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SunView™1 Programmer's Guide

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Audience for this Manual

This manual is addressed to anyone who is interested in writing SunView programs. It assumes that the reader understands the C programming language. Before you begin to write your own programs, read the *SunView 1 Beginner's Guide* and spend some time using the SunView environment to become familiar with the tools and demonstration programs provided with SunView.[1]

How this Manual is Structured

By convention, manuals fall into three categories, *Tutorial*, *User's Guide*, and *Reference*. This manual is a combination of all three.

Tutorial

Chapter 4, *Using Windows*, serves as a tutorial introduction to SunView. As you read and type in and finally modify its examples, you will be writing simple SunView programs in the proverbial "10 minutes to SunView" time frame. You can then read the later chapters when you need to incorporate the features they describe into your programs.

User's Guide

This entire manual is the user's guide. Start at the beginning, keep reading, and you will understand the SunView model, how SunView programs work, and how to create and use all the different SunView objects in your own window programs.

Reference

Chapter 19, *SunView Interface Summary*, lists all the attributes of the different SunView objects and packages, and the functions and macros to operate on them. Because of the nature of SunView and its use of an attribute value interface, it uses a few simple calls with many attributes for them. Hence in practice this is all the reference section you will need on a day-to-day basis.

Further Reading

This manual does not teach you how the SunView window system itself works, only how to make working SunView applications. The former is covered, along with many low-level, esoteric, and complex details, in the *SunView System Programmer's Guide*.

[1] These tools and demonstration programs are *optional software*. They may not be installed on your system. Consult *Installing the SunOS* for more details.

Format of Chapters

The chapters which explain the various SunView packages have a common format. Each chapter's first page usually mentions

- what the package does
- existing SunView programs you can run to see the package in action
- header files you must include to use the package
- what the "summary tables" for the package are, and on what pages they start in Chapter 19, *SunView Interface Summary*.

Lists, Summaries, and the *Index*

The second page of most of the chapters on packages has a list of the attributes and functions the package provides. This information doesn't tell you what you need to know to use the package; rather, it is intended to give you a feel for what you can do with the package. When you are more familiar with a package, you can go straight to its summary tables in Chapter 19 to quickly find out how to use some attribute or function. *However*, there may be tricks or nuances involved in using the package which are only covered in the chapters. You should consult the *Index* before using any attribute or function that you are not familiar with.

1

Introduction

1

Introduction

What is SunView?

SunView (Sun Visual/Integrated Environment for Workstations) is a user-interface toolkit to support interactive, graphics-based applications running within windows. It consists of two major areas of functionality: building blocks for output, and a run-time system for managing input. The building blocks include four types of windows:

- *canvases* on which programs can draw,
- *text subwindows* with built in editing capabilities,
- *panels* containing items such as buttons, choice items, and analog sliders,
- *tty subwindows* in which programs can be run.

Canvases, text subwindows, and panels can be scrolled.

These windows are arranged as *subwindows* within *frames*, which are themselves windows. Frames can be transitory or permanent.

Transient interactions with the user can also take place in *menus* which can "pop-up" anywhere on the screen, and in *alerts*.

The run-time system is based on a central *Notifier* in each application which distributes input to the appropriate window, and a *window manager* which manages overlapping windows, distributing to the appropriate application.

The exchange of data between applications running in separate windows (in the same or separate processes) is facilitated by a *Selection Service*.

The Sun implementations of graphics standards — CGI, CORE, GKS — include extensions to run within windows. See the *SunCGI Reference Manual*, the *SunCore Reference Manual*, and the *SunGKS* manual, respectively, for more information.

History

Release 3.0

SunView first appeared in SunOS Release 3.0. It is an extension and refinement of SunWindows 2.0, containing many enhancements, bug fixes and new facilities not present in SunWindows. SunView is upward compatible with SunWindows — applications originally written under 2.0 can be recompiled and run under SunView.

In Release 3.0, these changes were reflected in a new organization for the SunView documentation. The material on Pixrects from the 2.0 *SunWindows Reference Manual* was broken out into a separate document, the *Pixrect Reference Manual.* Two new documents were introduced, the *SunView Programmer's Guide* and the *SunView System Programmer's Guide.*

The basic SunView interface, intended to meet the needs of simple and moderately complex applications, is documented here. This basic interface covers the functionality of the SunWindows window and tool layers.

The companion to this document is the *SunView System Programmer's Guide.* Its contents are a combination of new and old material. Several of its chapters document new facilities such as the Notifier, the Selection Service and the Defaults Package. Also included is material from the old *SunWindows Reference Manual* which is of interest to implementors of window managers and other advanced applications, such as the window manager routines.

Release 3.2

Many bug fixes and performance improvements were made to SunView for Release 3.2. This guide was extensively revised and added to for Release 3.2.

Release 3.4

Further bug fixes and enhancements came out with Release 3.4. These were documented in the *Release 3.4 Manual.*

Release 3.5

Release 3.5 brought support for hardware double-buffering under SunView and pixrects.

Release 4.0

Release 4.0 brings major enhancements to the SunView user interface — 'Search and Replace' in text subwindows, shadowed frames, 'Props' frame menu item, keyboard control of the caret, etc. — without involving major changes to its programmatic interface. For example, when programs that use text subwindows are recompiled, their users will be able to use the new 'Select Marked Text' pop-up frame. The *alerts* package is a new package for presenting information to the user and allowing him/her to make choices based on it.

This guide was revised and reprinted again for 4.0. The major changes are the addition of a new *Alerts* chapter and lists of attributes and functions at the beginning of some chapters as well as in the *SunView Interface Summary* chapter and *Index.*

On-Line Help

For information on the programmatic interface to the on-line help facilities of the Sun386i, see the *Sun386i Developer's Guide.* The spot help interface will be supported on all Sun workstations in the next release of SunView.

Code No Longer Supported

Do not use `DEFINE_ICON_FROM_IMAGE` or `DEFINE_CURSOR_FROM_IMAGE` as these macros may not be supported in future releases. Instead, use `icon_create()` and `cursor_create()` to create the icon or cursor at runtime. `icon_create()` is described in Chapter 14, *Icons*. `cursor_create()` is described in Chapter 13, *Cursors*.

The old SunWindows stacking menu package has been supplanted by the SunView walking menu package, described in Chapter 12 of this document. You should convert your applications to use the menu package, as the old package may not be included in future releases.

The new *alerts* package, described in Chapter 10, replaces use of the old (undocumented) `menu_prompt()` routine in situations where programs want to force the user to acknowledge a message or make a choice. Alerts are more flexible and easy-to-use than `menu_prompt()`, and we strongly encourage you to convert to them. Again, the old package may not be included in future releases.

2

The SunView Model

2

The SunView Model

This chapter introduces the conceptual model presented by SunView, covering such basic concepts as *objects*, *windows* and the *Notifier*.

It is important that you understand the material in this chapter before you begin to write SunView applications.

2.1. Objects

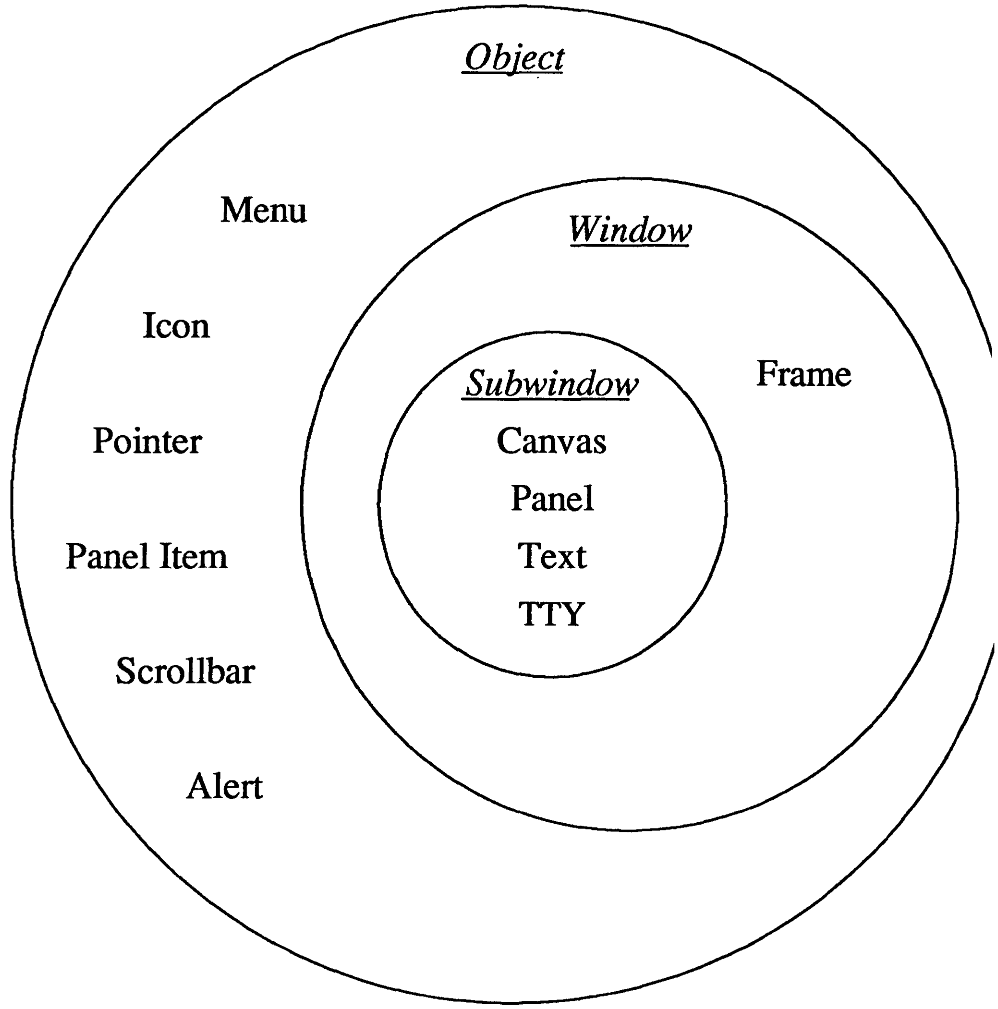
SunView is an *object-oriented* system. Think of SunView objects as visual building blocks which you use to assemble the user interface to your application. Different types of objects are provided, each with its particular properties; you employ whatever type of object you need for the task at hand.

The most important class of SunView objects are *windows*. Not all objects are windows, however. Other visual objects include cursors, icons, menus and scrollbars.

Technically, an object is a software entity presenting a functional interface. The implementation of the object is not exposed; you manipulate an object by passing its unique identifier, or *handle*, to its associated functions. The style of programmatic interface resulting from this object-oriented approach is outlined in this Chapter.

Figure 2-1 illustrates the different types and classes of SunView objects:

Figure 2-1 *SunView Objects*



The different types of objects are shown in normal font; the classes to which the objects belong are labeled in italics — *Subwindow*, *Window*, and *Object*.

Each object type is described briefly on the next page.

Window Objects

Window objects include *frames* and *subwindows*. Frames contain non-overlapping subwindows[2] within their borders. Currently, there are four types of subwindows provided by SunView:

- *Panel Subwindow* — A subwindow containing *panel items*.
- *Text Subwindow* — A subwindow containing text.
- *Canvas Subwindow* — A subwindow into which programs can draw.
- *TTY Subwindow* — a terminal emulator, in which commands can be given and programs executed.

The distinctions between frames and subwindows are explained in more detail in Section 2.3, *Windows*, later in this chapter.

Other Visual Objects

The other types of objects, like windows, are displayed on the screen, but they differ from windows in that they are less general and more tailored to their specific function. They include:

- *Panel Item* — A component of a panel that facilitates a particular type of interaction between the user and the application. Panel items can be moved, displayed or undisplayed under program control. There are several predefined types of items, including *buttons*, *message items*, *choice items*, *text items* and *sliders*.
- *Scrollbar* — An object attached to and displayed within a subwindow through which a user can control which portion of the subwindow's contents are displayed. Both vertical and horizontal scrollbars can be attached to panels and canvases. Text subwindows contain vertical scrollbars by default (they cannot contain horizontal scrollbars).
- *Menu* — An object through which a user makes choices and issues commands. By convention in SunView, menus pop up when the user presses the right mouse button. Like windows, menus appear on the screen when needed, and disappear when they have served their purpose. Menus, however, differ from windows in several ways. First, they are more ephemeral — a menu only remains on the screen as long as the menu button remains depressed,[3] in contrast to a window, which remains on the screen until the user indicates he is done or the controlling program explicitly undisplays it. Second, menus are less flexible than windows; they are designed specifically to allow the user to choose from among a list of actions.

[2] It is SunView's window layout policy that enforces non-overlapping subwindows, not some limitation of the system. If you access the window system at a very low level, subwindows can overlap successfully.

[3] The one exception is in the case of stay-up menus, which will appear when you click the RIGHT mouse button and disappear when you click it again.

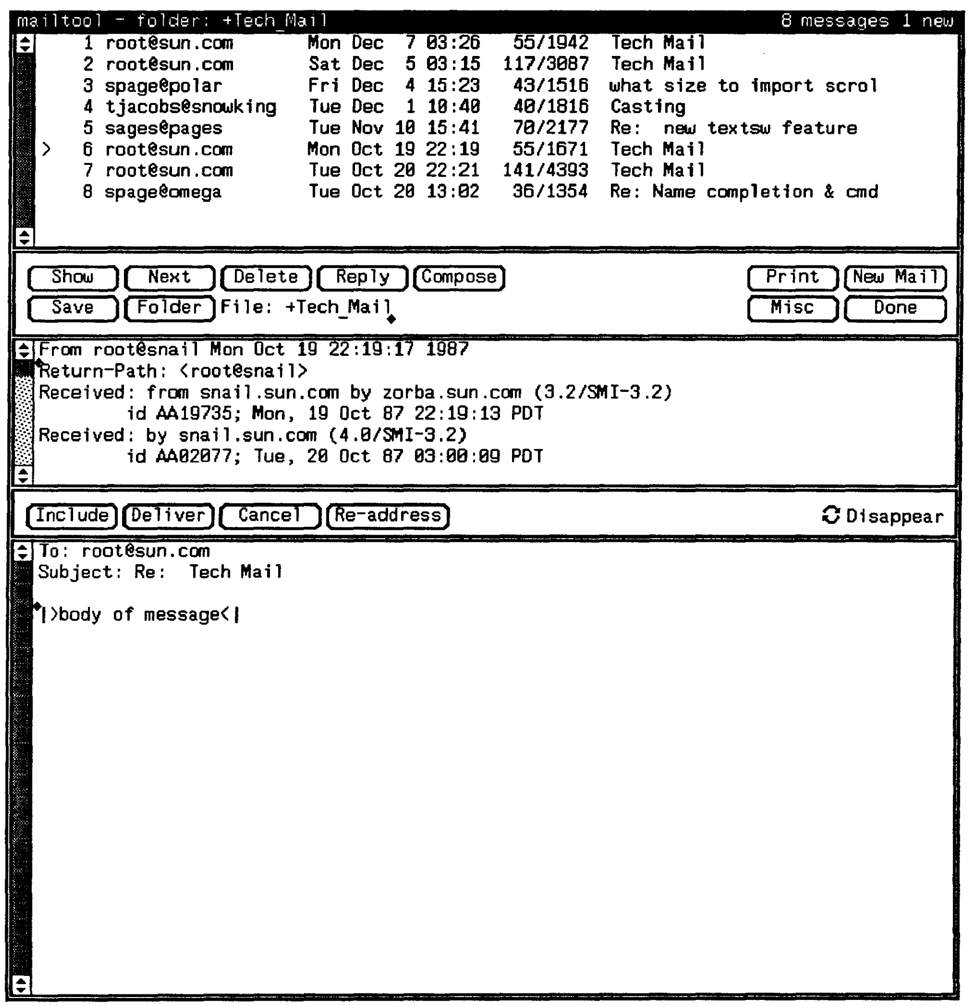
- *Alert* — a box on the screen which informs the user of some condition. It has one or more buttons which the user can push to dismiss the alert or choose a means of continuing. Like menus, alerts are ephemeral — they disappear as soon as the user pushes a button or otherwise dismisses the alert. Visually, they resemble simple panels containing only images, messages, and buttons.
- *Pointer* — The object indicating the mouse location on the screen.
- *Icon* — a small (usually 64 x 64 pixel) image representing the application.

The next section gives some examples showing how typical applications make use of SunView objects in their user interface.

2.2. Examples of the use of Objects by Applications

Figure 2-2 illustrates the `mailtool`(1), which uses SunView objects to provide a mouse-oriented interface to the SunOS `mail`(1) program:

Figure 2-2 *Mailtool*

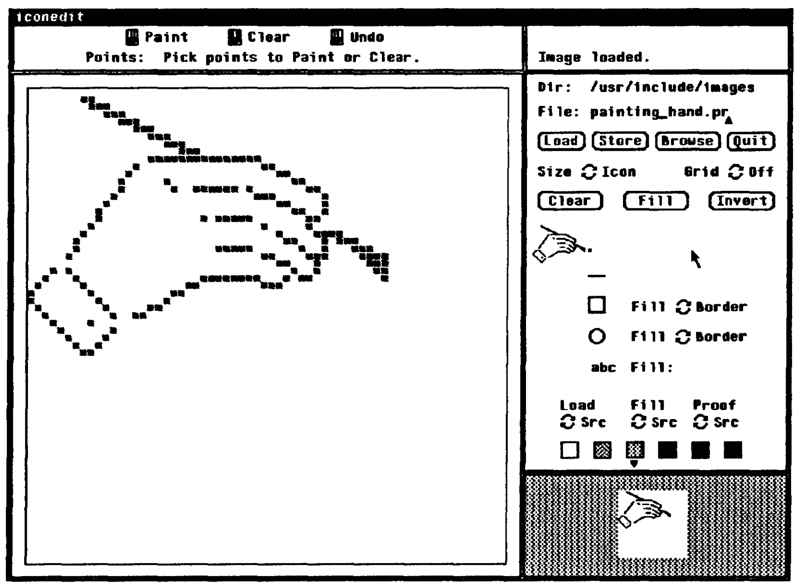


Mailtool consists of a frame containing three subwindows: a text subwindow in which the message headers are displayed, a panel containing various panel items (mostly buttons) through which the user can give commands to *mail*, and a text subwindow which displays the current message. An additional text subwindow and panel (shown in the figure) appear when you press the **reply** or **compose** buttons.

The text subwindows contain scrollbars, allowing the user to bring more information into view.

Figure 2-3 illustrates `iconedit(1)`, a simple bitmap editor for generating images to be used by SunView applications:

Figure 2-3 *iconedit*



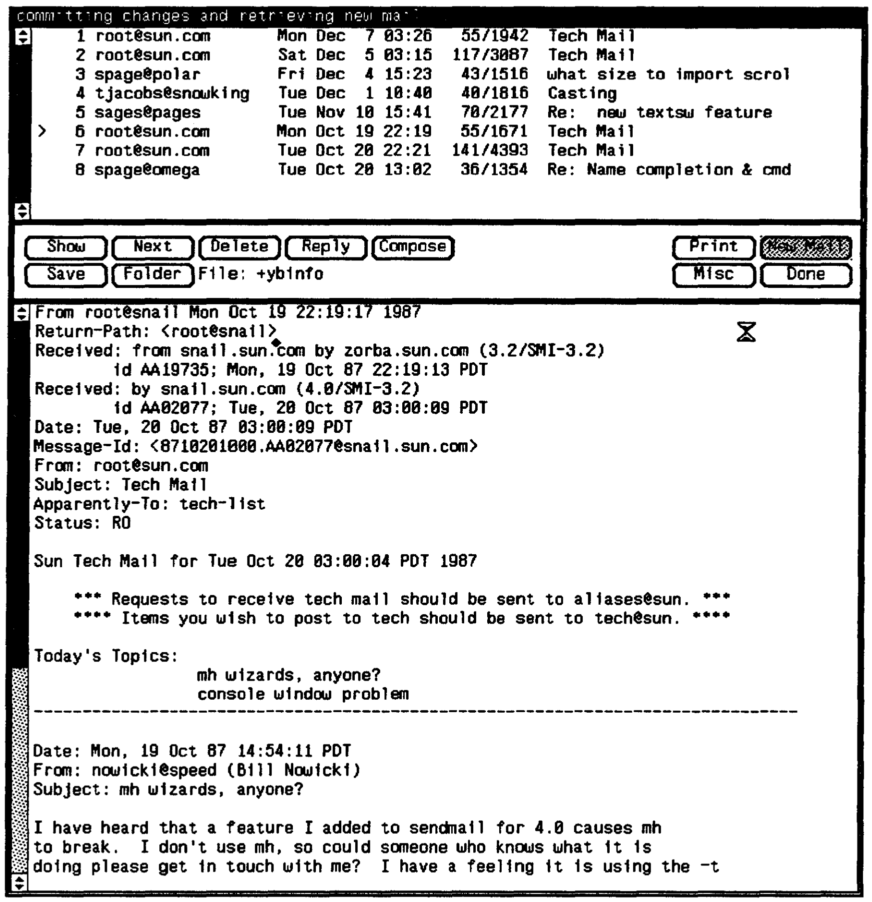
`iconedit` consists of a frame and five subwindows. From upper left to lower right they are:

- a panel containing instructions on how to use the mouse;
- a small panel for short messages;
- a canvas for drawing the image;
- a panel containing various items for issuing commands and setting options such as the size of the image being drawn, the drawing mode, etc;
- A small canvas for viewing the icon or cursor actual size.

