digits/transaction	6	10	5	10	10	6, 9, or 12	variable	12	10 or 25 (4)
Restricted Input									
Type	plugboard	programmed	covered switches	covered dials	covered dials	slides can be locked	none	slides can be locked	coded plug
Digits/transaction	10	no limit	5 (1)	8	8				3
Transaction Codes (No.)	10	9	none	7	12	10	none	10	11 or 18
Automatic Reset	yes	yes	no	yes	yes (1)	yes	yes	yes	yes
Visible Settings	yes	yes	yes	yes	yes	yes	no	yes	yes
OUTPUT									
Medium	punched tape	magnetic tape or CDC computer	magnetic tape, punched tape, or computer	punched tape	punched tape or GE computer	punched cards or IBM 1440 or 1460 computer	punched cards	punched cards or IBM 1440, 1460, or 360 computer	punched tape or RCA 301 or 3301 computer
Code	5-, 6-, 7-, or 8-level	7-level	BCD	8-level	8-level	Hollerith or 6-bit BCD	Hollerith	Hollerith or 6-bit BCD	7-level
Maximum Input: Output Unit Ratio	36:1	128:1	50:1 or greater	20:1	10:1	20:1	unlimited	24:1	25:1
Error Checks	input interlocks, message length, parity, special circuit checks	parity, message length, and special checks	parity, message length	input interlocks, message length, parity	parity, digit sum check	input interlocks, message length	message length, parity	input interlocks, parity, message length, punch comparison check	input interlocks, parity, start-end sequence, message length
Time Recording	yes	yes	yes (1)	yes	yes (1)	yes (1)	no	yes (1)	yes
Data Recording	yes	yes	yes (1)	yes	yes (1)	no	yes	no	yes
Feedback Capability	no	yes	no	no	(5)	(5)	no	yes	(5)
TRANSMISSION									
Speed (char/sec)	60	54	50	30	60 (cards) or 110 (dials)	20	12	60	27.7
Line Requirements	16- to 60-wire or 2-wire	24-wire or 2-wire	10-wire or 2-wire (3)	15-wire or 2-wire (3)	33-wire	41- to 66-wire or 2-wire (3)	2-wire (3)	2-wire	2-wire
Range	2,500 ft (2)	2,500 ft (2)	2,500 ft (2)	2 miles (2)	10,000 ft	5,500 ft (2)	(2)	8 miles (2)	(2)
COSTS (PER MONTH)									
Input Station	$68	$50	$40-140	$40-70	$61.50-71.50	$29-67	$15-23	$100-140	$69-135
Central Recorder	$350	$725 & $250	$600-3,200	$46	$45-75	$67 or 87	$95-135	$370	$400
Control Unit	$40 (1)	$275	none	$78	none	$79	none	none	$215
Typical 10-Station System	$1,030	N/A	$2,700	$824	$790	$816	$365	$1,620	$1,305

(1) Optional
(2) Range is essentially unlimited when telephone lines are used.
(3) A Data-Phone subset is required at each transmitting and receiving station for 2-wire operation.
(4) Variable input data may be alphanumeric.
(5) Feedback can be obtained through use of other units producted by this manufacturer.

SPECIAL REPORT

HOW COMPUTER RENTAL TERMS LOOK IN 1965

Prepared by

The Technical Staff of
AUERBACH Corporation

AUERBACH SPECIAL REPORT
HOW COMPUTER RENTAL TERMS LOOK IN 1965

.1 INTRODUCTION

At the heart of every computer procurement study is one principal question: "Which computer system will do the job at the lowest overall cost? " Despite its obvious importance, this question is a difficult one to answer accurately because of the numerous relatively intangible factors such as equipment reliability, availability and competence of the manufacturers' support personnel, software performance, and programming difficulty. Even the true cost of the computer equipment itself can be hard to pin down because of the complicating effects of varying extra-usage charges, down-time credits, discounts, and purchase options.

An accurate analysis of relative equipment costs involves projections of the monthly use of each system throughout the contract period, plus a study of the implications of all the clauses in each contract. The evaluation of such a study is difficult because most of the standard computer rental contracts fail to cover certain major cost factors. Often the contracts do not define potentially important points such as whether or not set-up time is to be included in chargeable machine usage time. Extra-usage charges are often established by individual branch managers rather than by specific terms in the standard contracts. In general, equipment rentals during the first decade of the computer era have been handled in a suprisingly informal way, perhaps because the essential question often was "Will it ever work?" rather than "Will it always work?"

Now that computers are a vital cog in most business organizations, rental contracts are more important than ever. A well-prepared contract* should show what costs the user will need to bear during the installation period and exactly how much help he can count on from the manufacturer. It should show how much computer time is allowed under the basic rental charge, how operational time is to be computed, the cost of extra time, and the discount, if any, that is applicable when the equipment is not fully utilized. It should show what the user can expect when a breakdown occurs: how soon the service engineer should arrive and what credits are allowed for time lost due to the breakdown. A well-prepared computer rental contract should cover all these and numerous other points that may involve major expenditures by one of the contracting parties.

Unfortunately, although contract terms are becoming increasingly important, objective comparisons between the terms offered by different manufacturers are still very difficult to make. Differences in terminology and frequent omissions of important factors from the standard contracts continue to make it hard for the prospective user to evaluate all of the alternatives.

The objective of this survey is to summarize, in plain, concise English, the major provisions of the standard commercial and government computer rental contracts currently being offered by eight major U.S. manufacturers. A knowledge of the terms that all eight manufacturers are prepared to offer can clearly strengthen the prospective user's bargaining position when negotiating with any one manufacturer.

.2 ORGANIZATION OF THE SURVEY

The arrangement of the tables which summarize the results of this survey is based upon the U.S. Government's Invitation for Bids to manufacturers of data processing equipment (General Services Administration Solicitation No. FPNN-E-27286-N-2-1-65, issued January 11, 1965). The General Services Administration issues such an Invitation for Bids each year; then it negotiates a one-year contract, running from July 1 to June 30, with each computer manufacturer. This contract, which in some cases is not finally negotiated until after July 1, then forms the standard contract between all Federal agencies and the manufacturer concerned.

* For advice on preparing a contract that will help to minimize the costs and maximize the value of your computer system, see the earlier AUERBACH Special Report, "Factors to Consider in Contracting for an Electronic Data Processing System," on page 23:010.001.

.2 ORGANIZATION OF THE SURVEY (Contd.)