None of these subwindows may be scrolled.

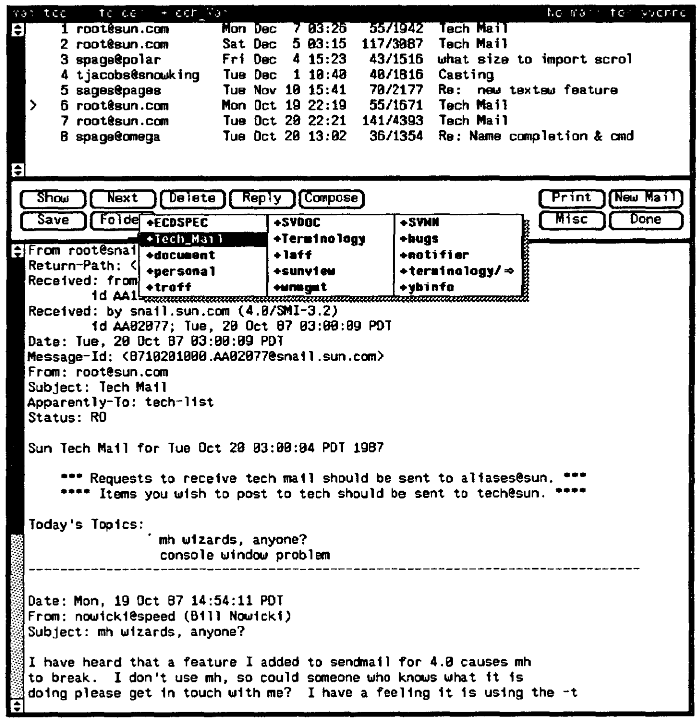
In Figure 2-4, the user has pushed the **New Mail** button, and the program brings up a hour glass cursor (in the upper right of the text subwindow) to denote that it is retrieving mail:

Figure 2-4 *iconedit-buttons*



In Figure 2-5, the user has pressed the mouse button over the **Folder** panel button in the panel:

Figure 2-5 *iconedit-menus*



`mailtool` has displayed a pop-up menu showing names of files which the user can insert into the text item **File:** by selecting a file. The purpose of this menu is to keep a current record of the mailfiles that the user has.

2.3. Windows

There are two basic classes of windows in SunView: overlapping *frames*, which contain non-overlapping *subwindows*. This section describes the distinction between the two.

Frames

A frame is not useful in itself — its purpose is to bring subwindows of different types together into a common framework so they can be operated on as a unit. A frame is said to *own* the subwindows it contains.

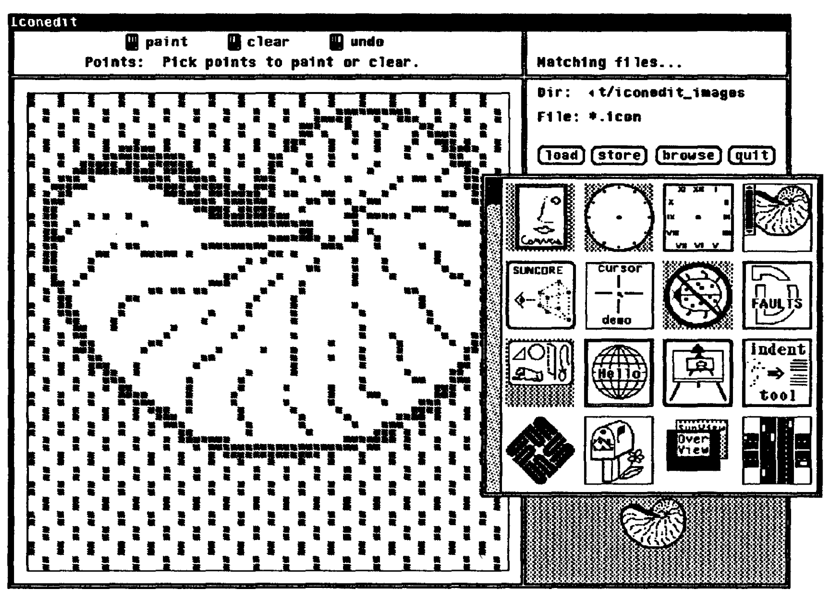
Frames may also own other frames. Thus the basic SunView structure is a hierarchy of windows. It could also be viewed as a tree of windows in which the non-leaf nodes are frames and the leaf nodes are subwindows.

The frame at the top of the hierarchy will be referred to in this document as the *base frame*; other frames will be referred to as *subframes*.[4] Subframes are typically used to implement *pop-ups*, which perform auxiliary functions such as allowing the user to set options, or displaying help text.[5]

`iconedit` uses a pop-up for browsing images. When the user presses the button labeled **Browse**, `iconedit` displays a pop-up which consists of a subframe containing a single panel subwindow.

Figure 2-6 illustrates `iconedit` with its pop-up displayed.

Figure 2-6 *A subframe*



[4] Note that while an application will usually be implemented as a single base frame (and its subwindows and subframes), it could well include several base frames.

[5] For details on pop-ups, see Section 4.5.1, *Pop-ups*, in Chapter 4, *Using Windows*.

Figure 2-7 and Figure 2-8 illustrate the structures of `iconedit` and `mail-tool` as a tree of windows. Frames are shown as rectangles; subwindows as circles:

Figure 2-7 *Structure of iconedit*

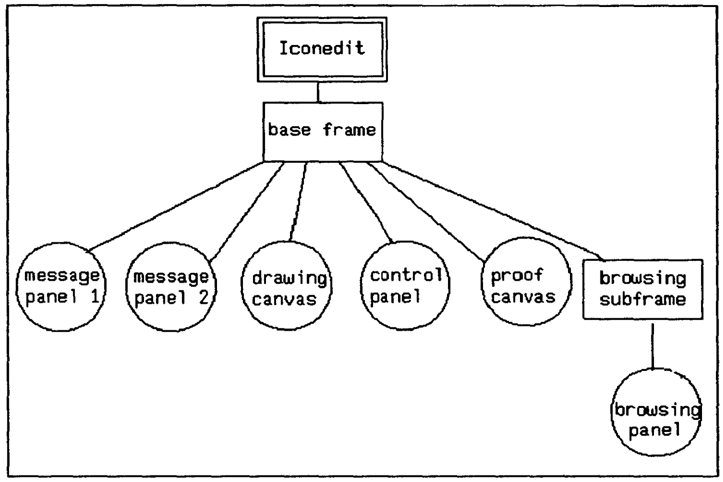
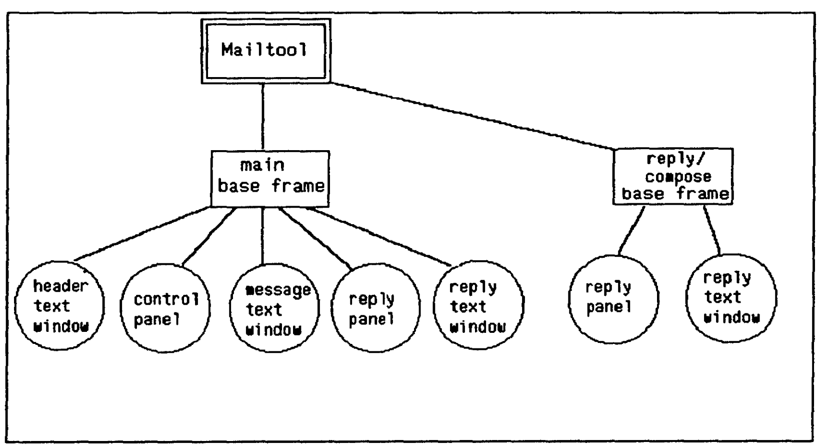


Figure 2-8 *Structure of mailtool*



Manipulating Frames Via Menus

Frames may be manipulated programmatically by setting the frame's *attributes*, as described in Chapter 4, *Using Windows* . Each frame also has a menu which allows the user to manipulate the frame directly. The frame menu is invoked by pressing the RIGHT mouse button on the exposed parts of the frame, which include the double lines surrounding the subwindows and the black *frame header* which usually appears at the top of the frame.

The menus for base frames and subframes differ slightly, as you can see from Figure 2-9 and Figure 2-10. The first window shows the base frame menu; the second window shows the subframe menu:

Figure 2-9 *Base frame menu*

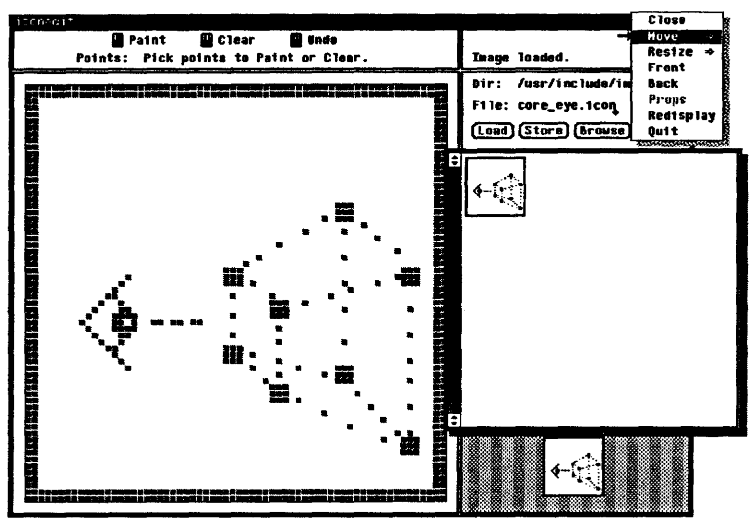
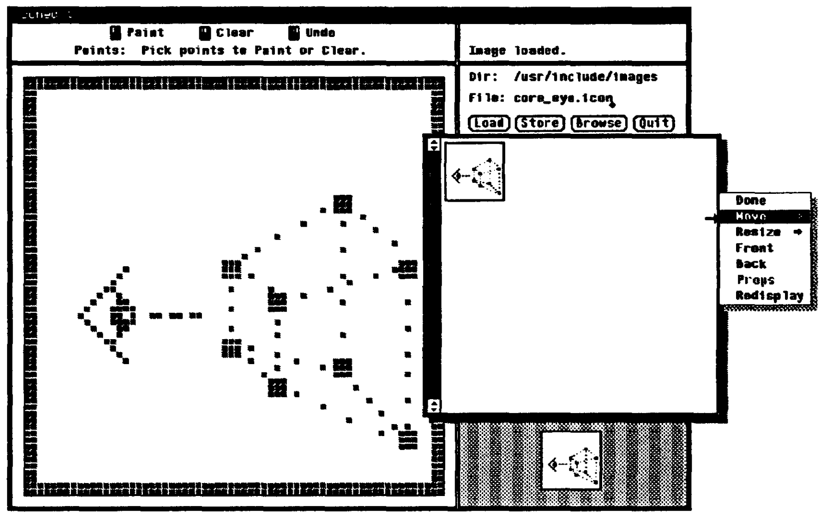


Figure 2-10 *Subframe menu*



Both menus contain the 'Move', 'Resize', 'Front', 'Back', and 'Redisplay' commands. 'Move' allows the user to change the frame's location. 'Resize' allows him or her to change the window's width and height. 'Front' causes the frame to move in front of the other windows, becoming fully visible on the "surface" of the screen, while 'Back' does the opposite, moving the frame behind any other windows occupying the same portion of the screen. 'Redisplay' simply causes the window to be displayed again.

When the user is finished working with a base frame he may want to destroy it for good, in which case he would choose 'Quit'. Or he may want to 'Close' the frame, with the anticipation of opening it later and continuing work where he left off. A base frame in its closed state is represented on the screen as a small (usually 64 by 64 pixel) *icon*. The icon is typically a picture indicating the function of the underlying application.

Subframes may not be closed into icons; when the user finishes with a subframe, he simply chooses *Done* from the menu. While not destroying the subframe, this causes it to disappear from the screen.

Subwindows

Subwindows differ from frames in several basic ways. Subwindows never exist independently. They are always owned by a frame, and may not themselves own subwindows or subframes. While frames can be moved freely around the screen, subwindows are constrained to fit within the borders of the frame to which they belong. Also in contrast to frames, subwindows are *tiled* — they may not overlap each other within their frame. Within these constraints (which are enforced by a run-time *boundary manager*) subwindows may be moved and resized by either a program or a user.

So far this chapter has discussed the static aspects of the SunView model. The section below outlines the system's model from a dynamic point of view.

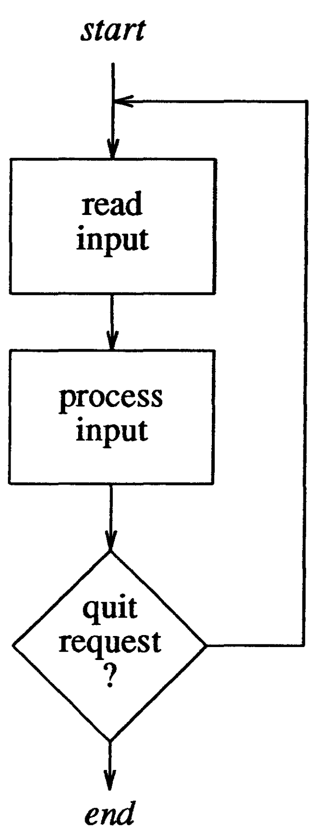
2.4. Input: The Notifier

SunView is a *notification-based* system. The Notifier acts as the controlling entity within a user process, reading UNIX input from the kernel, and formatting it into higher-level *events*, which it distributes to the different SunView objects.[6]

Callback Style of Programming

In the conventional style of interactive programming, the main control loop resides in the application. An editor, for example, will read a character, take some action based on the character, then read the next character, and so on. When a character is received that represents the user's request to quit, the program exits. Figure 2-11 illustrates this approach:

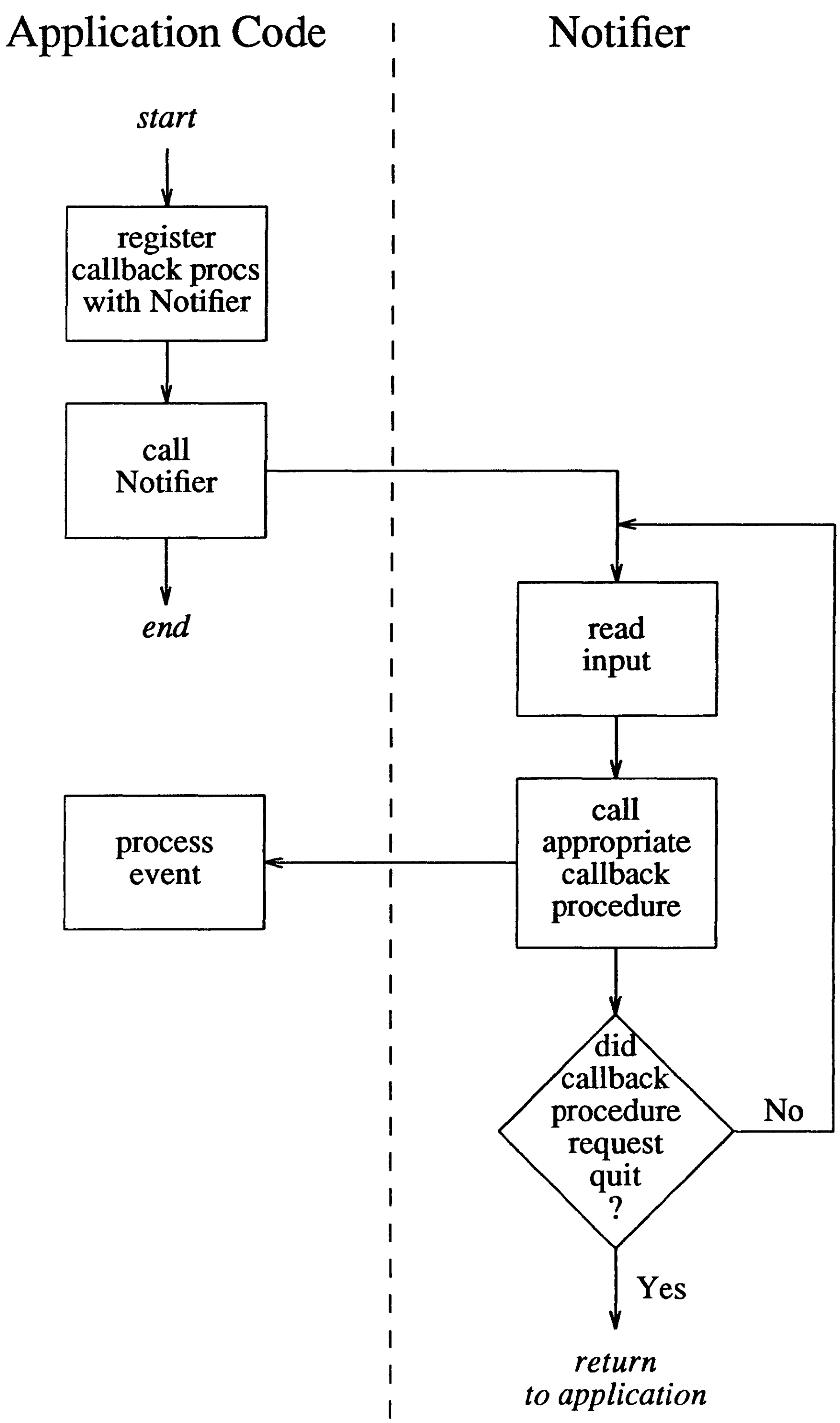
Figure 2-11 *Flow of Control in a Conventional Program*



Notification-based systems invert this "straight line" control structure. The main control loop resides in the Notifier, not the application. The Notifier reads events and *notifies*, or *calls out* to, various procedures which the application has previously registered with the Notifier. These procedures are called *notify procs* or *callback procs*. This control structure is shown in Figure 2-12.

[6] SunView events are in a form which you can easily use: an ASCII key has been pressed, a mouse button has been pressed or released, the mouse has moved, the mouse has entered or exited a window, etc. Events are described in detail in in Chapter 6, *Handling Input*.

Figure 2-12 *Flow of Control in a Notifier-based Program*



Why a Notification-Based System?

For programmers who are not used to it, this callback style of programming takes some getting used to. Its big advantage is that it takes over the burden of managing a complex, event-driven environment. In SunView, an application typically has many objects. In the absence of a centralized notifier, each application must be responsible for detecting and dispatching events to all the objects in the process. With a centralized Notifier, each component of an application receives only the events the user has directed towards it.