Because the U.S. Government is such an important computer user, the aims of its negotiators and the contracts which they negotiate are extremely influential in setting computer marketing trends. The aims of the negotiators are clearly indicated in the Invitation for Bids, which forms the basic framework for each round of contract negotiations, and the contracts themselves are part of the public records.

The tables that follow summarize the contract terms which are being sought by the U.S. Government negotiators for the coming year's contracts, with references to the particular section of the current Invitation for Bids that provides a detailed explanation of each point. Alongside the terms currently sought by the U.S. Government for each contract factor, the tables summarize the terms currently offered (as of May, 1965) in the standard government and commercial computer rental contracts of each of the following manufacturers: Burroughs, Control Data, General Electric, Honeywell, IBM, NCR, RCA, and UNIVAC The tables were prepared by obtaining, analyzing, and summarizing a copy of each manufacturer's Authorized Federal Supply Schedule Price List for July 1, 1964, through June 30, 1965, and (where available) a standard commercial contract form. The material to be published was submitted to each manufacturer for prepublication review and was discussed with the manufacturers' designated representatives for verification and clarification where necessary.

.3 CONCLUSIONS

In compiling and analyzing the tables of computer rental terms, the AUERBACH Standard EDP Reports staff arrived at four significant conclusions:

(1) Commercial contracts tend to omit many of the user safeguards that U.S. Government contracts include.

(2) Terms in the standard contracts, both commercial and government, vary widely enough so that they may well constitute a decisive factor in the decision to rent a specific computer system.

(3) Most manufacturers are willing, in varying degrees, to alter the terms of their standard contracts through clauses which are added during contract negotiations.

(4) From the user's viewpoint, standard contracts as presently written are inadequate in a number of important respects.

Looking at these conclusions in turn, among the subjects which simply are not specified in most of the standard commercial contracts are: firm delivery dates for hardware and software, standards for acceptance tests (or even the existence of such tests), and guidelines for assessing penalties for nonperformance. It would be nice to believe that all the equipment will be delivered on time, that all the required software will be available when needed, and that both the hardware and software will always perform according to expectations; but these are assumptions that no businessman can afford to make without some clearly-specified assurance — such as the terms requested by the U.S. Government negotiators.

Areas where the standard contract terms vary among the different manufacturers seem to be more prevalent than areas where the terms are in agreement. Extra-time charges (for operation beyond the time allowed by the basic monthly rental) can effectively double the rental cost of some computer systems, while involving no extra cost on others. Purchase options, by crediting some portion of the previously-paid rental charges, can reduce the purchase price of a system by 75% or more in some cases, or by a maximum of only 20% in others; the options are free in some cases, but involve an extra cost in others. Discounts for users who cannot keep their equipment busy throughout a full shift now appear in some contracts, but not in others.

Most of the standard commercial contracts are far from sacred, so the user is likely to find it worthwhile to engage in some bargaining before signing on the dotted line. During the preparation of this survey, we received comments from manufacturers' representatives which indicated that they are in a position to offer varying degrees of flexibility in their contract terms, depending upon the particular user's needs, the competitive situation, the potential for additional business, and other variable factors. This flexibility of terms applies to various manufacturers' policies regarding delivery, extra-time charges, acceptance tests, performance standards, program testing time, purchase option credits, and nearly every other item in the standard contracts except the basic monthly rental. Checks among computer users confirmed that contracts

(Contd.)

.3 CONCLUSIONS (Contd.)

currently in force do vary significantly from one another as a result of clauses added during negotiations.

Most of the current standard contracts do not offer the computer user as much protection as he might reasonably expect. None of the standard contracts reviewed in this survey contains any assurance that the program run times or software performance promised in the manufacturer's proposal will actually be achieved, nor any penalty for failure to achieve the anticipated throughput in the user's installation. Even where damages are specified in the standard contracts, the liability rates are generally inadequate to compensate for the actual losses; hence, the user generally remains "locked in" and must try to make the best of a less-than-satisfactory situation. Despite the recent emphasis on "integrated product lines," none of the current standard contracts assures the user that a faster, program-compatible system will actually be available to him when he needs it. Such assurance would help the user to formulate his future expansion plans with far greater confidence.

In the earlier Special Report on page 23:010.001, we suggested and explained the factors that should be considered when negotiating a computer contract. The survey tables that follow summarize the standard contract terms that are currently applicable (as of May, 1965) when computer systems are rented. The information in these two Special Reports should be well worth studying at an early stage in every computer procurement program, and judicious use of this information should help to insure that the resulting contract will be a relatively comprehensive and satisfactory one.

COMPUTER RENTAL TERMS

SUBJECT MATTER	TERMS SOUGHT BY U. S. GOVT. (From Solicitation of 1/11/65)	BURROUGHS STANDARD TERMS		CONTROL DATA STANDARD TERMS		GENERAL ELECTRIC STANDARD TERMS		HONEYWELL STANDARD TERMS		IBM STANDARD TERMS		NCR STANDARD TERMS		RCA STANDARD TERMS		UNIVAC STANDARD TERMS	
		Commercial (5/65)	Government (7/64-6/65)	Commercial (5/65)	Government (7/64-6/65	Commercial† (5/65)	Government 7/64-6/65)	Commercial (5/65)	Government (7/64-6/65)	Commercial (5/65)	Government (7/64-6/65)	Commercial (5/65)	Government (7/64-6/65)	Commercial (5/65)	Government (7/64-6/65)	Commercial†† (5/65)	Government (7/64-6/65)
What is the minimum rental period?	One year or less. (Ref: Sect. A-1, 1(a).)	2 years	1 year or less	1 year	1 year or less		1 year or less	1 year	1 year or less	1 year for the agreement	1 year or less	1 year	1 year or less	1 year	1 year or less		1 year or less
How much notice is needed to cancel the contract?	90 days for a complete computer system, or 30 days for any component of a system (Sect. A-1, 1(a).)	90 days	System — 90 days Parts — 30 days	System — 90 days Parts — 30 days	System — 90 days Parts — 30 days		System — 90 days Parts — 30 days	3 months	System — 90 days Parts — 30 days	System — 3 months Machine — 1 month	System — 90 days Parts — 30 days	90 days	System — 90 days Parts — 30 days	3 months	System — 90 days Parts — 30 days		System — 90 days Parts — 30 days
What software is to be supplied, and when?	As written into the contract, plus further future work developed by the manufacturer for general use. (Sect. A-1, 2(b).)	Unspecified	As request by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Service and utility routines.	As requested by U.S. Govt. (See 2nd col.)	Unspecified	Items selected from RCA lists, plus further future work developed for general use.		As requested by U.S. Govt. (See 2nd col.)
What damages will be paid if the hardware is not delivered on time?	Basic rental of the system, with a minimum amount of $100 per day delayed. (Sect. A-1, 3(a).)	No liability	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	None — no guaranteed delivery date.	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)
What damages will be paid if the software is not delivered on time?	$100 per day per software item delayed, with a maximum amount of the basic machine rental. (Sect. A-1, 3(b).)	No liability	As request by U.S. Govt. (See 2nd col.)	Unspecified	Lesser of basic rental or $100 per day.		Lesser of basic rental or $100 per day.	Unspecified	Lesser of basic rental or $100 per day.	Unspecified	Lesser of basic rental or $100 per day.	Unspecified	Lesser of basic rental or $100 per day.	Unspecified	Lesser of basic rental or $100 per day.		Lesser of basic rental or $100 per day.
What is the minimum acceptable performance during acceptance tests?	90% good time throughout 30 days running, with at least 100 hours used during the 30 days. (Sect. A-1, 4)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)
How many hours of operational use time per month is allowed in the basic monthly rental?	200 hours per month. (Sect. A-1, 5(c).)	176 hours	200 hours	176 hours	176 hours	GE-600 and Datanet-30 & 600 systems — unlimited; otherwise, 200 hrs/month.	GE-600 and Datanet-30 & 600 systems — unlimited; otherwise, 200 hrs/month.	176 on 1-year contracts; 200 on 3- year contracts.	200 hours	176 hrs.	176 hrs.	176 hours for NCR 315	200 hours for NCR 304. Unlimited for NCR 315.	Spectra 70 — unlimited use. Other systems — 200 hrs/month.	200 hours (Note: Spectra 70 not available before contract expires.)		200 hours
What is the extra usage rate, expressed as a percentage of the basic monthly rental hourly rate?	This is not mentioned in the Invitation for Bids.	40%	40%	Varies	Varies	20%	45%	40%	Approx. 45%	10% for most System/360 equipment; otherwise, normally 30%	10% for most System/360 equipment; otherwise, normally 30%	40%	40%	Vary with system and type of use; consult RCA.	RCA 3301 — 15%		25% of whole system rental, or 45% of processor rental
What is the standard rate for unlimited usage, expressed in terms of the basic monthly rental?	This is not mentioned in the Invitation for Bids.																
• 5-day week:		Unspecified	Unspecified	Unspecified	Unspecified	108%	Unspecified	140%*	140%*	Unspecified	Varies with each item of equipment	130%	Unspecified	Unspecified	Unspecified		130%
• 6-day week:		Unspecified	Unspecified	Unspecified	Unspecified	110%	Unspecified	150%*	150%*	Unspecified		139%	Unspecified	Unspecified	Unspecified		140%
• 7-day week:		Unspecified	Unspecified	Unspecified	Unspecified	112%	Unspecified	160%*	160%*	Unspecified		151%	Unspecified	Unspecified	120% for RCA 3301.		150%

† GE commercial terms are currently being revised.

* Reduced rates on Honeywell Series 200 equipment will be introduced 7/1/65.

†† UNIVAC commercial terms are currently being revised.

COMPUTER RENTAL TERMS (Contd.)

SUBJECT MATTER	TERMS SOUGHT BY U.S. GOVT. (From Solicitation of 1/11/65)	BURROUGHS STANDARD TERMS		CONTROL DATA STANDARD TERMS		GENERAL ELECTRIC STANDARD TERMS		HONEYWELL STANDARD TERMS		IBM STANDARD TERMS		NCR STANDARD TERMS		RCA STANDARD TERMS		UNIVAC STANDARD TERMS	
		Commercial	Government	Commercial	Government	Commercial †	Government	Commercial	Government	Commercial	Government	Commercial	Government	Commercial	Government	Commercial ††	Government
How is the amount of central processor time used computed for establishing the rental due?	Only that time between program START and program STOP, measured either by meters or by users' estimates. (Sect. A-1, 5(a).)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. on hourly contracts.	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)
How is the usage time of peripheral units computed for establishing the rental due?	Actual metered usage, where this is practical; otherwise program run time whenever the peripheral is used in the run. (Sect. A-1, 5(a).)	Any peripheral used is charged for full run-time.	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. (See 2nd col.)	As requested by U.S. Govt. on hourly contracts.	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)
How long will it take for a serviceman to respond to an emergency service call?	One hour maximum (Sect. A-1, 6)	Unspecified	Unspecified	Unspecified	Two hours		Unspecified	1 hour, under normal conditions.	1 hour, under normal conditions.	Unspecified	Unspecified	Unspecified	Unspecified	Unspecified	Unspecified		Unspecified
What credit is allowed to a user when his system is down?	Credit at basic rental rates whenever a down period exceeds 12 hours. (Sect. A-1, 6)	Unspecified	As requested by U.S. Govt. (see 2nd col.)	Credit at basic rental rates when fault	As requested by U.S. Govt. (see 2nd col.)		As requested by U.S. Govt. (see 2nd col.)	Unspecified	As requested by U.S. Govt. (See 2nd col.)	Unspecified	As requested by U.S. Govt. when production requirements interfered with.	Unspecified	Unspecified	Unspecified	As requested by U.S. Govt. (See 2nd col.)		As requested by U.S. Govt. (See 2nd col.)
How much computer time is provided free of charge before installation?	Enough time to put all the applications into operation on installation day. (Sect. A-1, 10)	Unspecified	Enough time to allow the major portion of a single shift to be utilized on installation day.	2 hrs /$1,000 basic rental	2 hrs/$1,000 basic rental		As requested by U.S. Govt. (See 2nd col.)	6 hrs/$1,000 basic monthly rental.	6 hrs/$1,000 basic month rental.	Unspecified allowance based on system configuration.		10 hrs./$1,000 basic rental.	NCR 310 - 20 hrs. NCR 304 - 40 hrs. NCR 315 - 40 hrs.	Unspecified	7 hrs/$1,000 basic monthly rental, subject to following maximum allowances: RCA 301 - 35 hrs. RCA 501 - 77 hrs. RCA 3301 - 85 hrs.		Per $1,000 basic monthly rental: U 1107 - 2 hrs. U 490 - 3 hrs. U III - 3 hrs. U 1050 - 7 hrs. USS - 7 hrs. U 1004 - 7 hrs.
How much computer time is provided free of charge after installation?	All available time outside basic rental period for the first 90 days, plus COBOL, FORTRAN, and ALGOL compilation time as required. (Sect. A-1, 10)	Unspecified	B 100 & 200: 6 hrs/$1,000 basic rental. B 5000 & 5500: 3 hrs/$1,000 basic rental. In all cases, compilation of debugged COBOL programs also allowed.	As requested by U.S. Govt. excluding any compilations.	As requested by U.S. Govt. excluding ALGOL and FORTRAN compilations.		40 hrs., plus all COBOL compilation & testing time.	Unspecified	Balance, if any, of pre-installation allowance.	All available time outside first shift, during first 30 or 90 days.	As requested by U.S. Govt. for most large tape & RAMAC systems. Otherwise 30 days only. COBOL compilation time allowed in addition.	Unused balance of preinstallation allowance.	Up to 10 hrs/ $1,000 basic monthly rental.	Unspecified	Unspecified		As requested by U.S. Govt. except that 90-day period applied only to U 490, III, & 1107. Otherwise, period is only 30 days.
What charge is made for machine time needed when free time allowances have been used?	Basic rental rate. (Sect. A-1, 10)	Unspecified	Basic rental rate	Basic rental rate	Basic rental rate		Unspecified	Unspecified	As negotiated	Basic rental rates	IBM Data Center rates	NCR Data Center rates	Basic rental rate	Unspecified	RCA System Center rates		Basic rental rate