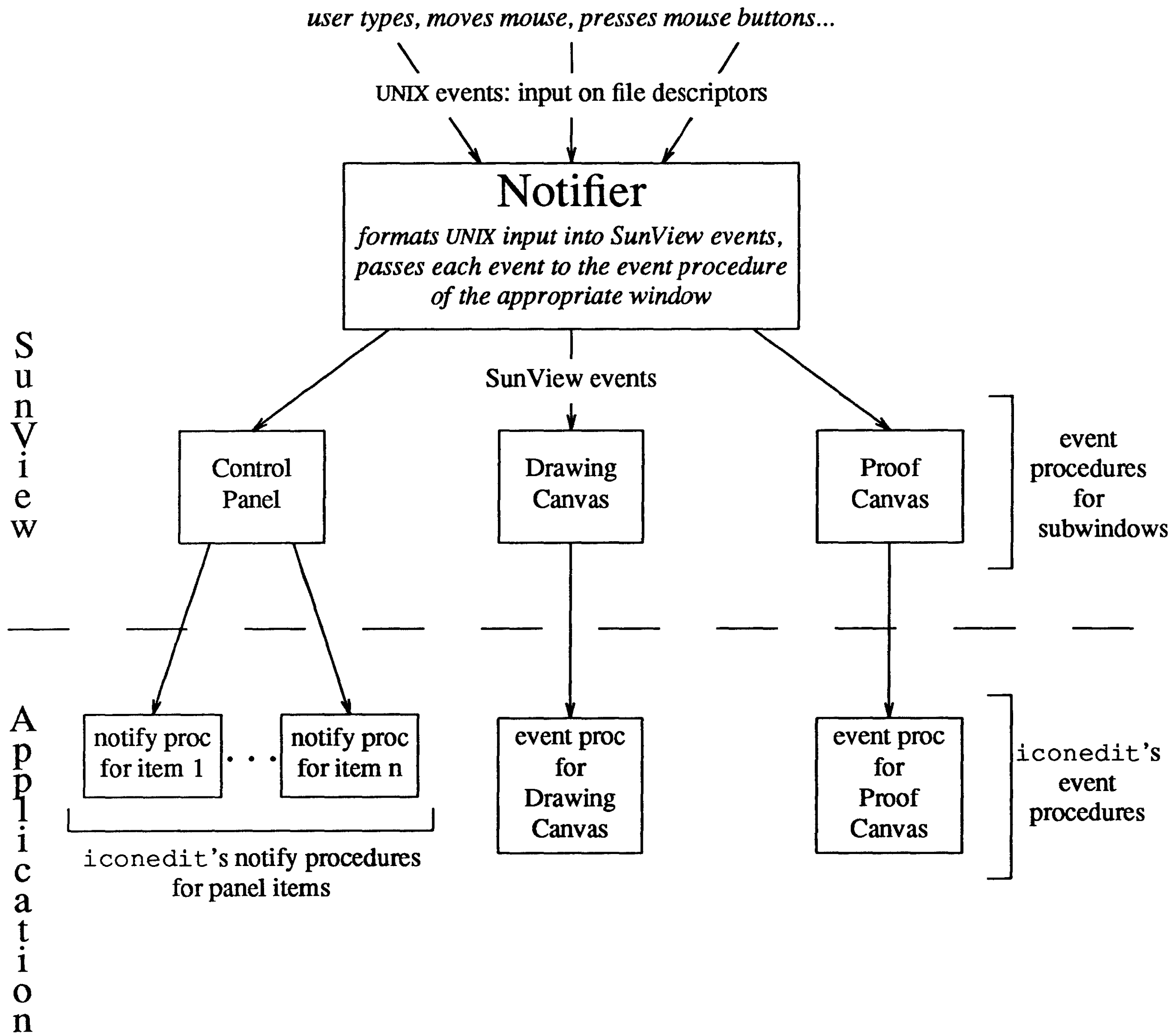
Relationship Between the Notifier, Objects, and the Application

It is not necessary for you to interact with the Notifier directly in your application. SunView has a two-tiered scheme in which the packages that support the various objects — panels, canvases, scrollbars, etc. — interact with the Notifier directly, registering their own callback procedures. The application, in turn, registers its own callback procedures with the object.

Typically, when writing a SunView application you first create the various windows and other objects you need for your interface, and register your callback procedures with the objects. Then you pass control to the Notifier. The work is done in the various callback procedures.

Let's illustrate the relationship of the Notifier, the SunView objects and the application by taking `iconedit` as an example. Figure 2-13 illustrates how the Notifier receives UNIX input and calls back to `iconedit`'s subwindows, which in turn call back to procedures supplied by `iconedit`.

Figure 2-13 *Flow of Input Events in* `iconedit`, *a SunView Application*



The main point of the diagram on the preceding page is to make clear the double-tiered callback scheme. How you register the callback procedures will be explained in the chapters on panels and canvases.

One point worth mentioning is the distinction between the "event procedures" for the canvases and the "notify procedures" for the panel items. They are all callback procedures, but they have different purposes. The canvas's event procedure doesn't do much work — basically it calls out to the application's event procedure each time an event is received. The application sees every event and is free to interpret the events however it likes.

The event procedure for panels, on the other hand, does quite a bit of processing. It determines which item should receive the event, and places its own interpretation on events — the middle mouse button is ignored, left mouse button down over an item is interpreted as a "tentative" activation of the item, etc. It does not call back to the notify procedure for the item until it receives a left mouse button up over the item. So panel item notify procedures are not so much concerned with the event which caused them to be called, but with the fact that the button was pushed, or a new choice made, etc.

Calling the Notifier Directly

As mentioned previously, for many applications you will not need to call or be called by the Notifier directly — the Notifier calls back to the subwindows, which in turn call back to your application.

However, if you need to use signals, or be notified of the death of a child process which you have spawned, you do need to call the Notifier directly.

The Notifier also provides calls which allow you to insert your own routine in the event stream ahead of a window. This technique is known as *interposition*.

When and how to call the Notifier directly is covered in Chapter 17, *The Notifier*.

3

Interface Outline

3

Interface Outline

This chapter outlines the SunView interface, the SunView libraries, header files, object handles, attributes and the standard functions applicable to objects of each type.

SunView Libraries

The SunView functions that an application calls are mostly in the library file /usr/lib/libsuntool.a if you are using the archive libraries and /usr/lib/libsuntool.so if you are using the shared libraries. These libraries include the code to create and manipulate high-level objects such as frames, panels, scrollbars and icons. These packages in turn call routines in /usr/lib/libsunwindow.a or /usr/lib/libsunwindow.so to create and manipulate windows and interact with the Notifier. These in turn call routines in /usr/lib/libpixrect.a or /usr/lib/libpixrect.so that do the drawing on the screen.

NOTE *Shared libraries are introduced in 4.0. The main benefit to using shared* libraries is that the executables are much smaller (for example, 24K instead of 1Mb for textedit alone) because the libraries are loaded dynamically at runtime and are subsequently shared by other executables. Additionally, when the shared libraries are recompiled, new functionality is added, or bug fixes are made, the client applications don't need to be recompiled and linked unless the .so or an interface changed. For more information on shared libraries, see *Programming Utilities and Libraries.*

Compiling SunView Programs

To compile a SunView program you must link in these three libraries, and, because they are built one on top of another, their order is important. For example, to compile a typical SunView application whose source is myprog.c, you would type in the command:

```
% cc -o myprog myprog.c -lsuntool -lsunwindow -lpixrect
```

Header Files

The basic definitions needed by a SunView application — covering windows, frames, menus, icons and cursors — are obtained by including the header file <suntool/sunview.h>. Definitions for the other types of object are found in their own include files — <suntool/canvas.h>, <suntool/text.h>, <suntool/panel.h>, etc.

Object Handles

When you create a SunView object, the creation function returns a *handle* for the object. Later, when you wish to manipulate the object or inquire about its state, you pass its handle to the appropriate function. This reliance on object handles is a way of *information-hiding*. The handles are *opaque* in the sense that you can't "see through" them to the actual data structure which represents the object.

Each object type has a corresponding type of handle. The window types of `Frame`, `Canvas`, `Textsw`, `Tty` and `Panel` are grouped under the type `Window`. So, for example, you can declare a panel as either a `Panel` or a `Window`, whichever is most appropriate. The other object types are `Panel_item`, `Menu`, `Scrollbar`, `Cursor`, and `Icon`.

Since C doesn't have an `opaque` type, all the opaque data types mentioned above are `typedef`'d to the UNIX type `caddr_t` (for "character address type"), which in turn is `typedef`'d to `char *`.

In addition to the opaque data types, there are several `typedefs` which refer not to pointers but to structs: `Event`, `Pixfont`, `Pixrect`, `Pixwin`, `Rect`, and `Rectlist`. Generally pointers to these structs are passed to SunView functions, so they are declared as `Event *`, `Pixwin *`, etc. The reason that the "*" is not included in the `typedef` is that the structs are publicly available, in contrast to the object handles, which include the "*" and which refer to structs that are not publicly available.

The SunView data types are summarized in the table beginning on page 324 in Chapter 19, *SunView Interface Summary*.

Attribute-based Functions

A model such as that used by SunView, which is based on complex and flexible objects, presents the problem of how the client is to manipulate the objects. The basic idea behind the SunView interface is to present a small number of functions, which take as arguments a large set of *attributes*.

For a given call to create or modify an object, only a subset of the set of all applicable attributes will be of interest. So that only the relevant attributes need be mentioned, SunView functions make use of variable-length *attribute lists*. An attribute list consists of attribute/value pairs, separated by commas, and ending with a zero.

Each type of object has its own set of attributes. The attributes have prefixes which indicate the type of object they apply to, i.e. `FRAME_*`, `TEXTSW_*`, `CANVAS_*`, `TTY_*`, `PANEL_*`, `MENU_*`, `CURSOR_*`, `ICON_*`, `SCROLL_*`, etc.

In addition to the sets of attributes applying to each type of object, there is a set of window attributes of the form `WIN_*` which apply to all window objects. These are attributes such as `WIN_HEIGHT` and `WIN_WIDTH`, which apply to all windows regardless of whether they happen to be panels, canvases, etc.

Standard Functions

For objects of all types there is a set of *standard functions* to create and destroy the object and to get and set the object's attributes.

Window functions are prefixed with `window_`, yielding

- `window_create()`,
- `window_get()`,
- `window_set()`, and
- `window_destroy()`.

Providing common window functions reduces the complexity of the interface. Non-window functions are prefixed with the name of the object. So, to take menus as an example, the standard functions are

- `menu_create()`,
- `menu_get()`,
- `menu_set()`, and
- `menu_destroy()`.

Example of SunView-Style Programming

The flavor of the interface is illustrated with the following code fragment, which creates a scrollbar with a width of 10 pixels and a black bubble. Later, the scrollbar's width is changed to 20 pixels. Finally, the scrollbar is destroyed:

```
Scrollbar bar;
bar = scrollbar_create(SCROLL_WIDTH,     10,
                SCROLL_BAR_COLOR, SCROLL_BLACK,
                0);
scrollbar_set(bar, SCROLL_WIDTH, 20, 0);
scrollbar_destroy(bar);
```

Note the zero which terminates the attribute lists in the `*_create()` and `*_set()` calls. The most common mistake in using attribute lists is to forget the final zero. This will not be flagged by the compiler as an error; however, it will cause SunView to generate a run-time error message.

Attribute List Size

As you can see from the example above, you can specify several attributes in a single `create()` or `set()` call. The maximum length of attribute lists in SunView is 250; see *Maximum Attribute List Size* in Chapter 18, *Attribute Utilities*.

Reserved Namespaces

SunView reserves names beginning with the object types, as well as certain other prefixes, for its own use.

The prefixes listed below should not be used by applications in lower, upper, or mixed case.

Table 3-1 *Reserved Prefixes*

ACTION_	icon_	scroll_
alert_	menu_	seln_
attr_	notify_	textsw_
canvas_	panel_	text_
cursor_	pixrect_	toolsw_
defaults_	pixwin_	tool_
ei_	pr_	ttysw_
es_	pw_	tty_
event_	rect_	window_
ev_	rl_	win_
frame_	scrollbar_	wmgr_
help_		

4

Using Windows

4

Using Windows

This chapter describes how to build SunView applications out of frames and subwindows.

The first section presents the basic window routines. Succeeding sections give examples, ranging from the simplest possible application to a moderately useful file manager. For quick reference, the examples are given in the table below:

Table 4-1 *Window Usage Examples*

Example	*Description*	*Illustrates*	*Page*
hello_world	Minimal SunView program.	Compilation, frames.	37
simple_panel	Panel w/message and button.	Basic attributes, panels.	39
lister	Front end to *ls*	Panels, tty subwindows.	42
filer	File manager	Pop-ups, Selection Service.	44
image_browser_1	Displays images	Subwindow layout.	50
image_browser_2	Displays images	Row/column space.	53

Summary Listing and Tables

To give you a feeling of what you can do with frames and subwindows, the following page lists the available window and frame attributes, functions and macros. Many attributes are discussed as they occur in the examples, and in other chapters (use the *Index* to check). However, this chapter does not attempt complete coverage of all the attributes. All are briefly described with their arguments in the window and frame summary tables in Chapter 19, *SunView Interface Summary*:

- the *Window Attributes* table begins on page 379;
- the *Frame Attributes* table begins on page 382;
- the *Window Functions and Macros* table begins on page 384;
- the *Command Line Frame Arguments* table begins on page 386.

Window Attributes		
WIN_BELOW	WIN_FIT_WIDTH	WIN_PERCENT_WIDTH
WIN_BOTTOM_MARGIN	WIN_FONT	WIN_PICK_INPUT_MASK
WIN_CLIENT_DATA	WIN_GRAB_ALL_INPUT	WIN_PIXWIN
WIN_COLUMNS	WIN_HEIGHT	WIN_RECT
WIN_COLUMN_GAP	WIN_HORIZONTAL_SCROLLBAR	WIN_RIGHT_MARGIN
WIN_COLUMN_WIDTH	WIN_IGNORE_KBD_EVENT	WIN_RIGHT_OF
WIN_CONSUME_KBD_EVENT	WIN_IGNORE_KBD_EVENTS	WIN_ROW_GAP
WIN_CONSUME_KBD_EVENTS	WIN_IGNORE_PICK_EVENT	WIN_ROW_HEIGHT
WIN_CONSUME_PICK_EVENT	WIN_IGNORE_PICK_EVENTS	WIN_ROWS
WIN_CONSUME_PICK_EVENTS	WIN_INPUT_DESIGNEE	WIN_SCREEN_RECT
WIN_CURSOR	WIN_KBD_FOCUS	WIN_SHOW
WIN_DEVICE_NAME	WIN_KBD_INPUT_MASK	WIN_TOP_MARGIN
WIN_DEVICE_NUMBER	WIN_LEFT_MARGIN	WIN_TYPE
WIN_ERROR_MSG	WIN_MENU	WIN_VERTICAL_SCROLLBAR
WIN_EVENT_PROC	WIN_MOUSE_XY	WIN_WIDTH
WIN_EVENT_STATE	WIN_NAME	WIN_X
WIN_FD	WIN_OWNER	WIN_Y
WIN_FIT_HEIGHT	WIN_PERCENT_HEIGHT	

Frame Attributes		
FRAME_ARGS	FRAME_DEFAULT_DONE_PROC	FRAME_NO_CONFIRM
FRAME_ARGC_PTR_ARGV	FRAME_DONE_PROC	FRAME_NTH_SUBFRAME
FRAME_BACKGROUND_COLOR	FRAME_EMBOLDEN_LABEL	FRAME_NTH_SUBWINDOW
FRAME_CLOSED	FRAME_FOREGROUND_COLOR	FRAME_NTH_WINDOW
FRAME_CLOSED_RECT	FRAME_ICON	FRAME_OPEN_RECT
FRAME_CMDLINE_HELP_PROC	FRAME_INHERIT_COLORS	FRAME_SHOW_LABEL
FRAME_CURRENT_RECT	FRAME_LABEL	FRAME_SUBWINDOWS_ADJUSTABLE

Window Functions and Macros	
window_bell(win)	window_get(win, attribute)
window_create(owner, type, attributes)	window_loop(subframe)
window_default_event_proc(window, event, arg)	window_main_loop(base_frame)
window_destroy(win)	window_read_event(window, event)
window_done(win)	window_refuse_kbd_focus(window)
window_fit(win)	window_release_event_lock(window)
window_fit_height(win)	window_return(value)
window_fit_width(win)	window_set(win, attributes)

4.1. Basic Routines

This section introduces the basic routines for using windows. It explains how to create, modify, and destroy windows.

Creating a Window

You create all windows with the function:

```
Window
window_create(owner, type, attributes)
    Window        owner;
    <window type> type;
    <attribute-list> attributes;
```

If you recall from Chapter 2, *The SunView Model*, a SunView application is implemented as a hierarchy of frames. Each frame owns one or more subwindows. The frame at the top of the hierarchy (the *base frame*) will have a null owner. In the above function, the `owner` parameter is the handle of the window to which the window returned by `window_create()` will belong. The `type` parameter is the type of the new window; for example, `FRAME`, `PANEL`, `TEXTSW`, `CANVAS`, or `TTY`.

A very simple example of this function would be to create a panel belonging to a frame called `base_frame`, you would use:

```
Panel panel;
window_create(base_frame, Panel, 0);
```

Initiating Event Processing

The `window_create()` call does not display the frame on the screen. You bring it to life after creating a base frame and its subwindows and subframes, by calling `window_main_loop(base_frame)`. This call displays the frame on the screen and begins processing the events by passing control to the Notifier. Chapter 2, *The SunView Model*, gave a brief explanation of the Notifier.

Keep in mind that subframes are treated different from base frames because they are not tied to the base frame that is activated in the `window_main_loop()` call. In addition, if you create a subframe with `WIN_SHOW` set to `TRUE`, when the user tries to manipulate the subframe 'garbage' data will appear on the screen.

Modifying and Retrieving Window Attributes

You modify and retrieve the value of window attributes with the following two functions:

```
int
window_set(window, attributes)
    Window window;
    <attribute-list> attributes;

caddr_t
window_get(window, attribute)
    Window window;
    Window_attribute attribute;
```

NOTE *If you call* `window_get()` *and specify an inappropriate attribute, a zero will* be returned. For example, a sub frame cannot be closed. Therefore, the call `window_get(sub_frame, FRAME_CLOSED_RECT)` will not work, so the value returned will be zero. A segmentation violation will occur if an attempt is made to dereference the return value.

When you get a pointer back from `window_get()`, the pointer points into a private data structure, whose contents may change.[7]

Destroying Windows

You destroy windows with the following two functions:

```
int
window_destroy(window)
    Window window;

int
window_done(window)
    Window window;
```

The difference between these two is that `window_destroy()` destroys only `window` and its subwindows and subframes. `window_done()`, on the other hand, destroys the entire hierarchy to which the subwindow or subframe belongs.

When `window_destroy()` is called on a window, the corresponding file descriptors cannot be used again until the Notifier is called. The file descriptor associated with the window is not reclaimed until the notifier has a chance to distribute notifications again.

The way `window_destroy()` works is that it asks the window owner if it is willing to be destroyed. If so, it queues up a notification procedure to destroy the window. This delay protects the program from destroying a window that is being accessed in the current call stack. You can work around this restriction, assuming you never reference this window again, by calling `notify_flush_pending()` after calling `window_destroy()`.

---

[7] For most attributes the pointer returned by `window_get()` points into per-window storage, but for some the storage is static, per-process data. These attributes are flagged in the tables Chapter 19, ***SunView Interface Summary***.

4.2. Example 1— *hello_world*

In learning a new programming language or environment, it usually helps to begin with a small program that simply prints some output. By creating, compiling, loading, and running the program, you will master the mechanical details. Here is a small SunView program:

```
#include <suntool/sunview.h>

main()
{
    Frame frame;
    frame = window_create(NULL, FRAME,
                          FRAME_LABEL,    "hello world",
                          0);
    window_main_loop(frame);
}
```

After you create the above program in a file called `hello_world.c`, you compile it with the command:

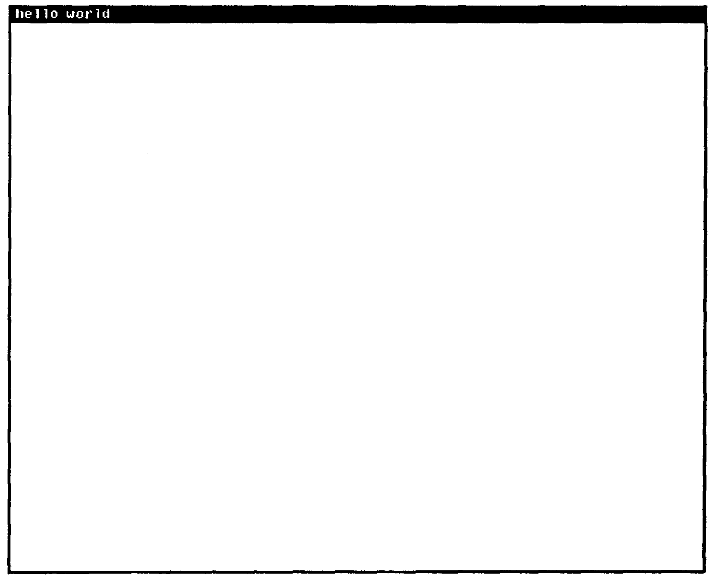
```
% cc -o hello_world hello_world.c -lsuntool -lsunwindow -lpixrect
```

Where,

- `hello_world` is the executable output file that will be created
- `-lsuntool` specifies to link with the suntool object library
- `-lsunwindow` specifies to link with the sunwindow object library
- `-lpixrect` specifies to link with pixrect object library

After you compile the program, type "hello_world", and the window will come up as shown in Figure 4-1 — a single frame with the words "hello world" in the frame header:

Figure 4-1 *Hello World Window*



This window is "alive" within the SunView user interface; it can be closed, moved, resized, hidden, etc. When closed, a default icon is displayed, which contains the text from the frame header.