† GE commercial terms are currently being revised.

†† UNIVAC commercial terms are currently being revised.

COMPUTER RENTAL TERMS (Contd.)

SUBJECT MATTER	TERMS SOUGHT BY U.S. GOVT. (From Solicitation of 1/11/65)	BURROUGHS STANDARD TERMS		CONTROL DATA STANDARD TERMS		GENERAL ELECTRIC STANDARD TERMS		HONEYWELL STANDARD TERMS		IBM STANDARD TERMS		NCR STANDARD TERMS		RCA STANDARD TERMS		UNIVAC STANDARD TERMS	
		Commercial	Government	Commercial	Government	Commercial†	Government	Commercial	Government	Commercial	Government	Commercial	Government	Commercial	Government	Commercial ††	Government
What reduction in monthly rental is allowed if full utilization is not achieved?	Some definite reduction is requested. (Sect. A-1, 5(e).)	166 hrs/month contracts can be pro-rated if between 83 and 166 hours used; 3-year contracts can allow for building from 125-hr usage for 75% to full use and rent in Year 3 (B 5500).	B 5000/5500 can be brought into use over two years, with reduced rent at 75% of basic rental for 125 hrs. being built up into full use.	No reduction	No reduction		No reduction	No reduction	No reduction	No reduction	No reduction	NCR 315 on a 3-year agreement can have 25% discount if used under 100 hours/month.	no reduction	No reduction	No reduction		No reduction
What discounts in the rental rate are applicable in special situations?	Discounts are requested for:																
	• Multiple systems	None	None	Unspecified	Unspecified		None	None	12% for 7 or more H-800s.	None	None	None	None	None	7% for 12 301s.		5% or 18%.
	• Educational use	None	None	20%	20%		Varies, 0-50%	25%	25%	Varies	20%	None	20%	20% on 301.	20 or 40%		20%
	• Hospitals (Sect. A-1, 5(e).)	None	None	Unspecified	Unspecified		None	None	None	None (some hospitals are considered educational).	None	None	None	20% on 301.	20% on 301.		None
What rental adjustments may come into force?	A rental adjustment is requested in each of the following circumstances:																
	° When the rental paid exceeds the purchase price of the equipment.	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.
	• Whenever the purchase price of the equipment is reduced.	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.
	° As soon as the equipment has become obsolete. (This is considered to occur as soon as a successor has been announced.) (Sect. A-1, 5(e).)	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.	No discount specified.		No discount specified.
What credit is allowed if a user purchases the equipment he has been renting?	The credit should take into account the physical age of the system rented, and the total rental paid by the user. (Sect. A-1, 19)	Unspecified.	Free credit of 60-65% of rental paid, with maximum credit of 60% of purchase price (75% for B-220).	Credit based on rental paid in specific years: 60% of Years 1 & 2, plus 40% thereafter, subject to 70% maximum. No charge made for option.	Credit based on rental paid in specific years: 60% of Years 1 & 2, plus 40% thereafter, subject to 70% maximum. No charge made for option.		Free credit of 50% of rental paid, up to 50% of purchase price.	Free credit of 70% of rental processor rental and 50-60% of peripheral rental paid during 1st 2 years of contract. Option lasts 2 years only.	Free credit of 70% of processor rental, and 50-60% of peripheral rental paid during 1st 2 years of contract. Option lasts 2 years only.	Option costing 1% of purchase price and valid for 1 year (2 years for state & local govts.) allows 45-70% of rental paid.	Option costing 1% of purchase price and valid for 2 years allows between 45-70% of rental paid. Another, free option allows up to 15% per year of machine age, up to specified limits.	Option costing 1% of purchase price and valid for up to 24 months allows between 50-70% of total rental paid as credit against purchase price.	NCR 304 offers free, no-time-limit option of 40-50% of rental paid, with max. of 60% credit. NCR 315 offers 24-month option costing 1% of purchase price allowing 50-70% of total rental paid as credit.	Free option of 65% (on Spectra 70 systems) or 45%-60% (on other systems) of total rental paid. Maximum credit: 75%.	Free option of 45-65% of total rental paid, depending upon system. Maximum credit: 75%.		Free option of between 40% and 65% of total rental paid within first 3 years.
What is the purchase price if a user purchases the equipment he has been renting?	The lesser of the then-current or the original purchase price. (Sect. A-1, 19)	Unspecified.	Lesser of current or original price.	Lesser of current or original price.	Lesser of current or original price.		Lesser of current or original price.	Lesser of current or original price.	Lesser of current or original price.	Original price.	Lesser of current or original price.	Lesser of current or original price.	Lesser of current or original price.	Original price.	Lesser of current or original price.		Lesser of current or original price.

† GE commercial terms are currently being revised.

†† UNIVAC commercial terms are currently being revised.