4.3. Example 2— *simple_panel*

The next program is more complex than the first program. It creates a frame that contains a frame label and a panel that contains a panel button and a message. This program also includes an image that appears when the window closes down to an icon. Some basic attributes dealing with fonts, icons, help, error messages and parsing command-line flags are introduced.

```
#include <stdio.h>
#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/icon.h>

static void quit_proc();
Frame frame;
Panel panel;
Pixfont *bold;
Icon icon;

static short    icon_image[] = {
#include <images/hello_world.icon>
};
mpr_static(hello_world, 64, 64, 1, icon_image);

main(argc, argv)
int argc; char **argv;
{
    bold = pf_open("/usr/lib/fonts/fixedwidthfonts/screen.b.12");
    if (bold == NULL) exit(1);

    icon = icon_create(ICON_IMAGE, &hello_world, 0);
    frame = window_create(NULL, FRAME,
                FRAME_LABEL,            "hello_world_panel",
                FRAME_ICON,             icon,
                FRAME_ARGS,             argc, argv,
                WIN_ERROR_MSG,          "Can't create window.",
                0);

    panel = window_create(frame, PANEL, WIN_FONT, bold, 0);

    panel_create_item(panel, PANEL_MESSAGE,
        PANEL_LABEL_STRING, "Push button to quit.", 0);
    panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,  panel_button_image(panel, "Good-bye", 0, 0),
        PANEL_NOTIFY_PROC,  quit_proc,
        0);

    window_fit(panel);
    window_fit(frame);
    window_main_loop(frame);
}

static void
quit_proc()
{
   window_set(frame, FRAME_NO_CONFIRM, TRUE, 0);
   window_destroy(frame);
}
```

This program creates a frame containing a single panel with a message and a button:

Figure 4-2 *Hello World Panel*

The features and attributes used in the above program are discussed below.

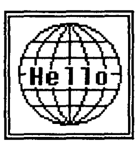
Some Frame Attributes

The attributes are discussed below in the order that they appear in the above panel.

`FRAME_LABEL`

The string given as the value for `FRAME_LABEL` will appear in a black frame header strip at the top of the frame. If you do not want the label and the frame header to appear, then set the attribute `FRAME_SHOW_LABEL` to `FALSE`.

`FRAME_ICON`



The program used `FRAME_ICON` to specify the icon to be shown when the frame is closed. This is done by first using the macro `mpr_static()` to define a static memory pixrect that contains this data. Where `hello_world` is the name of the pixrect to be defined. The next three arguments specify the width, height, and depth of the image. Typically, for an icon, this is 64, 64, and 1. The final argument is an array of shorts that contains the bit pattern of the icon image. It takes its image from the file `/usr/include/images/hello_world.icon`. This statically defined image is passed to `icon_create()` at runtime.

The application uses `FRAME_ARGS`[8] to pass command-line arguments given by the user to the frame. A set of command line arguments are recognized by all frames. These arguments allow the user to control such basic attributes as the frame's dimensions and label and whether the frame's initial state is open or closed, etc. These arguments begin with *-W*; for a complete list of them see the *Command Line Frame Arguments* table in Chapter 19, *SunView Interface Summary*.

`WIN_ERROR_MSG`

`WIN_ERROR_MSG` provides a simple form of error checking. If this attribute is not specified, then `window_create()` will return 0 on failure. If a value for `WIN_ERROR_MSG` is specified and `window_create()` fails, then it will print the error message on stderr and exit with a status of 1.

---

[8] As an alternative to `FRAME_ARGS`, you can use `FRAME_ARGC_PTR_ARGV`, which takes a pointer to argc, rather than argc itself. This attribute causes `window_create()` to strip all arguments beginning with *-W* out of argv, and decrement argc accordingly.

Panels

The panel is created by calling window_create() with the previously created frame as the owner and PANEL as the window type.

Fonts

By default, text in the panel is rendered in the default system font, which window_create() obtains by calling pf_default().[9] The program specified a font by first opening the font with pf_open(), and then passing it into the panel as WIN_FONT.

NOTE *In the SunView context, note that setting* WIN_FONT *is not equivalent to specifying* a font at run time with the **-Wt** command-line argument: **-Wt** opens the default system font, WIN_FONT doesn't. The only window types that currently make use of WIN_FONT to render characters are panels and text subwindows.

Panel Items

The panel contains two panel items: the message saying "Push button to quit." and the **Good-bye** button. They are created with panel_create_item().

Notify Procedure

The concept of *callback procedures* was introduced in Chapter 2, *The SunView Model.* Callback procedures for panel items are known as *notify procedures.*

The program registered its notify procedure quit_proc() with the **Quit** button using the attribute PANEL_NOTIFY_PROC. quit_proc() is called when the user selects the button. It in turn calls window_destroy(), which, as explained in the earlier subsection on *Destroying Windows*, causes window_main_loop() to return. Before calling window_destroy(), it disables the standard SunView confirmation by setting the attribute FRAME_NO_CONFIRM for the frame.

Window Sizing — window_fit()

The final feature illustrated by the example is the use of the window_fit() macro. This macro causes a window to exactly fit its contents.

The contents of a panel are its panel items; the contents of a frame are its subwindows. Therfore, the example program calls window_fit() twice, first fitting the panel around its two items, then fitting the frame around its panel.

A window_fit_width() macro and a window_fit_height() macro are used to permit adjusting in only one dimension. These correspond to the window attributes WIN_FIT_WIDTH and WIN_FIT_HEIGHT.

Fitting Frames Around Subwindows

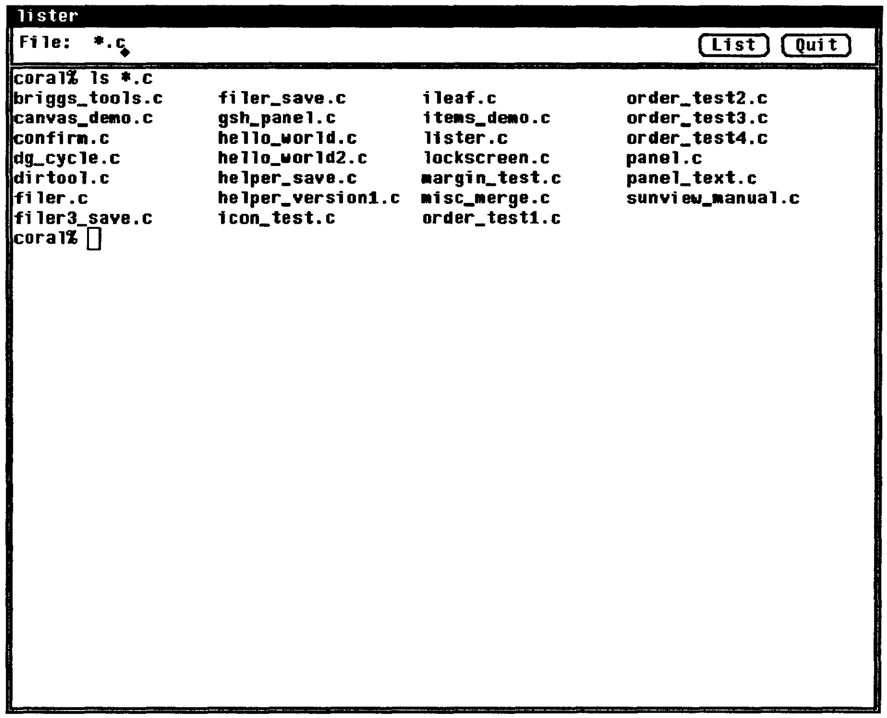
Since Release 3.2, if you use window_fit() or its variants for sizing the width and height of a frame, you need to be careful that the subwindows have some specified size, or they will be shrunk very small by the window_fit() call. Usually you give a subwindow a fixed size in one or both dimensions, or size it to be a percentage of the frame's size. The default size of a frame is that it encloses an area 34 rows by 80 columns in its default font.

[9] For details on fonts see the *Pixrect Reference Manual.*

4.4. Example 3— *lister*

Figure 4-3 illustrates a program to help manage files. The first version simply lets the user list files in the current directory, forming a front-end to the `ls(1)` command:

Figure 4-3 *lister*



The tool presents two subwindows. The top subwindow is a control panel with a text item. It contains a place to specify the files to be listed, a **List** button, and a **Quit** button.

Below the control panel is a tty subwindow. When the user pushes the **List** button, the program constructs a command string consisting of the string "ls ", followed by the value of the **File:** item, followed by a newline, and inputs the command string to the tty subwindow by calling `ttysw_input()`.

The program is listed in its entirety below.

Notice that the frame, the panel and the tty subwindow are all declared as type `Window`. They could just as well have been declared as type `Frame`, `Panel` and `Tty`.

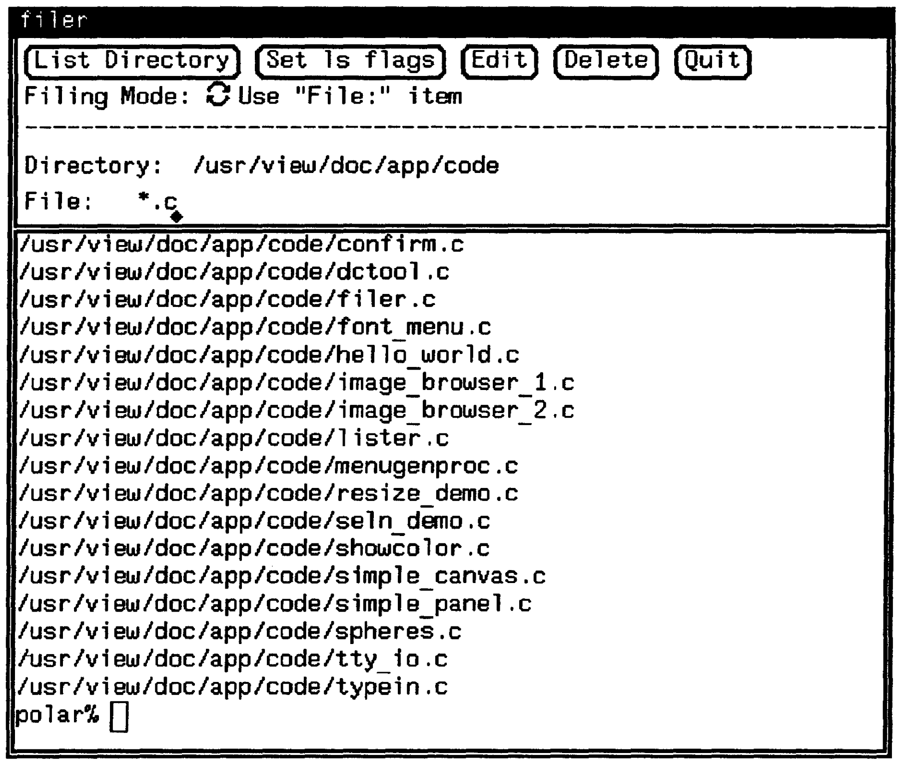
```
#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/tty.h>

Window frame, panel, tty;
Panel_item fname_item;

static void ls_proc(), quit_proc();

main(argc, argv)
int argc; char **argv;
{
    frame = window_create(NULL, FRAME,
                FRAME_ARGS,  argc, argv,
                FRAME_LABEL, "lister",
                0);
    panel = window_create(frame, PANEL, 0);
    create_panel_items();
    tty = window_create(frame, TTY, 0);
    window_main_loop(frame);
    exit(0);
}

create_panel_items()
{
    fname_item = panel_create_item(panel, PANEL_TEXT,
        PANEL_LABEL_STRING,         "File: ",
        PANEL_VALUE_DISPLAY_LENGTH, 55,
        0);

    panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "List", 5, 0),
        PANEL_NOTIFY_PROC, ls_proc,
        0);

    panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "Quit", 5, 0),
        PANEL_NOTIFY_PROC, quit_proc,
        0);

    window_fit_height(panel);
}

static void
ls_proc(/* ARGS UNUSED */)
{
    char cmdstring[256];

    sprintf(cmdstring, "ls %s\n", panel_get_value(fname_item));
    ttysw_input(tty, cmdstring, strlen(cmdstring));
}

static void
quit_proc(/* ARGS UNUSED */)
{
    window_destroy(frame);
}
```

4.5. Example 4—*filer*

Our next example builds on the simple front end to `ls` given in the previous example to create a more interesting file manipulation tool. This application illustrates the use of the text subwindow, the Selection Service, and *pop-ups* — windows that appear on the screen and disappear dynamically during execution of a program.

In appearance, *filer* is similar to *lister*, in that it contains a control panel and tty subwindow. The user specifies the directory and file, and pushes the **List** button, causing the `ls` command to be sent to the tty subwindow:

Figure 4-4 *filer*



There are three new buttons, each of which illustrates a typical use of pop-ups:

Set ls flags a pop-up *property sheet* for setting options to `ls`;

Edit a pop-up text subwindow for browsing and editing files;

Delete a pop-up *confirmer* which forces the user to confirm or cancel.

The three buttons are discussed in the pages that follow. The discussion makes reference to specific routines in the filer program, which is listed in its entirety as *filer* in Appendix A, *Example Programs*.

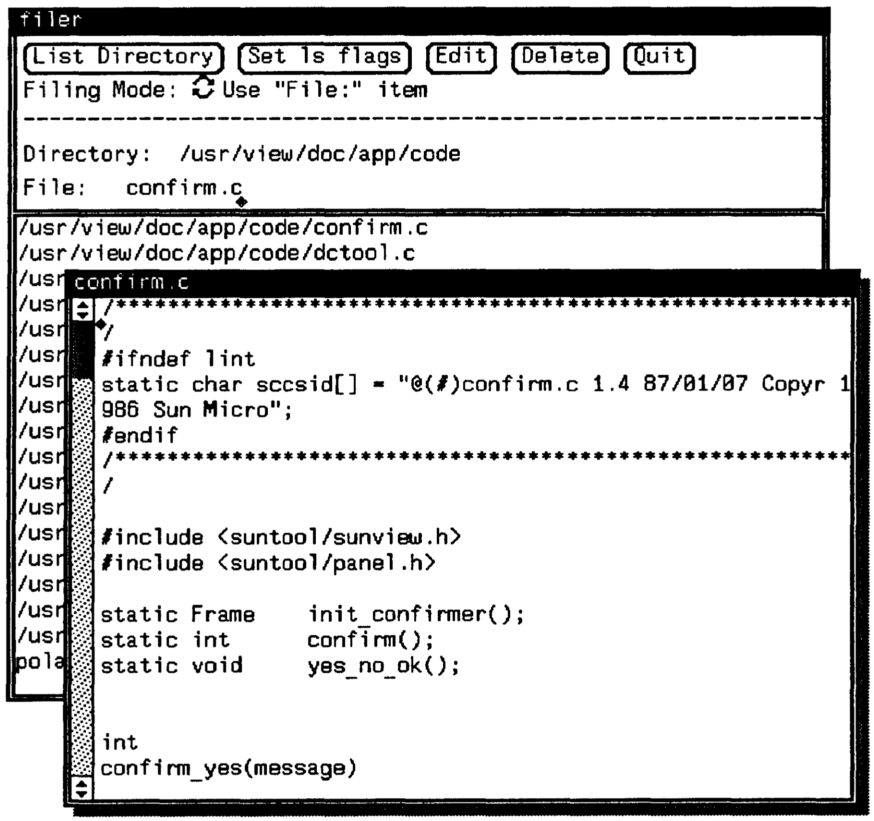
Pop-ups

In SunView, pop-ups are implemented as subframes containing subwindows. The subframe, along with its subwindows, is displayed and undisplayed as needed. Pop-ups may be displayed in either a blocking or a non-blocking mode. Examples of SunView pop-ups include the mailtool's composition window and textedit's search and replace.

Pop-up Text Subwindow

The **Edit** button illustrates a non-blocking pop-up. When the user selects a filename and presses the button, a pop-up text subwindow containing the file appears:

Figure 4-5 *A Pop-up Text Subwindow*



Both the subframe and text subwindow for the pop-up are created at initialization time with the calls:

```
edit_frame = window_create(base_frame, FRAME,
                           FRAME_SHOW_LABEL, TRUE,
                           0);
editsw = window_create(edit_frame, TEXTSW, 0);
```

When the user selects the **Edit** button, the notify procedure `edit_proc()` is invoked. This function first calls the Selection Service to get the name of the file the user has selected.[10]

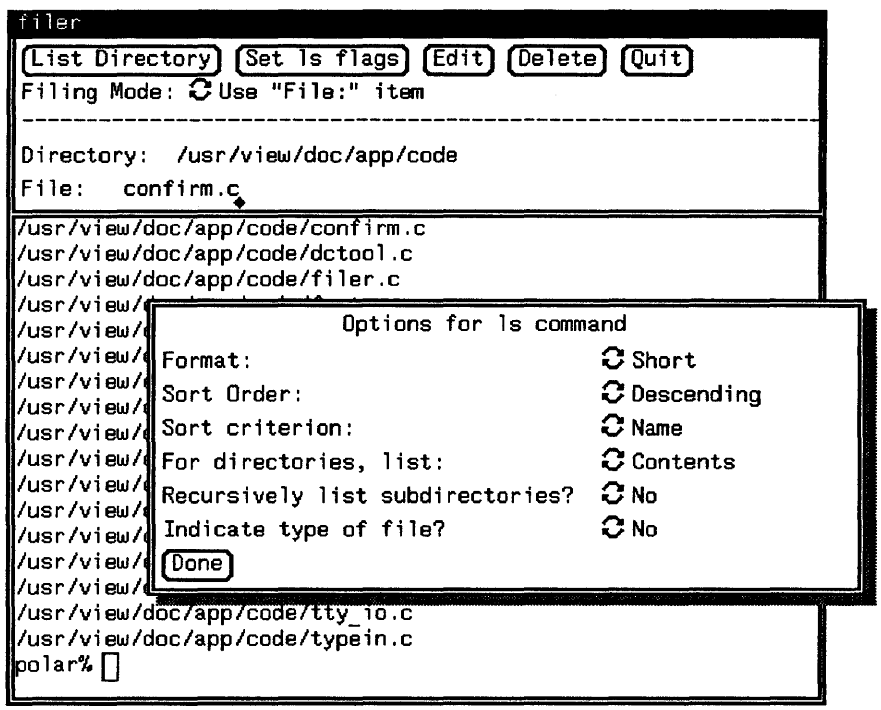
It then loads the file into the text subwindow, sets the frame header to the filename, and displays the frame with these two calls:

```
window_set(editsw, TEXTSW_FILE, filename, 0);
window_set(edit_frame, FRAME_LABEL, filename, WIN_SHOW, TRUE, 0);
```

Pop-up Property Sheet

The property sheet shown in Figure 4-6 is a typical example of a non-blocking pop-up. By pushing the **Set ls flags** button, the user can get a property sheet which allows him to set some of the options to the `ls` command. While the property sheet is displayed, the user can continue to interact with the application, setting options now and then. The user can cause the pop-up to disappear at any time by pushing the **Done** button, selecting *Done* from the subframe's menu, or by pressing the SunView function key labelled [Open].

Figure 4-6 *A Non-blocking Pop-up*



Invoking the 'Props' Menu Item

Two attributes are used to control whether the 'Props' menu item is active or able to be invoked in the frame's menu. The code fragment given below is taken from the *filer* program.

The `FRAME_PROPS_ACTION_PROC` attribute specifies which procedure will be called when the 'Props' menu item is chosen or the [Props] key is pressed. In the code below, `FRAME_PROPS_PROC` specifies that the procedure `ls_flags_proc()` is called when the [Props] key is pressed.