STANDARD EDP REPORTS

SPECIAL REPORT

DATA COMMUNICATIONS - WHAT IT'S ALL ABOUT

PREPARED BY

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SPECIAL REPORT
DATA COMMUNICATIONS - WHAT IT'S ALL ABOUT

.1 INTRODUCTION

Data communications is a new and rapidly expanding field that has emerged from a wedding of the communications and data processing technologies. The need for rapid, accurate transmission of data between the widely scattered plants and offices of modern corporations has imposed strong pressures upon both the communications common carriers and the computer manufacturers to develop the necessary techniques and equipment. Impressive progress has been made during the last few years, so that now nearly every company can find transmission facilities and equipment that will effectively fulfill its data communications needs.

U.S. industry is recognizing, at an ever-increasing rate, the advantages of company-wide data communications networks and of the closely related concepts of real-time data processing and integrated management information systems. Although only about 1 percent of the computers sold in 1965 were linked to a data communications system, Western Union has predicted that 60 percent of the computers likely to be sold in 1975 will be so linked. A.T.&T. expects that the volume of information transmitted in the form of digital data will eventually equal the volume transmitted by voice.

A data communications system can be considered to consist of a group of functional units whose primary purpose is to transfer digital data between two or more terminals in a reliable manner. Each unit has a specific set of functions to perform; the exact functions and the sequence and manner in which they are enacted are determined by the overall system requirements. Because system requirements vary from business to business and from application to application, the data communications systems in use today vary widely in their functions, their structures, and their degree of complexity. Some systems transfer messages between remote terminals via one or more switching centers where communications processors are located; other systems transmit inquiries from numerous remote terminals to a central data processing facility, which generates responses and routes them back to the inquiring terminals. The design of systems such as these demands a thorough knowledge of both communications and data processing technology.

This report provides an introduction to the concepts and techniques that should be understood by every prospective user of a data communications system. The sections that follow describe the types of applications in which data communications systems are being effectively employed, the factors to be considered in designing a system, the various components of a system and their functions, and the communications facilities and services provided by the common carriers.

This Special Report, which constitutes an introduction to the concepts and equipment involved in the design of modern data communications systems, is also appearing as a feature article in the April 1966 issue of Data Processing Magazine. The report is based upon material extracted from the System Design section of AUERBACH Data Communications Reports, another analytical reference service from AUERBACH Info, Inc.

.2 APPLICATIONS

Current applications of data communications systems vary widely in their functions, their scope, and their equipment and programming requirements. New applications are being developed every day, and it would clearly be impossible to describe, or even list, all of the specific applications in which data communications equipment is being used. A more rational approach is to divide the total spectrum of data communications applications into a few fundamental "application classes," each performing a certain general function and involving a certain type of data flow pattern. Most specific applications will then fall neatly into one application class or combine the functions of two or more classes.

Although coarser or finer breakdowns could be justified, it seems reasonable to consider six fundamental application classes. The function and data flow pattern of each of these classes are described in the paragraphs that follow.

.21 Data Collection

The function of this class of applications is the collection and transmission to a central processing point of information concerning the operations of geographically separated manufacturing plants, warehouses, branch and regional sales offices, and other outlying facilities. The basic data flow pattern is unidirectional, from multiple remote (and/or local) terminals to the central processing facility. This type of system can: (1) provide the complete, timely information about a firm's overall operations that is required for accurate cost control and informed management decisions, and (2) reduce the number of times and places at which data must be manually handled and transcribed, thereby cutting clerical costs and error rates.

.22 Data Distribution

In this class of applications, the principal function is the distribution of data generated and/or processed at a central facility to one or more outlying locations. Again the basic data flow pattern is unidirectional, from the central facility to the remote (and/or local) terminals. This function, of course, is the complement of the data collection function described in the preceding paragraph, and many data communications systems combine the collection and distribution functions. To appreciate the potential value of a data distribution system, it is necessary to realize that data has no real value until it has reached the actual point of application in a useful form. Significant financial benefits can frequently be realized through cutting down the elapsed time and improving the accuracy of the data dissemination process.

.23 Inquiry Processing

To meet the competitive demands of modern business, many firms are finding it desirable (and in some cases essential) to "go on-line" by establishing central data files that can be randomly accessed to provide prompt responses to inquiries from outlying locations. In this class of applications, the basic flow pattern is bidirectional; inquiry messages are transmitted from a network of remote terminals to the central processing facility, and appropriate response messages are generated and transmitted back to the inquiring terminals.

The inquiry processing function is frequently combined with real-time file updating; the appropriate entries in the central data files are modified each time a transaction occurs so that the central files always reflect the true current status of the business. Although inquiry processing and real-time file updating systems promise great benefits for nearly every type of business organization, their advantages in terms of faster response and centralized control should be carefully weighed against their costs to ensure that the higher direct cost of a real-time system, as compared with that of a more conventional batch-type processing system, is worthwhile. Real-time inquiry systems are especially beneficial for organizations such as banks, brokerage firms, airlines, and hotels, where prompt servicing of customer inquiries is of critical importance.

.24 Computer Load-Balancing

Organizations that have two or more computers in geographically separated locations may find it advantageous to connect them by means of communications links. This permits more effective utilization of each of the interconnected computers because the slack time in one computer's schedule can be used to help smooth out the peaks in another's. Reliability is greatly enhanced because the communications links make it easy for one or more computers to take over another computer's workload when a breakdown occurs. The data flow pattern in this class of application is bidirectional; input data and results are transmitted between each pair of interconnected computers, and the volume of data flow depends upon their relative workloads at any given time.

(Contd.)

.25 Computer Time-Sharing

In an effort to make the facilities of a computer system conveniently available to multiple users, extensive development work is in progress on "time-sharing" systems. The design objective of a time-sharing system is to furnish continuous computing service to many users simultaneously, while providing each user with virtually instantaneous responses. Multiple consoles, each equipped with appropriate input and output facilities, are employed, and each console is connected to the central computer facility by a communications link. (Some or all of the consoles are likely to be close enough to the central facility so that direct cable connections can be used.)

The basic data flow pattern in a time-sharing system is bidirectional and similar to the pattern for the inquiry processing class of applications; input data and operating instructions are transmitted from the consoles to the central computer facility, and the results of computations are transmitted back to the appropriate consoles. The widely-discussed "public utility" computer concept, in which multiple subscribers would share the facilities of a giant centralized computer complex on a toll basis, is a logical extension of the computer time-sharing class of applications.

.26 Message Switching

The activities of a modern corporation tend to be spread out over a large number of widely separated locations, and an efficient system for handling communications among all these locations is vitally necessary. Where communications traffic is high, a computer-controlled message switching system is likely to be the best overall choice. In this type of application, the data flow pattern involves two-way message traffic between a number of terminals and a central switching center. The sending terminal transmits each message to the center, which stores it temporarily, performs any processing or code conversion functions that may be required, and then transmits the message to one or more designated receiving terminals. Large networks may utilize two or more switching centers which are interconnected by high-speed communications links.

.3 SYSTEM DESIGN

The installation of a data communications system should always be preceded by a thorough study and re-evaluation of the patterns of information flow throughout the organization. Money spent in simply mechanizing the existing procedures for collecting, transmitting, and disseminating information is likely to be largely wasted. The real purpose and need for every type of information that is currently being transmitted should be questioned. It is likely that most executives are regularly receiving some information that is of little or no value to them, while failing to receive other information which could aid significantly in decision-making and cost control, and which could easily be provided if the need were recognized. In some cases, the improved flow of information resulting from such a thorough study of information needs will provide far greater benefits than the data communications equipment itself — and may even preclude or postpone the need for mechanization of the information system.

.31 Information Flow Requirements

In order to determine the most suitable structure for a specific data communications system, a number of basic factors must be evaluated. These can generally be described as the "information flow requirements," and they include the following:

- The number of data sources and points of distribution, and their locations.
- The volumes of information (in terms of number of messages and lengths of messages) that must flow among these locations.
- The intervals at which messages will be transmitted. Are these intervals fixed or random? What are the peak rates, and at what times of day will they occur?
- The form of the data to be transmitted.
- The form in which the data must be when received.
- How soon the information must arrive at its destination to be useful. How much delay is permissible, and what are the penalties for delay?
- The reliability requirements. What degree of accuracy must be maintained in the transmitted data? What is the penalty for system failure?

.32 Using Existing Facilities

Usually, by the time the need for data communications develops, a company has established extensive voice and message communications facilities. The locations served by these existing facilities frequently include the locations to be served by the proposed data communications network. A serious study of the implementation of a data communications system must include an analysis of the company's present communications facilities and the ways in which they can be employed. For example, leased lines may currently carry little or no traffic at night; these lines could be used for the transfer of data during the slack hours at no increase in the present cost of communications facilities other than for switching, termination, and terminal devices. Use of present facilities requires close coordination between the company personnel responsible for general communications and the personnel responsible for data communications. The local common-carrier communications consultants should be contacted for help in determining the ways in which existing facilities can best be used or modified for data communications.

.33 Design Problems

The design of a data communications system requires a careful analysis of the foregoing factors. It also demands satisfactory solutions to a wide variety of potential problems, many of which are interrelated in complex ways. These problem areas include the following:

- Estimating the volume of data to be transmitted, now and in the future, and the associated traffic statistics.
- Providing for traffic overloads.
- Distributing the storage and computer capabilities to best fulfull the system requirements, and balancing these capabilities with the capacities and speeds of the transmission facilities to minimize the overall cost.
- Optimizing the system configuration in terms of fulfulling reliability and backup requirements and maintaining continuous, efficient operation.
- Selecting adequate yet economical error detection and correction techniques.
- Establishing the programming requirements for any communications processors, and specifying the necessary storage and processing capabilities.
- Formulating a training program for operating and maintenance personnel, and an indoctrination program to help all employees understand the purpose of the system and its effects upon their jobs.

A design problem of a slightly different character, but one that deserves considerable emphasis, is the development of a system that is "open-ended"; i.e., one that is capable of expansion to handle new plants or offices, higher volumes of traffic, new applications, and other difficult-to-foresee developments associated with the growth of the business. The design and implementation of a data communications system is a major investment; proper planning at design time to provide for future growth will safeguard this investment.

These design problems cannot be treated separately; they are interrelated through the various system parameters, so that a decision that solves one problem may lead to a variety of others. Tradeoffs become necessary among the equipment, the programming systems, the communications facilities, and the operating requirements. A clear, explicit statement of the goals to be accomplished will aid greatly in determining the appropriate tradeoffs.

.4 SYSTEM COMPONENTS

Figure 1 illustrates how data flows between two terminals in a typical data communications system of the basic point-to-point type. In most cases, several of the functional units shown in the diagram are housed in a single cabinet and marketed as a single communications terminal device. Each of these functional units is briefly discussed in the following paragraphs.

.41 Input/Output Devices

The input device at the transmitting terminal may be a keyboard, paper tape reader, card reader, magnetic tape unit, or computer. The output device at the receiving terminal may be a tape punch, card punch, printer, magnetic tape unit, display device, or computer. Devices such as magnetic tape units and

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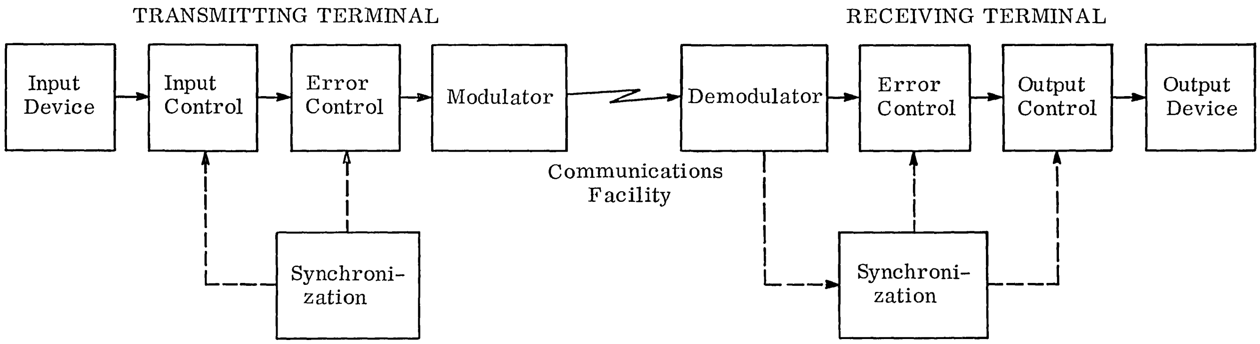

Figure 1. Data Flow in a Typical Data Communications System

.41 Input/Output Devices (Contd.)

computers frequently perform both input and output functions, either alternately or simultaneously.

The data communications terminals on the market today differ widely with respect to input/output media, speed, flexibility, operating convenience, compatibility with other equipment, and, of course, cost. The system designer's choice can range from conventional low-speed equipment (such as Teletype Corporation's low-cost and widely used line of teleprinters) to specialized high-speed devices (such as IBM's line of Synchronous Transmit-Receive Terminals, RCA's Video Data display units, and small programmable computers such as UNIVAC's 1004). Faced with such a wide variety of equipment choices, the system designer must approach the selection of terminal equipment in a systematic, objective manner.