The FRAME_PROPS_ACTIVE attribute specifies whether the procedure that is specified by the FRAME_PROPS_ACTION_PROC will be called or not. If the attribute FRAME_PROPS_ACTIVE is TRUE, then the frame menu will contain an un-greyed 'Props' menu item. If the attribute FRAME_PROPS_ACTIVE is FALSE, then the frame menu will contain a greyed out 'Props' menu item.

```
base_frame = window_create(NULL, FRAME,
                  FRAME_ARGS,                argc, argv,
                  FRAME_LABEL,               "filer",
                  FRAME_PROPS_ACTION_PROC,   ls_flags_proc,
                  FRAME_PROPS_ACTIVE,        TRUE,
                  0);
```

WIN_SHOW

The display of a non-blocking pop-up is controlled using the WIN_SHOW attribute. The initialization routine create_ls_flags_popup() creates the subframe, panel, and panel items for the property sheet. When the subframe is created, WIN_SHOW is FALSE.[11] The notify procedure for the **Set ls flags** button, ls_flags_proc(), simply sets WIN_SHOW to TRUE for the subframe.[12]

When the notify procedure for the **List** button, ls_proc(), is called, it calls compose_ls_options() to construct the appropriate string of flags based on the settings of the items in the property sheet.

Pop-up Confirmer

Both the property sheet and the editing subwindow described in the preceding section are examples of non-blocking pop-ups, in which the application continues to receive input while the pop-up is displayed.

Blocking pop-ups differ in that, when displayed, they receive all input directed to the screen. Blocking pop-ups are appropriate when you want to force the user to confirm or cancel an irreversible operation before changing the application's state in any way.

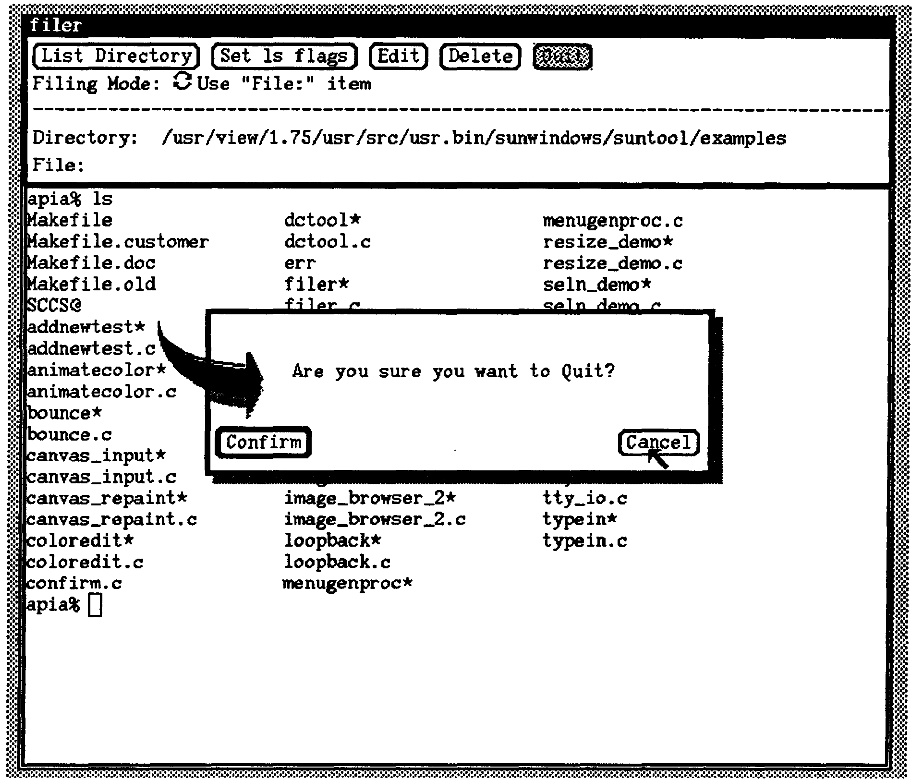
Most uses of blocking pop-ups should use the alert package described in Chapter 10, *Alerts*. In the example given below, filer uses an alert for the **Delete** button confirmation. However, if you want to use other panel features, or other kinds of windows, then you can use window_loop() for the same effect.

For example, in Figure @NumberOf(alert-win), when the user makes a selection and pushes the **Quit** button, *filer* displays a pop-up asking for confirmation. All input is directed into this confirmer, and the user is forced to either accept the deletion by selecting **Yes** or cancel it by selecting **No** :

[11] Note that while WIN_SHOW defaults to TRUE for base frames, it defaults to FALSE for subframes. The same holds for FRAME_SHOW_LABEL.

[12] Note that the subframe won't actually be displayed until control is returned to the Notifier.

Figure 4-7 *Pop-up Confirmer*



`window_loop`

The display of a non-blocking pop-up is controlled using the `WIN_SHOW` attribute. The display of a blocking pop-up, on the other hand, is controlled with the two functions `window_loop()` and `window_return()`.

```
caddr_t
window_loop(subframe)
    Frame subframe;

void
window_return(return_value)
    caddr_t return_value;
```

`window_loop()` causes the pop-up to be displayed and receive all input directed to the screen. The call will not return until `window_return()` is called from one of the pop-up's notify procedures. The value passed to `window_return()` as `return_value` will be returned by `window_loop()`. Its interpretation is up to the application. That is, it may be used to indicate whether the command was confirmed, whether a valid file name was entered, and so on.

Restrictions on Pop-Up Frames

There are some restrictions on pop-up frames displayed using `window_loop()`:

- You can only have one subwindow in the pop-up frame.
- The only subwindow types that work properly are canvases and panels.

These limitations do not apply to non-blocking pop-ups displayed using `WIN_SHOW`.

Controlling a Pop-up or Frame's Shadowing

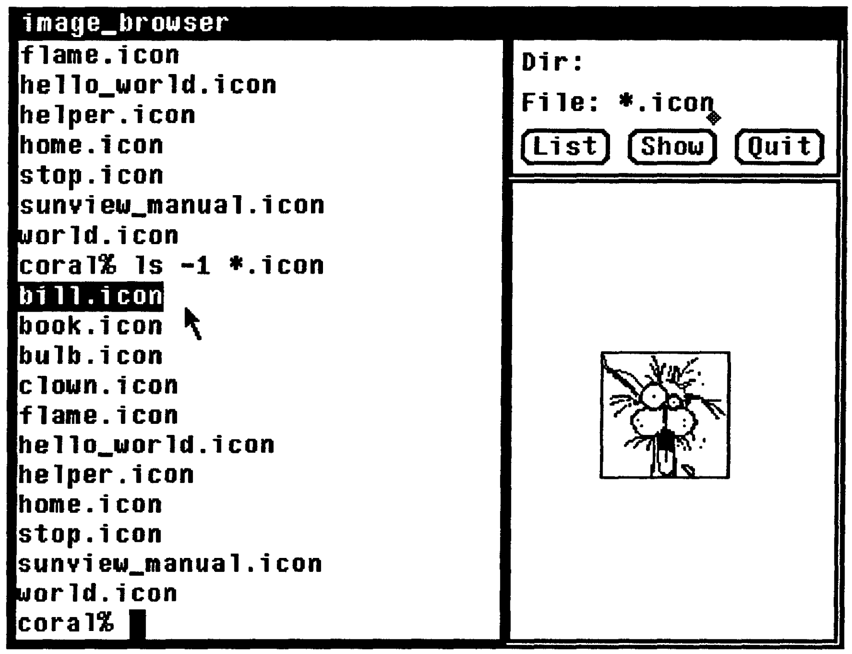
Sun's convention is that only transient items such as pop-ups have shadows. However, using the attribute `FRAME_SHOW_SHADOW` you may control the shadowing effect of a frame or a subframe:

- If you want your base frame to have a shadow, then set the attribute `FRAME_SHOW_SHADOW` to `TRUE`.
- You may stop a shadow from appearing with a sub_frame during create time by setting `FRAME_SHADOW` to `FALSE`.

4.6. Example 5— *image_browser_1*

Figure 4-8 illustrates how to specify the size and position of subwindows in order to get the layout that you want. This application lets the user view the images in files generated by `iconedit`. The user first presses the **List** button to get a listing. The user then selects a file that contains an image and press the **Show** button to view the image:

Figure 4-8 *image_browser_1*



This example presents a somewhat more complex subwindow layout: the tty subwindow has been moved to the left, the control panel to the upper right, and a panel for displaying the image added on the lower right.

Specifying Subwindow Size

You can specify the size of a subwindow either in pixels, with `WIN_HEIGHT` and `WIN_WIDTH` or in terms of rows and columns, with `WIN_ROWS` and `WIN_COLUMNS`.[13] If its dimensions are not specified, then a subwindow will extend in the *y* direction to the bottom edge, and in the *x* direction to the right edge of the frame. In this case the subwindow's height and width will have the special value `WIN_EXTEND_TO_EDGE`,[14] and will track the edge of the frame at run time, expanding or shrinking appropriately when the user resizes the frame.

Keep in mind that if you alter the size of a frame so that it exactly borders on a subwindow by calling `window_fit()`, the dimension of the subwindow that touches the frame will automatically become `WIN_EXTEND_TO_EDGE`.

[13] Row/column space is discussed in the next example.

[14] It is meaningless to set the width or height of a frame to `WIN_EXTEND_TO_EDGE`, and it will interfere with subwindow behavior.

Default Subwindow Layout

The default subwindow layout algorithm is simple. The first subwindow is placed at the upper left corner of the frame (leaving space for the frame's header and a border). If the width of the previously-created subwindow is fixed, not extend-to-edge, then the next subwindow is placed to the right of it. If the width of the previously-created subwindow *is* extend-to-edge, then the next subwindow is placed below it, at the left of the frame.

Explicit Subwindow Layout

This default layout algorithm handles only very simple topologies. SunView provides attributes that allow you to specify more complex layouts by explicitly positioning subwindows. You can position one subwindow relative to another by using `WIN_BELOW` and `WIN_RIGHT_OF`. These attributes take as their value the handle of the subwindow you want the new subwindow to be below or to the right of.

image_browser_1, pictured on the preceding page, illustrates the use of `window_fit()` along with explicit subwindow positioning to obtain a particular layout. The relevant calls are shown below:

```
tty = window_create(frame, TTY,
                    WIN_ROWS,    20,
                    WIN_COLUMNS, 30,
                    0);

control_panel = window_create(frame, PANEL, 0);

(create panel items...)

window_fit(control_panel);

display_panel = window_create(frame, PANEL,
                              WIN_BELOW,    control_panel,
                              WIN_RIGHT_OF, tty,
                              0);
window_fit(frame);
```

First the tty subwindow is created with a fixed height and width. Then the control panel is created, with no specification of origin or dimensions.

Since the width of the previous subwindow was fixed, the control panel is placed by default just to the right. After its items are created, the control panel is shrunk around its items in both dimensions with `window_fit()`.

Next, the display panel is created and explicitly positioned below the control panel and to the right of the tty subwindow. Both dimensions of the display panel default to `WIN_EXTEND_TO_EDGE`.

Finally, `window_fit()` is called to shrink the frame to the height of the tty window and the combined width of the tty window and the control panel.[15]

[15] `window_fit()` causes the window to shrink until it encounters the first fixed border. Subwindows which are extend-to-edge don't stop the shrinking.

NOTE *One thing to watch out for is that* WIN_BELOW *only affects the subwindow's y dimension, and* WIN_RIGHT_OF *only affects the x dimension.*

Specifying Subwindow Sizes and Positions

You can also specify the origin of a subwindow in pixels using WIN_X and WIN_Y. The computations for these attributes take the borders and header of the frame into account, so that specifying WIN_X and WIN_Y of 0 will then result in the subwindow being placed correctly at the upper left corner of the frame.

The program *resize_demo*, listed in Appendix A, uses these attributes to lay out its subwindows in a non-standard manner.

Changing Subwindow Layout Dynamically

If you programmatically change the size or position of subwindows after you create them, then you must explicitly re-specify the origin of any subwindows that are below or to the right of the altered subwindows. This must be done even if you specified the positions of these other subwindows using relative position attributes, such as WIN_BELOW.

This step is necessary because subwindows are not automatically laid out again when the positions and sizes of other subwindows are changed. They are only laid out again if the frame changes size. When re-specifying the layout of the other subwindows, you *can* use relative position attributes such as WIN_BELOW.

The Rect Structure

The attributes WIN_X, WIN_Y, WIN_WIDTH and WIN_HEIGHT, taken together, define the rectangle occupied by a window. This rectangle is actually stored as a Rect struct, which you can get or set using the attribute WIN_RECT. The definition of a Rect, found in <sunwindow/rect.h>, is:[16]

```
typedef struct rect {
    short r_left;
    short r_top;
    short r_width;
    short r_height;
} Rect;
```

The Rect is the basic data structure used in SunView window geometry. Where complex shapes are required, they are built up out of groups of rectangles.[17]

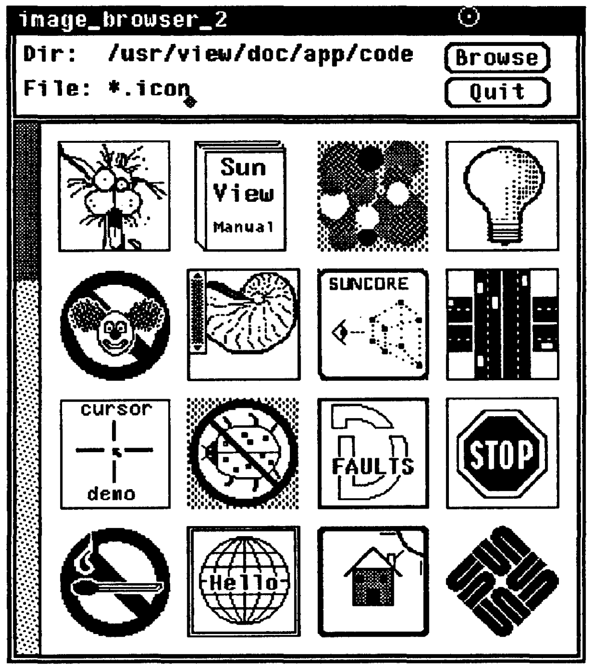
[16] The result that a window returns is relative to a frame's *positioning space*. It is not self-relative and it is not parent-relative. Therefore, WIN_RECT should only be used for window positioning operations. Do not use it for pw_lock().

[17] For a detailed discussion of rectangle geometry, including useful macros for operating on rectangles, see the chapter entitled *Rects and Rectlists* in the *SunView 1 System Programmer's Guide*.

4.7. Example 6— *image_browser_2*

In the next example, when the user specifies a filename and pushes **Browse** the images in the files are displayed in a scrollable panel:

Figure 4-9 *image_browser_2*



The point of this example is to illustrate how you can use *row/column space* to specify the size of a subwindow. The goal was to make the panel just the right size to display a single page of icons, with four rows, four columns, and 10 pixels of white space around each icon.

Row/Column Space

Row/column space refers to a logical grid defining the rows and columns of a window. You can define the row/column space for a window by using the attributes in the following table:

Table 4-2 *Window Row/Column Geometry Attributes*

Attribute	*Description*	*Default*	*Def. in Panels*
WIN_BOTTOM_MARGIN	Bottom margin.	0	(same)
WIN_COLUMN_GAP	Space after columns.	0	(same)
WIN_COLUMN_WIDTH	Width of a column.	Width of WIN_FONT.	(same)
WIN_LEFT_MARGIN	Left margin.	5	4
WIN_RIGHT_MARGIN	Right margin.	5	0
WIN_ROW_GAP	Space after rows.	0	5
WIN_ROW_HEIGHT	Height of a row.	Height of WIN_FONT	(same)
WIN_TOP_MARGIN	Top margin.	5[19]	4

[19] In frames with headers, the default for WIN_TOP_MARGIN depends on the system font. With the default

Defining a Panel's Row/Column Space

Using the row/column space attributes, the icon browsing panel pictured on the preceding page is specified as follows:

```
Scrollbar scrollbar = scrollbar_create(SCROLL_MARGIN,10,0);
bar_width = (int)scrollbar_get(scrollbar, SCROLL_THICKNESS, 0);
display_panel = window_create(base_frame, PANEL,
                WIN_VERTICAL_SCROLLBAR, scrollbar,
                WIN_ROW_HEIGHT,         64,
                WIN_COLUMN_WIDTH,       64,
                WIN_ROW_GAP,            10,
                WIN_COLUMN_GAP,         10,
                WIN_LEFT_MARGIN,        bar_width + 10,
                WIN_TOP_MARGIN,         10,
                WIN_ROWS,               4,
                WIN_COLUMNS,            4,
                0);
window_set(display_panel, WIN_LEFT_MARGIN, 10, 0);
```

This achieves our goal of a panel the right size for a 4x4 array of 64 pixel square icons, with 10 pixels of white space around each icon.

Positioning Panel Items in Row/Column Space

Once you have defined your row/column space, you can position panel items within that space with the `ATTR_ROW()` and `ATTR_COL()` macros.[20] The code fragment shown below shows how the items for the browsing panel are created and positioned at the proper row and column each time the **Browse** button is pushed:

```
for (row = 0, image_count = 0; image_count < files_count; row++)
    for (col = 0; col <= 4 && image_count < files_count; col++) {
      if (image = get_image(image_count)) {
         panel_create_item(display_panel, PANEL_MESSAGE,
                           PANEL_ITEM_Y,      ATTR_ROW(row),
                           PANEL_ITEM_X,      ATTR_COL(col),
                           PANEL_LABEL_IMAGE, image, 0);
         image_count++;
      }
    }
```

This example is complicated somewhat by an inconsistency in the way margins are handled in the current release of SunView. The left and top margins are used in two ways: for determining the size of the panel, and for determining the location of panel items positioned with `ATTR_COL()` and `ATTR_ROW()`. The size computation does not take into account any scrollbar which may be present; the positioning computation, on the other hand, does take the scrollbar into account. That is why, in the call to `window_create()` above, `WIN_LEFT_MARGIN` is set to the width of the scrollbar plus 10 pixels, and then set immediately afterward to 10 pixels.

system font, it defaults to 17.

[20] These "character unit macros" are described fully in Chapter 18, *Attribute Utilities*.

4.8. Attribute Ordering

The general rule is that attributes in SunView are evaluated in the order they are given. The following two examples of text subwindow calls illustrate how giving the same attributes in different orders can produce different effects:

```
window_set(textsw, TEXTSW_FILE, "file_1", 0);
window_set(textsw, TEXTSW_FIRST, 20, TEXTSW_FILE, "file_2", 0);

window_set(textsw, TEXTSW_FILE, "file_1", 0);
window_set(textsw, TEXTSW_FILE, "file_2", TEXTSW_FIRST, 20, 0);
```

In the first pair of calls, the index is first set to the 20th character of `file_1`, then `file_2` is loaded, starting at character zero. The second pair of calls first loads `file_2`, then sets the index in `file_2` to 20.

Command-line Arguments

The attribute `FRAME_ARGS` bears special mention. As described in the second example in this chapter, *simple_panel*, this attribute causes the frame to process the command-line arguments given by the user at run time. Some of these arguments correspond to attributes that can be set programmatically; for example, `-Wh` corresponds to `WIN_ROWS`.[21]

The basic rule, that attributes are evaluated in the order given, applies equally to attributes that are explicitly specified in the program and to those that are specified at run time using their command-line equivalents. If a given attribute is specified more than once, then the last setting is the one that takes effect. You can therefore control whether your application or the user has the last word by specifying attributes after or before `FRAME_ARGS`.

Let's take a couple of examples:

```
window_create(0, FRAME,
              FRAME_ARGS,  argc, argv,
              FRAME_LABEL, "LABEL FROM PROGRAM",
              WIN_ROWS,    10,
              0);

window_create(0, FRAME,
              FRAME_LABEL, "LABEL FROM PROGRAM",
              WIN_ROWS,    10,
              FRAME_ARGS,  argc, argv,
              0);
```

Assume that the program was invoked with a command line containing the following arguments:

```
-Wl "LABEL FROM COMMAND-LINE" -Wh 4
```

In the first call, by putting `FRAME_ARGS` at the start of the list, the application overrides the command-line arguments, and guarantees that the frame header will read "LABEL FROM PROGRAM" and the height will be 10 lines.

[21] For a complete list of these arguments see the *Command Line Frame Arguments* table in Chapter 19, *SunView Interface Summary*.

In the second call, since FRAME_ARGS appears at the end of the list, the command-line arguments override what the application has specified, resulting in a label of "LABEL FROM COMMAND-LINE" and a height of 4 lines.

Keep in mind that if you specify WIN_FONT, it does not override the font that the user specified using *-Wt*.