Numerous data communications terminal devices are described in AUERBACH Standard EDP Reports. Table I lists some of these devices and the report sections where they are described.

.42 Input/Output Control Units

The input control unit at the transmitting terminal controls and accepts data from the input device at a rate that is usually dictated by the input device's speed. The control unit stores the data temporarily and transmits it at a rate compatible with that of the communications facility. At the receiving

TABLE I: REPRESENTATIVE DATA COMMUNICATIONS TERMINAL EQUIPMENT

Manufacturer	Equipment	Reference
Burroughs	B 493 Typewriter Inquiry Station	201:103, 203:101
GE	GE-115 Computer System	310:011
Honeywell	288 Data Station	510:108
IBM	1013 Card Transmission Terminal	420:106.128
	1050 Data Communication System	420:106.121
	1060 Data Communication System	420:106.122
	1070 Process Communication System	420:106.123
	2740 Communication Terminal	420:106.134
	2741 Communication Terminal	420:106.135
	7701 & 7702 Magnetic Tape Transmission Terminals	420:106.129
	7711 Data Communication Unit	420:106.131
	2260 Display Station	420:102
NCR	42-501 On-Line Window Machine	601:106
RCA	6050 Video Data Terminal	710:104
	6051 Video Data Interrogator	710:104
UNIVAC	Data Line Terminals (with UNIVAC 1004)	770:101

.42 Input/Output Control Units (Contd.)

terminal, the output control unit accepts the received data, stores it temporarily, and supplies it to the output devices at the appropriate rate. In control units which terminate more than one line, the type and capacity of the buffer storage is a primary concern because it determines the frequency at which each line must be serviced. Various types of buffers are available, such as magnetic core memories, magnetic drums, transistorized shift registers, and delay lines.

It should be noted that not all data communications terminals employ buffered input/output control units. When no buffers are used, the input, data transmission, and output functions must proceed simultaneously and at the same speed.

Complex data communications systems that terminate many lines in a central facility usually use either a multi-line communications controller in conjunction with a general-purpose computer or a specialized, stored-program communications processor. These units are capable of buffering and controlling simultaneous input/output transmissions on many different lines. Again, a wide variety of equipment is now available to perform these functions. The available devices differ in the number and speed of lines they can terminate and in their potential for performing auxiliary or independent data processing. Examples include the three multi-line communications controllers available for use with the general-purpose IBM System/360 computers and the Collins Data Central system, a computer system designed especially for message switching applications.

AUERBACH Standard EDP Reports contains descriptions of most of the communications control equipment that is available for use in conjunction with general-purpose computer systems. Table II lists some of these controllers and the report sections where they are described. More detailed analyses of an even broader range of communications equipment can be found in AUERBACH Data Communications Reports, the specialized AUERBACH Info, Inc. reference service for designers and users of data communications systems.

.43 Error Control Units

The primary purpose of a data communications system is to transmit useful information from one location to another. To be useful, the received copy of the transmitted data must constitute an accurate representation of the original input data, within the accuracy limits dictated by the application requirements and the necessary economic tradeoffs. Errors will occur in every data communications system. This basic truth must be kept in mind throughout the design of every system. Important criteria for evaluating the performance of any communications system are its degree of freedom from data errors, its probability of detecting the errors that do occur, and its efficiency in overcoming the effects of these errors.

Errors in the received messages which form the output from a data communications system can result from:

- Operator errors in preparing the input or in operating the transmitting or receiving terminal.
- Malfunctioning of the transmitting or receiving terminal equipment.
- Malfunctioning of the communications lines, due either to random pulses interfering with data transmission or to a more permanent condition, such as complete failure of the line.

Techniques which merely detect and indicate errors are generally less complex and expensive than techniques which detect errors and then correct them. In most error control schemes, the digital data at the transmitting terminal is encoded to conform to some set pattern. At the receiver, the data is decoded and checked to see whether the received data pattern conforms to the prescribed rules.

There are two basic, commonly-used methods for automatic checking of data: validity and redundancy. A validity check ascertains whether each data code is one of a number of permitted bit configurations; this checking is usually performed on a character basis, and any code configuration which does not represent a legitimate member of the character set is considered an error. In redundancy checking, one or more additional bits are added to each data configuration in accordance with a specific formulation rule. Checking is accomplished by testing the additional bits to see whether they still conform to the formulation rule. The most common form of redundancy checking is parity

(Contd.)

TABLE II: REPRESENTATIVE DATA COMMUNICATIONS CONTROLLERS

Manufacturer	Equipment	Reference
Burroughs	B 100/200/300 Series Data Communications System	201:103
	B 5500 Data Communications System	203:101
Control Data	3276 Communication Terminal Controller	260:102
	6600 Series Data Set Controller	260:103
GE	Datanet-30 Data Communications Processor	330:104, 340:101
	Datanet-70 Communications Controller	330:105
Honeywell	281 Single-Channel Communication Control	510:103
	286 Multi-Channel Communication Control	510:104
IBM	1009 Data Transmission Unit	401:101
	1448 Transmission Control Unit	414:103
	2701 Data Adapter Unit	420:106
	2702 Transmission Control	420:107
	2703 Transmission Control	420:108
	7710 Data Communication Unit	401:106
	7740 Communication Control System	414:106, 420:106
	7750 Programmed Transmission Control	402:105, 420:106
	7770 Audio Response Unit	420:103
	7772 Audio Response Unit	420:104
NCR	Teletype Inquiry System	601:105
	On-Line Savings System	601:106
RCA	3378 Communications Mode Control	703:101
	3376 Communications Control	703:103
	70/652 & 70/653 Communication Controls	710:101
	70/668 Communication Controller (Multichannel)	710:102
UNIVAC	Communication Terminal Module Controller	785:102, 790:101
	Word Terminal Synchronous	785:102, 790:101
	Communication Terminal Synchronous	785:102, 790:101

.43 Error Control Units (Contd.)

checking, in which the total number of "1" bits in a data configuration of some arbitrary length is required to be either even or odd. Parity checking can be performed on a character basis, on a message basis, or both.

Error correction procedures may be fully automatic, or they may require extensive manual intervention by the operators. The most common method of error correction is retransmission of either the complete message or individual segments of it until the entire message has been received with no detected errors.