Different Classes of Attributes

In the case of different objects, the window attributes (those beginning with WIN_) are processed after the others (FRAME_*, PANEL_*, and so on).

Suppose that you want to create a canvas with a scrollbar. You also want the logical canvas to expand when the user makes the window bigger, but never to shrink past its initial size, even if the user shrinks the window. The initial size of the canvas should be the size of the "inner" portion of the window — not including the scrollbar.

The straightforward approach would be to simply set all relevant attributes when the window is created, as in:

```
canvas = window_create(frame, CANVAS,
                       WIN_VERTICAL_SCROLLBAR, scrollbar_create(0),
                       CANVAS_AUTO_SHRINK,     FALSE,
                       0);
```

This call, however, results in a canvas which is too big, extending underneath the vertical scrollbar. This is because of the order in which the CANVAS_ and WIN_ attributes are evaluated.

Since the window attributes are evaluated after the canvas attributes, the canvas size is set according to the initial size of the window, which does not have a scrollbar. By the time WIN_VERTICAL_SCROLLBAR is evaluated, the canvas refuses to shrink to the smaller inner portion of the window, since CANVAS_AUTO_SHRINK has already been evaluated and set to FALSE.

In general, you can force a particular order of evaluation by using separate window_set() calls, as in:

```
canvas = window_create(frame, CANVAS,
                       WIN_VERTICAL_SCROLLBAR, scrollbar_create(0),
                       0);
window_set(canvas, CANVAS_AUTO_SHRINK, FALSE, 0);
```

The Panel Package

The panel package deviates from the norm in that its attributes are generally not order-dependent. For example, you can specify the label of an item before the font, and the font will be used even though it appears after the label.

The only thing to watch out for is that you can't change the font in a single call, as in:

```
panel_set(text_item,
        PANEL_FONT,           font_1,
        PANEL_LABEL_STRING,   "Label:",
        PANEL_FONT,           font_2,
        PANEL_VALUE,          "initial value",
        0);
```

The above call will cause both the label and the value for `text_item` to be rendered in `font_2`.

4.9. File Descriptor Usage

In SunView, each window is actually a device, `/dev/win`*nnn*, that is accessed through a file descriptor. Other packages such as the selection service also use file descriptors. In SunOS there is a limit to the number of file descriptors one program can have open; in Release 4.0 it is 64. Thus it is possible for your application to run out of file descriptors.

The following table summarizes how file descriptors are used in SunView.

Table 4-3 *SunView File Descriptor Usage*

Window Type/ Package	*FD Usage*	*How FDs are used*
FRAME	1	1 for the window.
CANVAS	1	1 for the window.
TEXTSW	3	1 for the window, + 1 for the file to be edited (if any), + 1 for scratch (the `/tmp/Text...` file),
	(2)	2 temporarily created during a save.
PANEL	1	1 for the window.
TTYSW	2	1 for the window, + 1 for the *pty* (pseudo-tty).
MENU	0	Fullscreen access uses the window's FD.
ALERT	1	1 for positioning Alerts have a frame and a panel; however, the FDs are allocated for the first alert and reused by subsequent alerts.
Pointer	0	Most pointers are managed by the kernel.
Icon	0	Frame uses same FD whether open or iconic.

Table 4-3 *SunView File Descriptor Usage— Continued*

Window Type/ Package	*FD Usage*	*How FDs are used*
Scrollbar	0	(implemented as a region -- read the *SunView System Programmer's Guide*)
window manager	(1)	1 temporarily used for window management operations.
UNIX	3	`stdin/stdout/stderr`
framebuffer	1	frame buffer FD gets allocated automatically with the base frame. The screen device must be opened for your program to draw on it.
Selection Service	3	selection service fd's are allocated whenever there is something that will set or get from the selection service. For example, if you put in selection service code or the first time a panel item is allocated. This uses sockets to communicate: 1 for the connection to the service + 1 to receive UDP requests + 1 TCP rendezvous socket for transfers.
	(1)	1 transiently opened when a transfer is in progress to carry it.

5

Canvases

5

Canvases

The most basic type of subwindow provided by SunView is the *Canvas*. A canvas is essentially a window into which you can draw.

For a demonstration of the various canvas attributes, run the program `/usr/demo/canvas_demo`. For examples of canvases that illustrate event handling, run the image editor `iconedit(1)`. `iconedit` uses two canvases, the large drawing canvas on the left, and the small proof area on the lower right.

In order to use canvases you must include the header file `<suntool/canvas.h>`.

Summary Listing and Tables

To give you a feeling for what you can do with canvases, the following page lists the available canvas attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the canvas summary tables in Chapter 19, *SunView Interface Summary*:

- the *Canvas Attributes* table begins on page 319;
- the *Canvas Functions and Macros* table begins on page 320.

Canvas Attributes		
CANVAS_AUTO_CLEAR	CANVAS_FIXED_IMAGE	CANVAS_REPAINT_PROC
CANVAS_AUTO_EXPAND	CANVAS_HEIGHT	CANVAS_RESIZE_PROC
CANVAS_AUTO_SHRINK	CANVAS_MARGIN	CANVAS_RETAINED
CANVAS_FAST_MONO	CANVAS_PIXWIN	CANVAS_WIDTH

Canvas Functions and Macros	
canvas_event(canvas, event)	canvas_window_event(canvas, event)
canvas_pixwin(canvas)	

5.1. Creating and Drawing into a Canvas

Like all windows in SunView, canvas subwindows are created with `window_create()`. When drawing into a canvas use the *canvas pixwin*, which you can get with the `canvas_pixwin()` macro.

The pixwin is the structure through which you render images in a window. You draw points, lines and text on a pixwin with a set of functions of the form `pw_*()` — `pw_write()`, `pw_vector()`, `pw_text()` etc.[22]

Example 1:

As a beginning example, the following program puts up a canvas containing a box with the words "Hello World!":

```
#include <suntool/sunview.h>
#include <suntool/canvas.h>

main(argc, argv)
int    argc;
char **argv;
{
    Frame       frame;
    Canvas      canvas;
    Pixwin     *pw;

    /* create frame and canvas */
    frame  = window_create(NULL, FRAME, 0);
    canvas = window_create(frame, CANVAS, 0);

    /* get the canvas pixwin to draw into */
    pw = canvas_pixwin(canvas);

    /* draw top, bottom, left, right borders of box */
    pw_vector(pw, 100, 100, 200, 100, PIX_SRC, 1);
    pw_vector(pw, 100, 200, 200, 200, PIX_SRC, 1);
    pw_vector(pw, 100, 100, 100, 200, PIX_SRC, 1);
    pw_vector(pw, 200, 100, 200, 200, PIX_SRC, 1);

    /* write text at (125,150) in default font */
    pw_text(pw, 125, 150, PIX_SRC, 0, "Hello World!");

    window_main_loop(frame);
    exit(0);
}
```

The `PIX_SRC` argument to `pw_vector()` and `pw_text()` is a *rasterop* function specifying the operation which is to produce the destination pixel values. There are several other rasterop functions besides `PIX_SRC`; they are described in Chapter 2 of the *Pixrect Reference Manual.*

[22] Pixwins and their associated functions are covered in detail in Chapter 7, *Imaging Facilities: Pixwins.*

5.2. Scrolling Canvases

Many applications need to view and manipulate a large object through a smaller viewing window. To facilitate this SunView provides *scrollbars*, which can be attached to subwindows of type canvas, text or panel.

Example 2:

The code below creates a canvas that is scrollable in both directions:

```
frame  = window_create(NULL, FRAME, 0);
canvas = window_create(frame, CANVAS,
             CANVAS_AUTO_SHRINK,         FALSE,
             CANVAS_WIDTH,               1000,
             CANVAS_HEIGHT,              1000,
             WIN_VERTICAL_SCROLLBAR,     scrollbar_create(0),
             WIN_HORIZONTAL_SCROLLBAR,   scrollbar_create(0),
             0);
```

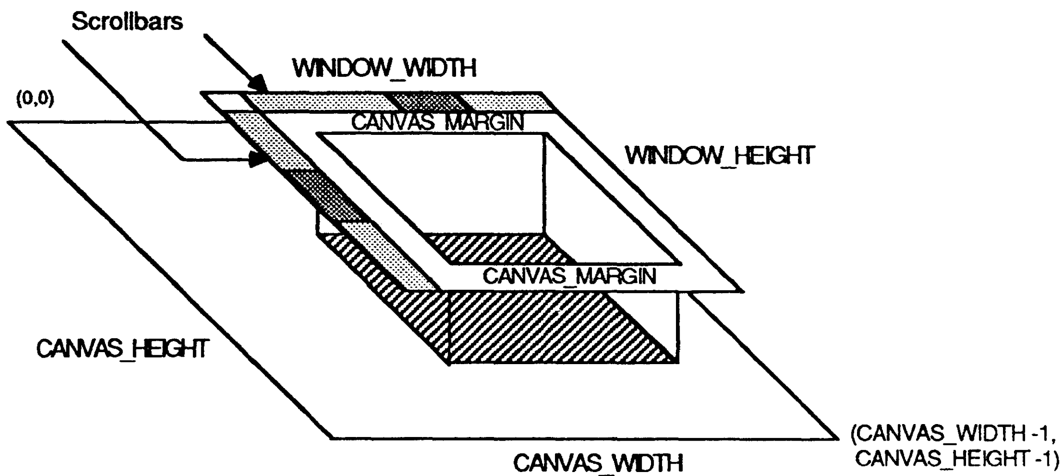
The distinction between the dimensions of the *canvas* and of the *window* is important. In the above example, we set the canvas width and height to 1000 pixels. Since the dimensions of the canvas subwindow (i.e. `WIN_WIDTH` and `WIN_HEIGHT`) were not explicitly set, the subwindow extends to fill the frame. The frame's dimensions, in turn, were not explicitly set, so it defaults to 25 lines by 80 characters in the default font. The result is a logical canvas roughly the area of the screen, which is viewed through a window about one fourth that size.

NOTE *It is necessary to explicitly disable the "auto-shrink" feature in the above example.* If this were not done, the canvas size would be truncated to the size of the window. See Section 5.6, *Automatic Sizing of the Canvas*.

5.3. Canvas Model

The components of a canvas subwindow and their relationships can be seen in Figure 5-1.

Figure 5-1 *Canvas Geometry*



The Canvas

Think of the canvas itself as a logical surface on which you can draw. The width and height of the canvas are set via the attributes `CANVAS_WIDTH` and `CANVAS_HEIGHT`. So the coordinate system is as shown in Figure 5-1, with the origin at the upper left corner and the point (`CANVAS_WIDTH-1`, `CANVAS_HEIGHT-1`) at the lower right corner. Note that the logical canvas origin is always at (0, 0).

The Canvas Pixwin

As mentioned above, you draw on the canvas by writing into the canvas pixwin, which is retrieved via the `CANVAS_PIXWIN` attribute or the `canvas_pixwin()` macro.

The canvas pixwin is set up to take scrolling into account by performing the transformation from your canvas coordinate system to its pixwin coordinate system. So when you draw into the canvas pixwin using the `pw_*` functions you don't have to do any mapping yourself — the arguments you give should be in the canvas coordinate system.

Between the frame border and the canvas pixwin is a margin, set via the attribute `CANVAS_MARGIN`. This margin defaults to zero pixels, so in the simple case, the canvas pixwin occupies the entire inner area of the window pixwin. If one or more scrollbars are present, the canvas margin begins at the inside border of the scrollbar.

Note the distinction between the pixwin of the canvas (attribute `CANVAS_PIXWIN`) and the pixwin of the window (attribute `WIN_PIXWIN`). The canvas pixwin is one of several regions of the window's pixwin, which also includes the regions occupied by the scrollbars and the margin.

The canvas package manages the canvas pixwin for you. In particular, the clipping list is restricted to the area of the canvas pixwin actually backed by the canvas. This means that you can never draw off the edge of the canvas. For example, if you have set the canvas height to be less than the height of the canvas pixwin, any `pw_*` operations that attempt to draw below the canvas height will be clipped away.

5.4. Repainting

By default, canvases are *retained* — i.e. the canvas package maintains a copy of the bits on the screen in a *backing pixrect*, from which it automatically repaints the screen image when necessary. If you wish to handle repainting yourself, you can defeat this feature.

Retained Canvases

The canvas package allocates a backing pixrect the size of the logical canvas. When the canvas width or height changes, a new backing pixrect of the proper dimensions is allocated, the contents of the old pixrect are copied into the new pixrect, and the old pixrect is freed.

Non-Retained Canvases

For a non-retained canvas, set `CANVAS_RETAINED` to `FALSE`, and give your own repaint function as the value of `CANVAS_REPAINT_PROC`.

The repaint procedure is called whenever some part of the canvas has to be repainted onto the canvas pixwin. Note that if you supply a repaint proc, it will be called even if the canvas is retained — i.e. the canvas package will not automatically copy from the backing pixrect to the canvas pixwin.

The Repaint Procedure

The form of the repaint procedure is:

```
sample_repaint_proc(canvas, pixwin, repaint_area)
    Canvas      canvas;
    Pixwin     *pixwin;
    Rectlist   *repaint_area;
```

The first two arguments are the canvas and its pixwin (i.e. the value of `canvas_pixwin(canvas)`). The third argument, `repaint_area`, is a pointer to a list of rectangles (type `Rectlist *`) which define the area to be painted.[23]

Before the canvas package calls your repaint procedure, it restricts the clipping list to the area which needs to be painted. Thus if your application is not capable of repainting arbitrary areas of the canvas you can repaint the entire image without worrying about excessive repainting.

If you choose not to redraw each individual rect in the repaint area, you can use the rectangle given by `repaint_area->rl_bound`, which is the bounding rectangle for the repaint area.

Note that if the attribute `CANVAS_AUTO_CLEAR` is `TRUE`, the canvas package will clear the repaint area before calling your repaint procedure.

[23] Rectlists are covered in detail in the chapter on *Rects* and *Rectlists* in the *SunView 1 System Programmer's Guide*.

Retained vs. Non-Retained

A retained canvas has two advantages. First, the repainting will be faster since it is a simple block copy operation. Second, it eliminates the need for the application to keep a display list from which to regenerate the image.

On the other hand there is a performance penalty on writing, since each operation is performed both on the canvas pixwin and the backing pixrect. This penalty may be reduced by using the `pw_batch()` call described in the chapter entitled *Imaging Facilities: Pixwins.*

5.5. Tracking Changes in the Canvas Size

The client's resize procedure is called whenever the canvas width or height changes. Its form is:

```
sample_resize_proc(canvas, width, height)
     Canvas     canvas;
     int        width;
     int        height;
```

NOTE *You should never repaint the image in the resize procedure, since if there is any new area to be painted, the repaint procedure will be called later.*

There are some subtle points to be aware of related to whether or not the image is fixed size (`CANVAS_FIXED_IMAGE` is `TRUE`). In the default case the image is fixed size, and the repaint procedure will not be called when the canvas gets smaller, since there will be no new canvas area to be repainted. If the image is *not* fixed size, then whenever the canvas size changes, the canvas package assumes that the entire canvas needs to be repainted, and the repaint area will contain the entire canvas.

Initializing a Canvas

Neither the repaint procedure nor the resize procedure will be called until the canvas subwindow has been displayed at least once. This allows you to create and initialize a canvas without having to deal with the resize/repaint procedures. The very first time the canvas is displayed, the resize procedure will be called with the current canvas size. This initial call to the resize procedure allows you to synchronize with the canvas size.

Example 3:

The canvas in the program below has a repaint procedure which fills the canvas with an appropriately sized rectangle and diagonals.

```
#include <suntool/sunview.h>
#include <suntool/canvas.h>

static void repaint_canvas();

main(argc, argv)
int    argc;
char **argv;
{
    Frame frame;

    frame = window_create(NULL, FRAME, 0);
    window_create(frame, CANVAS,
        CANVAS_RETAINED,      FALSE,
        CANVAS_FIXED_IMAGE,   FALSE,
        CANVAS_REPAINT_PROC,  repaint_canvas,
        0);
    window_main_loop(frame);
    exit(0);
}

static void
repaint_canvas(canvas, pw, repaint_area)
    Canvas       canvas;
    Pixwin      *pw;
    Rectlist    *repaint_area;
{
    int width   = (int)window_get(canvas, CANVAS_WIDTH);
    int height  = (int)window_get(canvas, CANVAS_HEIGHT);
    int margin  = 10;
    int xleft   = margin;
    int xright  = width - margin;
    int ytop    = margin;
    int ybottom = height - margin;

    /* draw box */
    pw_vector(pw, xleft, ytop, xright, ytop, PIX_SRC, 1);
    pw_vector(pw, xright, ytop, xright, ybottom, PIX_SRC, 1);
    pw_vector(pw, xright, ybottom, xleft, ybottom, PIX_SRC, 1);
    pw_vector(pw, xleft, ybottom, xleft, ytop, PIX_SRC, 1);

    /* draw diagonals */
    pw_vector(pw, xleft, ytop, xright, ybottom, PIX_SRC, 1);
    pw_vector(pw, xright, ytop, xleft, ybottom, PIX_SRC, 1);
}
```

There are several points to note from the example on the previous page. First, since the width and height of the canvas are not specified, they default to the width and height of the window. Second, since the image being drawn is dependent on the size of the canvas, we set CANVAS_FIXED_IMAGE to FALSE. Third, when the repaint proc is called, we don't bother to draw the specified repaint area, instead we rely on the clipping list to be restricted correctly and simply redraw the entire image.

5.6. Automatic Sizing of the Canvas

Two attributes requiring some explanation are CANVAS_AUTO_EXPAND and CANVAS_AUTO_SHRINK. Setting both these attributes to TRUE allows you to have a drawing area which automatically tracks the size of the window.

If CANVAS_AUTO_EXPAND is TRUE, the canvas width and height are never allowed to be less than the edges of the canvas pixwin. For example, if you try to set CANVAS_WIDTH to a value which is smaller than the width of the canvas pixwin, the value will be automatically expanded (rounded up) to the width of the canvas pixwin.

The main use of CANVAS_AUTO_EXPAND is to allow the canvas to grow bigger as the user stretches the window. For example, if the canvas starts out exactly the same size as the canvas pixwin, and the user stretches the window, the canvas pixwin will get bigger, which will cause the canvas itself to expand.

Another point to keep in mind is that whenever you set CANVAS_AUTO_EXPAND to TRUE, the canvas will be expanded to the edges of the canvas pixwin (if it is smaller to begin with).

CANVAS_AUTO_SHRINK is symmetrical to CANVAS_AUTO_EXPAND. If CANVAS_AUTO_SHRINK is TRUE, the canvas width and height are never allowed to be greater than the edges of the canvas pixwin.

NOTE *As described in Section 4.8, Attribute Ordering, the canvas attributes are evaluated before the generic window attributes.* This means that, if you want to set the window size and then disable automatic sizing of the canvas, you must *first* set the window size, *then*, in a separate window_set() call, disable CANVAS_AUTO_SHRINK and/or CANVAS_AUTO_EXPAND. If you do both in the same call, the auto-sizing will be turned off before the window size is set, so the canvas size will not match the window size you specify. Here is an example of how to do it correctly:

```
canvas = window_create(frame, CANVAS,
                       WIN_HEIGHT, 400,
                       WIN_WIDTH,  600,
                       0);

window_set(canvas,
           CANVAS_AUTO_SHRINK, FALSE,
           CANVAS_AUTO_EXPAND, FALSE,
           0);
```

5.7. Handling Input in Canvases

This section gives some hints on basic handling of input in canvases.[24]

Default Input Mask

By default, canvases enable LOC_WINENTER, LOC_WINEXIT, LOC_MOVE and the three mouse buttons, MS_LEFT, MS_MIDDLE and MS_RIGHT.[25]

NOTE *Since the canvas pixwin is actually a region of the subwindow's pixwin, your event procedure will receive* LOC_RGNENTER *and* LOC_RGNEXIT *events rather than* LOC_WINENTER *and* LOC_WINEXIT. The locator motion events — LOC_MOVE, LOC_STILL, LOC_DRAG, and LOC_TRAJECTORY — will only be passed to your event procedure if they fall within the canvas pixwin.

You can enable events other than those listed above with the window attributes applying to events. So, for example, you could allow the user to type in text to a canvas by calling:

```
window_set(canvas, WIN_CONSUME_KBD_EVENT, WIN_ASCII_EVENTS, 0);
```

An application needing to track mouse motion with the button down would enable LOC_DRAG by calling:

```
window_set(canvas, WIN_CONSUME_PICK_EVENT, LOC_DRAG, 0);
```

Writing Your Own Event Procedure

If you supply an event procedure as the value of WIN_EVENT_PROC, it will get called when any event is received for the canvas. Before your event procedure gets called, however, the canvas package does some processing. If the event is WIN_REPAINT or WIN_RESIZE, the canvas package calls your repaint or resize procedures if necessary. If the event is SCROLL_REQUEST, then the canvas package performs the scroll.[26] The repaint, resize and scroll events are then passed to your event procedure. In the case of events which have x-y coordinates, the canvas package translates the events from the coordinate space of the canvas pixwin to that of the logical canvas.

Translating Events from Canvas to Window Space

Functions are provided to translate event coordinates from the coordinate space of the canvas to the coordinate space of the canvas subwindow, and *vice versa.*

To go from canvas space to window space, use canvas_window_event(). Keep in mind that the canvas_window_event function changes fields in its event argument structure. For example, if you want to put up a menu in a canvas

[24] The general input paradigm for Sunview is discussed in Chapter 6, *Handling Input.* See that chapter for a full discussion of the available input events and how to use them.

[25] Note that the canvas package expects to receive these events, and will not function properly if you disable them. Also, if the user has the enabled the *Left_Handed* option in the *Input* category of defaultsedit(1), the mouse buttons are reversed: MS_LEFT refers to the right mouse button, MS_RIGHT to the left mouse button.

[26] If you want write a procedure which is called *before* the repaint, resize or scroll event is processed by the canvas package, in order to modify the interpretation of the event, you must *interpose* on the event, as described in Chapter 17, *The Notifier* .

subwindow, you need to specify the menu's location in the coordinate of the subwindow, not of the canvas.

To go from window space to canvas space, use `canvas_event()`. This returns the `Event *` it is passed, with the x and y fields changed. The translation is necessary if you read your own events with `window_read_event()`, described in the next chapter, *Handling Input*.

Border Highlighting

The SunView convention is that a subwindow indicates that it is accepting keyboard events by highlighted its border. By default, canvas subwindows do not enable any keyboard events, so the border is not highlighted. However, if you explicitly enable keyboard events, by consuming `WIN_ASCII_EVENTS`, the canvas package will highlight the canvas border when it is given the input focus.

Example 4:

The program below prints out the corresponding string when the user types **0**, **1**, or **2** into its canvas:

```
#include <suntool/sunview.h>
#include <suntool/canvas.h>

static void my_event_proc();

main(argc, argv)
int    argc;
char **argv;
{
    Frame frame;

    frame = window_create(NULL, FRAME, 0);
    window_create(frame, CANVAS,
        WIN_CONSUME_KBD_EVENT, WIN_ASCII_EVENTS,
        WIN_EVENT_PROC,        my_event_proc,
        0);
    window_main_loop(frame);
    exit(0);
}

static void
my_event_proc(canvas, event)
    Canvas  canvas;
    Event  *event;
{
   char *string = NULL;

   switch (event_action(event)) {
      case '0':
        string = "zero";
        break;

      case '1':
        string = "one ";
        break;
```

```
        case '2':
          string = "two ";
          break;

        default:
          break;
    }
    if (string != NULL)
        pw_text(canvas_pixwin(canvas),
                10, 10, PIX_SRC, NULL, string);
}
```

5.8. Color in Canvases

You can use color in canvases by specifying a colormap segment for the canvas with the colormap manipulation routines described in Chapter 6, *Handling Input*.

Setting the Colormap Segment

The first thing to note is that since the canvas pixwin is a region of the WIN_PIXWIN, you must also set the colormap segment for the canvas pixwin.

Color in Retained Canvases

If the canvas is retained, then the colormap segment must be set *before* CANVAS_RETAINED is set to TRUE. This is because the canvas package will determine the depth of the backing pixrect based on depth of the colormap segment defined for the WIN_PIXWIN. (If the colormap segment depth is greater than two, then the full depth of the display will be used. Otherwise, the backing pixrect depth will be set to one.)

Since the depth of the backing pixrect is determined when the canvas is created, you must create the canvas with CANVAS_RETAINED FALSE, then set the colormap segment, then set CANVAS_RETAINED to TRUE.

Color in Scrollable Canvases

If the canvas has scrollbars, you need to attach the scrollbars to the canvas *after* the colormap segment has been changed. If the canvas has already been created with scrollbars attached, you should change the colormap, then re-attach the scrollbars. This will insure that the scrollbar pixwin regions use the new colormap segment.

Example 5:

Below is an example of setting the colormap segment for a canvas:

```
#include <suntool/sunview.h>
#include <suntool/canvas.h>
#include <sunwindow/cms_rainbow.h>


init_color_canvas(base_frame)
Frame base_frame;
{
{
    Canvas          canvas;
    Pixwin         *pw;
    unsigned char   red[CMS_RAINBOWSIZE];
    unsigned char   green[CMS_RAINBOWSIZE];
    unsigned char   blue[CMS_RAINBOWSIZE];

    canvas = window_create(base_frame, CANVAS,
        CANVAS_RETAINED,          FALSE,
        0);

    cms_rainbowsetup(red, green, blue);

    /* set the WIN_PIXWIN colormap */
    pw = (Pixwin *) window_get(canvas, WIN_PIXWIN);
    pw_setcmsname(pw, CMS_RAINBOW);
    pw_putcolormap(pw, 0, CMS_RAINBOWSIZE, red, green, blue);

    /* set the CANVAS_PIXWIN colormap */
    pw = (Pixwin *) canvas_pixwin(canvas);
    pw_setcmsname(pw, CMS_RAINBOW);
    pw_putcolormap(pw, 0, CMS_RAINBOWSIZE, red, green, blue);

    window_set(canvas,
        CANVAS_RETAINED,          TRUE,
        WIN_VERTICAL_SCROLLBAR,   scrollbar_create(0),
        WIN_HORIZONTAL_SCROLLBAR, scrollbar_create(0),
        0);
}
}
```

6

Handling Input

6

Handling Input

Material Covered

This chapter explains how input is handled in SunView. Specifically it:

- gives an overview on how input is handled in SunView
- describes *events* and how they are used;
- gives various classes of events —ASCII, action events, function keys, locator buttons, locator motion, window generated events, and so on;
- explains the input focus model distinguishing between *pick* and *keyboard* focuses;
- shows how to control where input is distributed using *input masks*;
- shows how to query the state of an event;
- shows how to explicitly read events.

The material in this chapter applies to the window system as a whole. However, it is of special interest to alerts or clients of canvases, who typically will want to handle events themselves.

Header Files

The definitions necessary to use SunView's input facilities are in the header file `<sunwindow/win_input.h>`, which is included by `<sunwindow/window_hs.h>`, which in turn is included by default when you include `<suntool/sunview.h>`.

Related Documentation

The chapter titled *Workstations* in the *SunView 1 System Programmer's Guide* explains the input system at a lower level, covering such topics as how to add user input devices to SunView.

Summary Listing and Tables

To give you a feeling for what you can do with events, a list of the available event descriptors and input related window events is given on the following page. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the input summary tables in Chapter 19, *SunView Interface Summary*:

- the *Event Descriptors* table begins on page 333;
- the *Input-Related Window Attributes* table begins on page 334.

Input-Related Window Attributes	
WIN_INPUT_DESIGNEE	WIN_CONSUME_KBD_EVENTS
WIN_GRAB_ALL_INPUT	WIN_IGNORE_KBD_EVENTS
WIN_KBD_FOCUS	WIN_CONSUME_PICK_EVENT
WIN_KBD_INPUT_MASK	WIN_IGNORE_PICK_EVENT
WIN_PICK_INPUT_MASK	WIN_CONSUME_PICK_EVENTS
WIN_CONSUME_KBD_EVENT	WIN_IGNORE_PICK_EVENTS
WIN_IGNORE_KBD_EVENT	

Event Descriptors	
WIN_NO_EVENTS	WIN_RIGHT_KEYS
WIN_ASCII_EVENTS	WIN_TOP_KEYS
WIN_IN_TRANSIT_EVENTS	WIN_UP_ASCII_EVENTS
WIN_LEFT_KEYS	WIN_UP_EVENTS
WIN_MOUSE_BUTTONS	

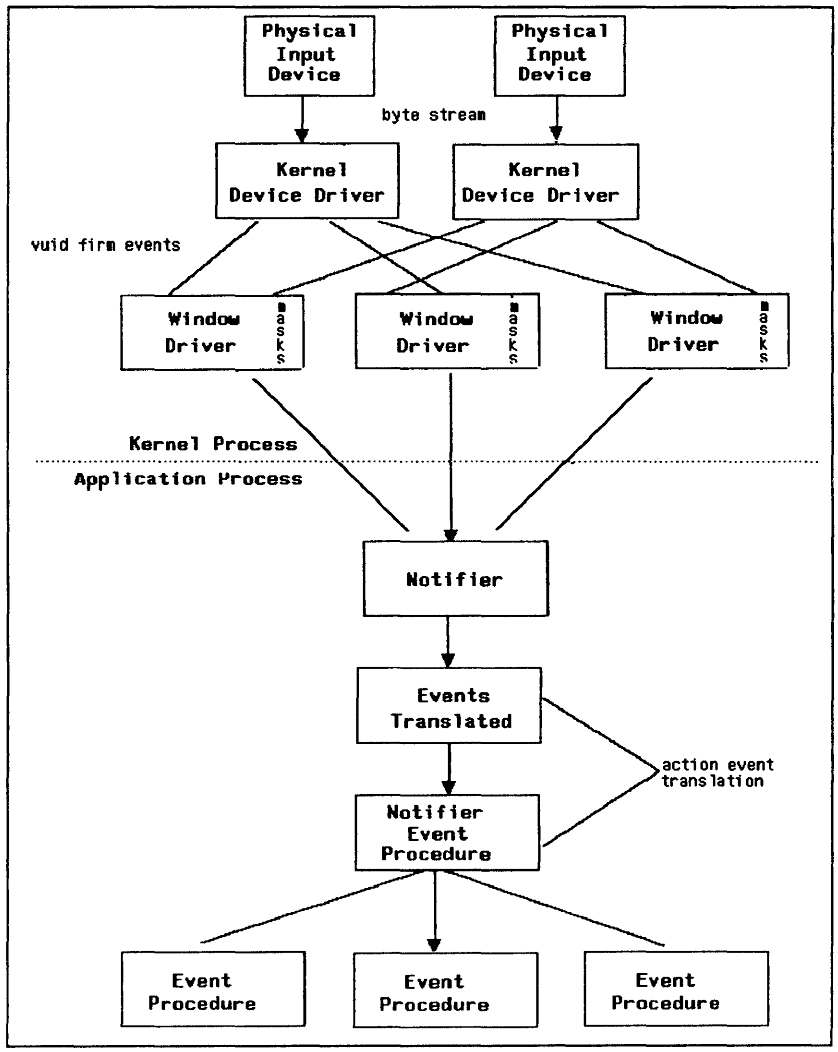
6.1. An Overview of the Input Environment

The input environment for SunView differs from UNIX programs. Most UNIX programs read characters from standard input by using either the `read`(2) system call or the standard I/O functions such as `getc`(3S), `gets`(3S), or `scanf`(3S). SunView is different in that the underlying Notifier formats user input into uniform *events*, which it distributes to the window's *event procedure*.

How are events generated ?

Figure 6-1 illustrates how events are generated and handled in SunView.

Figure 6-1 *Input Events*



Events are generated from several sources. These include standard devices such as the keyboard and mouse, special input devices such as graphics tablets, and the window system itself.

SunView does not directly receive events from the hardware devices. Instead each user action is interpreted by a "virtual" user input device (VUID) interface. This interface packages the data it receives into an event and sends it to the application process.[27]

What does the Notifier do with these events ?

The Notifier weaves events from all of these sources into a single, ordered *event stream.* This event stream eliminates the need for the application to poll separate streams from the different devices.

Because the underlying Notifier multiplexes the input stream between windows, each individual window operates under the illusion that it has the user's full attention. That is, it sees precisely those input events that the user has directed to it.

How do windows determine which input they will receive?

Each window indicates which events it is prepared to handle using *input masks,* described in Section 6.6, *Controlling Input in a Window.* These masks only let specified events through to the process.

6.2. Events

As discussed in the previous section, each user action generates an input event. This event is passed to your event procedure as an `Event` pointer (type `Event *`). Three types of information are encoded as part of an event:

- an identifying code, accessed with the macro `event_action()`
- the location of the event in the window's coordinate system, accessed with the macros `event_x()` and `event_y()`
- a timestamp, accessed with the macro `event_time()`

Notice that the macro `event_action()` has replaced the old `event_id()`. For compatibility reasons, `event_id()` is still supported, so that old code that does not use the new action event codes will still work. See Section 6.4, *Classes of Events,* for an explanation of action events. New programs that want to take advantage of the new action events must use the `event_action()` macro.

An event Procedure

Use the following form to specify an an event procedure in your applications:

```
void
sample_event_proc(window, event, arg)
    Window     window;
    Event     *event;
    caddr_t    arg;
```

[27] It is possible to bypass the VUID and receive unencoded events. Refer to the section on *Unencoded Input* in Chapter 7 of the *SunView 1 System Programmer's Guide.*

The arguments passed in are the window, the event, and an optional argument containing data pertaining to the event. For example, if the event is a SCROLL_REQUEST, arg will be the scrollbar that sent the event.

How Subwindows Handle Events

The canvas and panel subwindows pass events that they receive on to an event procedure. These event procedures are supplied by the application as the value of WIN_EVENT_PROC. If you set the WIN_EVENT_PROC of a canvas or panel to a function you have written, you can receive events after they have been processed by the canvas or panel. Both the canvas and panel packages process SCROLL_REQUEST, WIN_RESIZE, and WIN_REPAINT events before calling your event procedure. The form of an event procedure is:

```
void
sample_event_proc(window, event, arg)
    Window    window;
    Event       event;
    caddr_t     arg;
```

The arguments passed in are the window (canvas or panel), the event, and an optional argument containing data pertaining to the event. For example, if the event is a SCROLL_REQUEST, arg will be the scrollbar that sent the event.

The default panel event procedure maps events to actions and determines which panel item to send the event to. The default canvas event procedure does no further processing of the event. You can call the default window event procedure by calling window_default_event_proc() with the same arguments passed to your event procedure.[28]

6.3. A List of Events

Two tables are given on the following pages. Table 6-1, *Event Codes*, lists the predefined event codes and their values.[29] The event id or code numbers that the window system uses to represent an event are included in this table. These event code numbers are in the range of 0-65535. The numbers are useful when debugging a program because the debugger reports event codes as decimal integers and not as names.

Table 6-2, *Keyboard Motions and Accelerators*, lists the event name and its associated keyboard accelerator.

[28] If you need to receive an event before it is processed by a canvas, panel, or any other type of window, you can use the more general notifier interposition mechanism described in Chapter 17, *The Notifier*,

[29] The same table also appears in the input summary section of Chapter 19, *SunView Interface Summary*.

Table 6-1 *Event Codes*

Event Code	*Description*	*Value (for debugging)*
ASCII_FIRST	Marks beginning of ASCII range	0
ASCII_LAST	Marks end of ASCII range	127
META_FIRST	Marks beginning of META range	128
META_LAST	Marks end of META range	255
ACTION_ERASE_CHAR_BACKWARD	Erase char to the left of caret	31744
ACTION_ERASE_CHAR_FORWARD	Erase char to the right of caret	31745
ACTION_ERASE_WORD_BACKWARD	Erase word to the left of caret	31746
ACTION_ERASE_WORD_FORWARD	Erase word to the right of caret	31747
ACTION_ERASE_LINE_BACKWARD	Erase to the beginning of the line	31748
ACTION_ERASE_LINE_END	Erase to the end of the line	31749
ACTION_GO_CHAR_BACKWARD	Move the caret one character to the left	31752
ACTION_GO_CHAR_FORWARD	Move the caret one character to the right	31753
ACTION_GO_WORD_BACKWARD	Move the caret one word to the left	31754
ACTION_GO_WORD_END	Move the caret to the end of the word	31756
ACTION_GO_WORD_FORWARD	Move the caret one word to the right	31755
ACTION_GO_LINE_BACKWARD	Move the caret to the start of the line	31757
ACTION_GO_LINE_END	Move the caret to the end of the line	31759
ACTION_GO_LINE_FORWARD	Move the caret to the start of the next line	31758
ACTION_GO_COLUMN_BACKWARD	Move the caret up one line, maintaining column position	31761
ACTION_GO_COLUMN_FORWARD	Move the caret down one line, maintaining column position	31762
ACTION_GO_DOCUMENT_START	Move the caret to the beginning of the text	31763
ACTION_GO_DOCUMENT_END	Move the caret to the end of the text	31764
ACTION_STOP	Stop the operation	31767
ACTION_AGAIN	Repeat previous operation	31768
ACTION_PROPS	Show property sheet window	31769
ACTION_UNDO	Undo previous operation	31770
ACTION_FRONT	Bring window to the front of the desktop	31772
ACTION_BACK	Put the window at the back of the desktop	31773
ACTION_OPEN	Open a window from its icon form or close if already open)	31775
ACTION_CLOSE	Close a window to an icon	31776
ACTION_COPY	Copy the selection to the clipboard	31774
ACTION_PASTE	Copy clipboard contents to the insertion point	31777
ACTION_CUT	Delete the selection, put on clipboard	31781
ACTION_COPY_THEN_PASTE	Copies then pastes text	31784
ACTION_FIND_FORWARD	Find the text selection to the right of the caret	31779
ACTION_FIND_BACKWARD	Find the text selection to the left of the caret	31778
ACTION_FIND_AND_REPLACE	Show find and replace window	31780
ACTION_SELECT_FIELD_FORWARD	Select the next delimited field	31783
ACTION_SELECT_FIELD_BACKWARD	Select the previous delimited field	31782

Table 6-1 *Event Codes— Continued*

Event Code	*Description*	*Value (for debugging)*
ACTION_MATCH_DELIMITER	Selects text up to a matching delimiter	31894
ACTION_QUOTE	Causes next event in the input stream to pass untranslated by the keymapping system	31898
ACTION_EMPTY	Causes the subwindow to be emptied	31899
ACTION_STORE	Stores the specified selection as a new file	31785
ACTION_LOAD	Loads the specified selection as a new file	31786
ACTION_GET_FILENAME	Gets the selected filename	31788
ACTION_SET_DIRECTORY	Sets the directory to the selection	31788
ACTION_INCLUDE_FILE	Selects the current line (in pending-delete mode) and attempts to insert the file described by that selection	31891
ACTION_CAPS_LOCK	Toggle caps lock state	31895
PANEL_EVENT_CANCEL	The panel or panel item is no longer "current"	32000
PANEL_EVENT_MOVE_IN	The panel or panel item was entered with no mouse buttons down	32001
PANEL_EVENT_DRAG_IN	The panel or panel item was entered with one or more mouse buttons down	32002
SCROLL_REQUEST	Scrolling has been requested	32256
SCROLL_ENTER	Locator (mouse) has moved into the scrollbar	32257
SCROLL_EXIT	Locator (mouse) has moved out of the scrollbar	32258
LOC_MOVE	Locator (mouse) has moved	32512
LOC_STILL	Locator (mouse) has been still for 1/5 second	32513
LOC_WINENTER	Locator (mouse) has entered window	32514
LOC_WINEXIT	Locator (mouse) has exited window	32515
LOC_DRAG	Locator (mouse) has moved while a button was down	32516
LOC_RGNENTER	Locator (mouse) has entered a region of the window	32519
LOC_RGNEXIT	Locator (mouse) has exited a region of the window	32520
LOC_TRAJECTORY	Inhibits the collapse of mouse motions; clients receive LOC_TRAJECTORY events for every locator motion the window system detects.	32523
WIN_REPAINT	Some portion of window requires repainting	32517
WIN_RESIZE	Window has been resized	32518
WIN_STOP	User has pressed the *stop* key	32522
KBD_REQUEST	Window is about to become the focus of keyboard input	32526
KBD_USE	Window is now the focus of keyboard input	32524
KBD_DONE	Window is no longer the focus of keyboard input	32525
SHIFT_LEFT	Left shift key changed state	32530
SHIFT_RIGHT	Right shift key changed state	32531
SHIFT_CTRL	Control key changed state	32532
SHIFT_META	Meta key changed state	32534
SHIFT_LOCK	Shift lock key changed state	32529
SHIFT_CAPSLOCK	Caps lock key changed state	32528