.44 Synchronization Units

Because the data signals are time-dependent (i.e., the bits are transmitted at precise time intervals), some means must be provided to ensure synchronization between the transmitting and receiving stations. Two commonly-employed techniques are referred to as "start/stop synchronization" and "synchronous transmission."

In the start/stop technique, extra signals are transmitted with each character of data to identify the beginning and the end of the character. The data bits within each character are transmitted in a strict time sequence, but characters are transmitted asynchronously; i.e., there is no definite time relationship between the transmission of successive characters. The advantages of this method are that it allows data transmission from sources with highly irregular data input rates (such as manual keyboards), and that the probability of cumulative errors in synchronization is minimized. The disadvantage of start/stop synchronization is that it increases the required line capacity due to the extra start and stop bits that need to be transmitted along with the data bits.

.44 Synchronization Units (Contd.)

In the synchronous transmission technique, a specific character is transmitted to the receiving terminal, which interprets the character and adjusts its synchronizing circuitry to conform with the transmitted bit rate. The synchronous method is sometimes referred to as "bit stream synchronization." The advantage of this type of synchronization is that it permits higher data transmission rates than the start/stop method; the disadvantage is that it requires highly precise and relatively expensive circuitry to maintain synchronization throughout the transmission of long messages.

.45 Modulation-Demodulation Units

The pulse signals generated by business machines usually need to be modified to obtain greater transmission efficiency and compatibility with common-carrier communications facilities. The unit used at the transmitting terminal to accomplish this modification is called a "modulator." At the receiving terminal a "demodulator" is required to convert the signals back into a form usable by business machines. Typically, both functions are incorporated into a modulation-demodulation unit for two-way data communications. This unit is commonly called a modem or data set.

Data sets are available from the common carriers for use with a wide range of standard communications facilities. Among the most widely used are the Bell System Data-Phone 200 Series Data Sets, which permit use of the public telephone network for data communications at speeds of up to 2,000 bits per second. In addition, several other companies (such as Collins Radio Co. and Lenkurt Electric Co.) manufacture data sets for use with private communications facilities or, in some cases, with leased common-carrier facilities.

.5 COMMUNICATIONS FACILITIES

A communications facility, in the broadest sense, is a means by which data can be transmitted between two or more points. Some of the common types of communications facilities are telephone and telegraph cables, high-frequency radio, and line-of-sight microwave. Although there are many types of communications facilities, the types most commonly used for data transmission at present, because of their wide availability and economy, are the standard telegraph and public telephone line facilities. Telephone line facilities, though designed specifically for voice communications, can be employed for transferring digital data at higher rates than are possible with telegraph facilities.

Communications facilities, in conjunction with appropriate terminal and/or processing equipment, can be employed for operation in one or more of the following basic modes:

- Simplex — transmission in one direction only.
- Half-duplex — transmission in both directions, but in only one direction at a time.
- Full-duplex — transmission in both directions simultaneously.

The allowable volume of data communications and the flexibility of operations are greater for full-duplex operation than for half-duplex or simplex operation, but the cost of the communications facilities and terminal equipment is also higher.

.51 The Common Carriers

A communications common carrier is a company whose services are offered for public hire for handling interstate or foreign communications by electrical means. All interstate (across state lines) traffic is regulated by the Federal Communications Commission. Intrastate (within a state) traffic is regulated by a state utility board. In some large cities, intracity traffic is regulated by a city agency.

The major common carriers providing interstate communications services are the Bell System and the Western Union Telegraph Company. The American Telephone and Telegraph Company (A.T.&T.) heads the Bell System and coordinates the operations of its wholly or partly owned operating companies. In addition, there are a number of independent telephone companies, the largest of which is the General Telephone and Electronics Company. In general, the independent telephone companies offer the same types of services as the Bell System, although rates and exact services vary to some extent. Some of the smaller companies have limited capabilities, and care must be taken when planning data communications facilities within their areas.

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.51 The Common Carriers (Contd.)

The communications facilities offered by each common carrier and the attendant costs are published in documents called tariffs, which are available to the public. Because of the complexity of these tariffs, the common-carrier communications consultants should be contacted early in the planning stages for a data communications system to determine the facilities and rates in the areas to be served.

.52 Classes of Common-Carrier Facilities

The facilities offered by the common carriers can logically be divided into three classes:

- Narrow-Band Facilities: These facilities provide data communications capabilities at up to 200 bits per second, and they are most commonly used with low-speed teleprinter terminals.
- Voice-Band Facilities: These facilities make use of communications channels having bandwidths of about 3,000 to 4,000 cycles per second. The public telephone network uses channels with a bandwidth of about 3,000 cycles per second. Equipment is currently available from the common carriers for data transmission at up to 2,400 bits per second over leased voice-band facilities and up to 2,000 bits per second over the public telephone network.
- Broad-Band Facilities: These facilities commonly use microwave transmission techniques to provide data communications at rates significantly higher than voice-band facilities. Telpak is a group of services of graduated capacity that can provide transmission rates of up to 500,000 bits per second. Other broad-band facilities can provide transmission rates of up to several million bits per second. In some cases, one broad-band channel can be subdivided to provide several logically independent communications channels of lower capacity.

.53 Types of Common-Carrier Service

Within a particular class of common-carrier communications facilities, different types of service can be obtained. The three general types of service are:

- Leased Service: Provides the user with the exclusive use of a communications line. Leased lines are available in all three classes.
- Public Switched Service: Provides the user with access to a communications network which is available to the general public. In general, charges are based on usage. The Bell System TWX network and the Western Union TELEX network are examples of narrow-band (low-speed) public switched services for message transmission. The public telephone network provides voice-band service on a switched (dialed) basis.
- Multistation Leased Systems: Provides the user with a private communications network accessible only by stations installed by that user. The majority of the available multistation leased systems are for narrow-band (low-speed) communications networks. In general, such a system is a packaged plan designed to provide a specific type of service, but the package is variable within certain limits to meet the needs of individual applications. Examples include the Bell System 83B series and Western Union Plans 115, 116, and 117, which are packaged systems with polling capabilities.

.6 SUMMARY

A data communications system may be of value wherever data must be transmitted between georgraphically separated locations. During the past few years a wide variety of communications equipment and facilities has become available, and the impact of data communications upon business and industry is growing rapidly. Designing a data communications system for a specific application requires a good understanding of both data processing and communications technology and of their interrelationships. A systematic, objective analysis of the information flow requirements and of the available equipment and facilities should always be performed to ensure that the resulting system will achieve its primary aim — to transmit useful information economically from one location to another.