Table 6-1 *Event Codes— Continued*

Event Code	*Description*	*Value (for debugging)*
`BUT(i)`	Locator (mouse) buttons 1–10	BUT(1) is 32544
`MS_LEFT`	Left mouse button	32544
`MS_MIDDLE`	Middle mouse button	32545
`MS_RIGHT`	Right mouse button	32546
`KEY_LEFT(i)`	Left function keys 1–15	`KEY_LEFT(1)` is 32554
`KEY_RIGHT(i)`	Right function keys 1–15	`KEY_RIGHT(1)` is 32570
`KEY_TOP(i)`	Top function keys 1–15	`KEY_TOP(1)` is 32586

Table 6-2 *Keyboard Motions and Accelerators*

Command Token	*SunView 4.0*	*SunView 3.x*
ACTION_ERASE_CHAR_BACKWARD	Delete	Delete
ACTION_ERASE_CHAR_FORWARD	Shift-Delete	Shift-Delete
ACTION_ERASE_WORD_BACKWARD	Control-W	Control-W
ACTION_ERASE_WORD_FORWARD	Shift-Control-W	Shift-Control-W
ACTION_ERASE_LINE_BACKWARD	Control-U	Control-U
ACTION_ERASE_LINE_END	Shift-Control-U	Shift-Control-U
ACTION_GO_CHAR_BACKWARD	Control-B or Shift-Control-F or R10	
ACTION_GO_CHAR_FORWARD	Control-F or Shift-Control-B or R12	
ACTION_GO_WORD_BACKWARD	Control-*comma* or Shift-Control-*period* or Shift-Control-*slash*	
ACTION_GO_WORD_END	Control-*period*	
ACTION_GO_WORD_FORWARD	Control-*slash* or Shift-Control-*comma*	
ACTION_GO_LINE_FORWARD	Control-*semicolon* or R11	
ACTION_GO_LINE_BACKWARD	Control-A or Shift-Control-E	
ACTION_GO_LINE_END	Control-E or Shift-Control-A	
ACTION_GO_COLUMN_BACKWARD	Control-P or Shift-Control-N or R14	
ACTION_GO_COLUMN_FORWARD	Control-N or Shift-Control-P or R18	
ACTION_GO_DOCUMENT_START	Shift-Control-Return or R7	
ACTION_GO_DOCUMENT_END	Control-Return or R13	Control-Return
ACTION_STOP	L1	L1
ACTION_AGAIN	L2 or *Meta*-A	L2
ACTION_PROPS	L3	L3
ACTION_UNDO	L4 or *Meta*-U	L4
ACTION_FRONT	L5	L5
ACTION_BACK	Shift-L5	Shift-L5
ACTION_OPEN	L7	L7
ACTION_CLOSE	Shift-L7	Shift-L7
ACTION_COPY	L6 or *Meta*-C	L6
ACTION_PASTE	L8 or *Meta*-V	L8 or Control-G
ACTION_CUT	L10 or *Meta*-X	L10 or Control-D
ACTION_COPY_THEN_PASTE	*Meta*-P	Control-P
ACTION_FIND_FORWARD	L9 or *Meta*-F	L9 or Control-F
ACTION_FIND_BACKWARD	Shift-L9 or Shift-*Meta*-F	Shift-L9 or Shift-Control-F
ACTION_FIND_AND_REPLACE	Control-L9	
ACTION_SELECT_FIELD_FORWARD	Control-Tab	
ACTION_SELECT_FIELD_BACKWARD	Shift-Control-Tab	
ACTION_MATCH_DELIMITER	*Meta*-D	
ACTION_QUOTE	*Meta*-Q	
ACTION_EMPTY (Document)	*Meta*-E	
ACTION_STORE	*Meta*-S	

Table 6-2 *Keyboard Motions and Accelerators— Continued*

Command Token	*SunView 4.0*	*SunView 3.x*
ACTION_LOAD	Meta-L	
ACTION_INCLUDE_FILE	Meta-I	
ACTION_HELP[30]	Meta-? (Meta-Shift-/)	
ACTION_GET_FILENAME	Escape	Escape
ACTION_CAPS_LOCK	T1	T1

6.4. Classes of Events

This section groups each of the events described in Table 6-1, *Event Codes*, into logical classes. Each class is described below.

ASCII Events

The event codes in the range 0 to 255 inclusive are assigned to the ASCII event class. This includes the standard 7-bit ASCII codes and their 8-bit META counterparts.

If a user strikes a key which has an obvious ASCII meaning; that is, a key in the main typing array labeled with a single letter, it causes the VUID to enqueue for the appropriate window an event whose code is the corresponding 7-bit ASCII character.

The *META* event code values (128 through 255) are generated when the user strikes a key that would generate a 7-bit ASCII code while the META key is also depressed.

Locator Button Events

The standard Sun locator is a three button mouse, whose buttons generate the event codes MS_LEFT, MS_MIDDLE and MS_RIGHT.

In general, a physical locator can have up to 10 buttons connected to it. In some cases, the locator itself may not have any buttons on it; however, it may have buttons from another device assigned to it. A light pen is an example of such a locator.

Each button that is associated with the VUID's locator is assigned an event code; the *i-th* button is assigned the code BUT(i). Thus the event codes MS_LEFT, MS_MIDDLE and MS_RIGHT correspond to BUT(1), BUT(2) and BUT(3).

Locator Motion Events

The physical locator constantly provides an (x, y) coordinate position in pixels; this position is transformed by SunView to the coordinate system of the window receiving an event. Locator motion event codes include LOC_MOVE, LOC_DRAG, LOC_TRAJECTORY, and LOC_STILL.

Since the locator tracking mechanism reports the current position at a set sampling rate, 40 times per second, fast motions will yield non-adjacent locations in consecutive events.

[30] If your keyboard has the L16 key, you may also use it.

A LOC_MOVE event is reported when the locator moves, regardless of the state of the locator buttons. If you only want to know about locator motion when a button is down, then enable LOC_DRAG instead of LOC_MOVE. This will greatly reduce the number of motion events that your application has to process.

When you enable LOC_MOVE or LOC_DRAG, the window system gives you the current locator position by collapsing consecutive locator motion events into one. This operation is appropriate for applications such as dragging an image from one point to another, in which it is important to keep up with the mouse cursor.

For some applications, however, each point on the cursor trajectory is of interest; for example, a program that lets the user draw. In these situations you may not want to collapse consecutive motion events. In such a situation you should ask for LOC_TRAJECTORY events, which suppresses any event collapsing so that you get all the locator movements that the window system sees.

Note that when you ask for LOC_TRAJECTORY events, you get (many!) LOC_TRAJECTORY events in place of LOC_MOVE's, but you still get LOC_DRAG events if you have enabled them.

If you ask for LOC_STILL, a single LOC_STILL event will be reported after the locator has been still for 1/5 of a second.

Window Events

Window events are generated by the window system itself. They are meaningful only to the window to which they are directed.

To be informed when the locator enters or exits a window, enable events with the codes LOC_WINENTER and LOC_WINEXIT.

NOTE *If you are using the tile mechanism described in the SunView 1 System Programmer's Guide,* then you will be told when the locator has entered or exited a tile using the LOC_RGNENTER and LOC_RGNEXIT events. To receive these events you must also have LOC_MOVE enabled.

Resize & Repaint Events

When the size of a window is changed (either by the user or programmatically) a WIN_RESIZE event is generated to give the client a chance to adjust any relevant internal state to the new window size. You should *not* repaint the screen on receiving a resize event. You will receive a separate WIN_REPAINT event when a portion of the window needs to be repainted.

NOTE *If you are using a canvas subwindow you will not need to track resize and repaint* events directly. The canvas package receives these events, computes the new window dimensions or the precise area requiring repainting, and calls your resize or repaint procedures directly. See Chapter 5, *Canvases* for more details.

Keyboard Focus Events

Three events let your application interact with the keyboard focus mechanism (the keyboard focus is explained in section 6.6, *Controlling Input in a Window*). When the user explicitly directs the keyboard focus towards your window, you will receive a KBD_REQUEST event. Your window will then become the keyboard focus unless you call window_refuse_kbd_focus(). Refusing the keyboard focus, when you don't need it, contributes to the usefulness of the split keyboard/pick focus mode available as a runtime option to *sunview(1)*.

The events KBD_USE and KBD_DONE parallel the locator events LOC_WINENTER and LOC_WINEXIT, respectively. KBD_USE indicates that your window now has the keyboard focus and KBD_DONE indicates that your window no longer has it.

Stop Event

If the user presses and releases the Stop key, an event with the code WIN_STOP will be sent to the window under the cursor.[31] In addition, a SIGURG signal is sent to the window's process. Your application can use the Stop key by clearing a stop flag and setting a SIGURG interrupt handler[32] before entering a section of code that might, from the user's perspective, take a long time. If your SIGURG handler is called, set the stop flag and return. In the code that is taking a long time, query the stop flag whenever convenient. When you notice that the stop flag has been set, read the event, then gracefully terminate your long operation.

Function Key Events

The function keys in the VUID define an idealized standard layout that groups keys by location: 15 left, 15 right, 15 top and 2 bottom.[33]

The event codes associated with the function keys are KEY_LEFT(i), KEY_RIGHT(i) and KEY_TOP(i), where *i* ranges from 1 to 15.

If you specifically ask for a function key event code, then that event code will be passed to your event procedure.

If you *don't* specifically ask for a given function key event code, then when the user presses that function key you will get an escape sequence instead of the function key event code (assuming ASCII events have been enabled). For physical keystations that are mapped to cursor control keys, events with codes that correspond to the ANSI X3.64 7-bit ASCII encoding for the cursor control function are transmitted. For physical keystations mapped to other function keys, events with codes that correspond to an ANSI X3.64 user-definable escape sequence are transmitted.

31 WIN_STOP only works when enabled in the PICK event mask and not in the KBD event mask.

32 See notify_set_signal_func() in in Chapter 17, *The Notifier*

33 The actual position of the function keys on a given physical keyboard may differ — see kbd(5) for details on various keyboards.

Shift Key Events

Applications can notice when a shift key changes state by enabling events with the following codes: SHIFT_LEFT, SHIFT_RIGHT, SHIFT_CTRL, SHIFT_META, SHIFT_LOCK and SHIFT_CAPSLOCK. Although these codes allow you to treat one or more shift key as function-invoking keys, this is not recommended. Instead of watching for the event directly, you should query the state of the shift keys via the macros described on the next page.

Semantic Events

Release 4.0 of the SunOS introduces a new type of event. These events are called action events and represent some old and many new functions in the window system. They are similar to the old events in that they are mapped to specific keys on the keyboard. That is, certain combinations of keystrokes in SunView correspond to high-level action events. For example, pressing the [Copy] key copies the current selection to the Clipboard in text subwindows, panels and tty subwindows.

Action events differ from the old events in that applications can directly express interest in the high-level action, "Copy the selection to the Clipboard" rather than in the low-level, "The L6 key was pushed". These events appear in Table 6-1 with the prefix ACTION_. Applications *should* use action events, because left-handed users can assign [Copy] to a different key, and in the future users will be allowed to tie high-level events to arbitrary key combinations.

Other Events

Your application may receive events which don't fall into any of the classes described above. For example, a non-standard input device, such as a second mouse, may emit its own types of events. Also, a software object may communicate with other software objects via events, as is the case when a scrollbar sends a SCROLL_REQUEST to a panel or a canvas.

In general, your event procedure should not treat such unexpected events as errors. They can simply be ignored.

6.5. Event Descriptors

Events have been further grouped into descriptors. Descriptors describe classes of events such as all ASCII events, all mouse buttons, all top function keys, and so on. You will use these descriptors to set input masks, described in Section 6.7 *Enabling and Disabling Events*

The descriptors are summarized in the following table.

Table 6-3 *Event Descriptors*

Event Descriptor	*Explanation*
WIN_NO_EVENTS	Clears input mask — no events will be accepted. Note: the effect is the same whether used with a *consume* or an *ignore* attribute. A new window has a cleared input mask.
WIN_ASCII_EVENTS	All ASCII events. ASCII events that occur while the META key is depressed are reported with codes in the META range. In addition, cursor control keys and function keys are reported as ANSI escape sequences: a sequence of events whose codes are ASCII characters, beginning with <ESC>.
WIN_IN_TRANSIT_EVENTS LOC_WINENTER, and	Enables immediate LOC_MOVE, LOC_WINEXIT events. Pick mask only. Off by default.
WIN_LEFT_KEYS	The left function keys, KEY_LEFT(1) — KEY_LEFT(15).
WIN_MOUSE_BUTTONS MS_MIDDLE and MS_LEFT.	Shorthand for MS_RIGHT, Also sets or resets WIN_UP_EVENTS.
WIN_RIGHT_KEYS	The right function keys, KEY_RIGHT(1) — KEY_RIGHT(15).
WIN_TOP_KEYS	The top function keys, KEY_TOP(1) — KEY_TOP(15).
WIN_UP_ASCII_EVENTS	Causes the matching up transitions to normal ASCII events to be reported — if you see an 'a' go down, you'll eventually see the matching 'a' up.
WIN_UP_EVENTS	Causes up transitions to be reported for button and function key events being consumed.

6.6. Controlling Input in a Window

Input may be controlled using *input focus* and *input mask*. The input focus is the window that is currently receiving input. The input mask specifies which events a window will receive and which events a window will ignore. This section introduces these concepts and gives the algorithm used by the window system to decide which window will receive a given input.

Input Focus

SunView supports two types of focus models, a single focus model and a split focus model.

The single focus model specifies that all input, no matter which input device it came from, goes to the same window. The split input focus lets the user control the *pick input focus* and the *keyboard input focus* separately.

The word *pick* comes from the general graphics term *pick device*, which is a user input device that allows you to move a cursor on the screen and then click a button to choose a point on the screen. The most common pick devices are the mouse, light pen and graphics tablet.

Under the split input focus model, mouse clicks and keystrokes may be distributed to different windows. This makes some operations easier for the user. For example, the user can select text in one window and move it to another window without having to position the cursor over the destination window.

In general, the user controls the keyboard focus by using specific button clicks and controls the pick focus by moving the mouse. Sometimes, it is appropriate for input focuses to be under program control. Generally you should only change an input focus based on some explicit and predictable user action.

You can indicate that you want a window to become the keyboard focus by setting the `WIN_KEYBOARD_FOCUS` attribute to `TRUE`. Note that this is only a hint to the window system. If the keyboard focus is tied to the pick focus, then this call has no effect. The target window might also refuse the keyboard focus request generated by this call (see `KBD_REQUEST` under *Window Events* above). You can set the pick focus via the `WIN_MOUSE_XY` attribute, which sets the mouse cursor to a particular position within a window.

For example, the call

```
window_set(win, WIN_MOUSE_XY, 200, 300, 0);
```

sets the cursor to the window-relative position (200, 300) and sets the pick focus to `win`.

Input Mask

An input mask specifies which events a window will receive and which events it will ignore. In other words, an input mask serves as a read enable mask. Each window has both a *pick input mask*, to specify which pick related events it wants, and a *keyboard input mask*, to specify which keyboard related events it wants.

When a window is the pick focus, its pick mask is used to screen events. When a window is the keyboard focus, its keyboard mask is used to screen events.

This section describes how to specify which events a window will receive and which it will ignore.

Determining which Window will Receive Input

The Notifier determines which window will receive a given event according to the following algorithm:

- First, the keyboard input mask for the window which is the keyboard focus is checked to see if it wants the event. If so, then it becomes the recipient; otherwise the next test is applied.
- Second, the pick input mask for the window which is under the cursor is checked to see if it wants the event. If several windows are layered under the cursor, then the event is tested against the pick input mask of the topmost window. If the mask wants the event, then it becomes the recipient; otherwise the next test is applied.
- If the event does not match the pick input mask of the window under the cursor, then the event will be offered to that window's *designee*. By default the *designee* is the window's owner. You can set the designee explicitly by calling `window_set()` with the `WIN_INPUT_DESIGNEE` attribute.[34]
- If an event is offered unsuccessfully to the root window, it is discarded. Windows which are not in the chain of designated recipients never have a chance to accept the event.
- Occasionally you may want to specify that a given window is to receive *all* events, regardless of their location on the screen. You can do this by setting the `WIN_GRAB_ALL_INPUT` attribute for the window to `TRUE`.
- If a recipient is found, then the locator coordinates are adjusted to the coordinate system of the recipient, and the event is appended to the recipient's input stream. Thus, every window sees a single ordered stream of time-stamped input events, which contain only the events that a window has declared to be of interest.

---

[34] Note that you must give the `WIN_DEVICE_NUMBER` of the window you wish to be the designee, not its handle. This is to allow specifying windows in another user process as the input designee. So the following call would set `win2` to be the designee for `win1`: `window_set(win1, WIN_INPUT_DESIGNEE, window_get(win2, WIN_DEVICE_NUMBER));`

6.7. Enabling and Disabling Events

You specify which events a window will receive and which it will ignore by setting the window's input masks via the following set of attributes:

Table 6-4 *Attributes Used to Set Window Input Masks*

Events Taking a Single Code	***Events Taking a Null Terminated List***
`WIN_CONSUME_KBD_EVENT`	WIN_CONSUME_KBD_EVENTS
`WIN_IGNORE_KBD_EVENT`	WIN_IGNORE_KBD_EVENTS
`WIN_CONSUME_PICK_EVENT`	WIN_CONSUME_PICK_EVENTS
`WIN_IGNORE_PICK_EVENT`	WIN_IGNORE_PICK_EVENTS

The above attributes take as values either event codes such as `LOC_MOVE`, `MS_LEFT`, `KEY_LEFT(2)`, and so on, or *event descriptors*. The attributes in the left column, ending in "`_EVENT`", take a single code or descriptor, while those on the right, ending in "`_EVENTS`", take a null terminated list.

Which Mask to Use

To enable or disable ASCII events, use the keyboard mask. To enable or disable locator motion and button events, use the pick mask.

Function keys are typically associated with the keyboard mask, but sometimes it makes sense to include some function keys in the pick mask — in effect extending the number of buttons associated with the pick device. For example, in the SunView interface the [Again], [Undo], [Copy], [Paste], [Cut], and [Find] function keys are associated with the keyboard mask, while the [Stop], [Front], and, [Open] keys are associated with the pick mask.

Examples

The event attributes cause precisely the events you specify to be enabled or disabled — the input mask is *not* automatically cleared to an initial state. To be sure that an input mask will let through the events you specify, first clear the mask with the special `WIN_NO_EVENTS` descriptor. Take, for example, the following two calls:

```
window_set(win, WIN_CONSUME_PICK_EVENTS,
           WIN_MOUSE_BUTTONS, LOC_DRAG, 0,
           0);

window_set(win, WIN_CONSUME_PICK_EVENTS,
           WIN_NO_EVENTS, WIN_MOUSE_BUTTONS, LOC_DRAG, 0,
           0);
```

The first call adds the mouse buttons and `LOC_DRAG` to the existing pick input mask, while the second call sets the mask to let *only* the mouse buttons and `LOC_DRAG` through.

Canvases by default enable LOC_WINENTER, LOC_WINEXIT, LOC_MOVE, and the three mouse buttons, MS_LEFT, MS_MIDDLE, and MS_RIGHT.[35] You could allow the user to type in text to a canvas by calling:

```
window_set(canvas, WIN_CONSUME_KBD_EVENT, WIN_ASCII_EVENTS, 0);
```

Sometime later you could disable type-in by calling:

```
window_set(canvas, WIN_IGNORE_KBD_EVENT, WIN_ASCII_EVENTS, 0);
```

An application needing to track mouse motion with the button down would enable LOC_DRAG by calling:

```
window_set(canvas, WIN_CONSUME_PICK_EVENT, LOC_DRAG, 0);
```

You can enable or disable the left, right or top function keys as a group via the event descriptors WIN_LEFT_KEYS, WIN_RIGHT_KEYS, or WIN_TOP_KEYS. Note that if you want to see the up event you must also ask for WIN_UP_EVENTS, as in:

```
window_set(win, WIN_CONSUME_KBD_EVENTS, WIN_LEFT_KEYS,
        WIN_UP_EVENTS, 0);
```

In order to improve interactive performance, in the default case, windows do not receive locator motion events (LOC_WINENTER, LOC_WINEXIT, and LOC_MOVE) until after a LOC_STILL has been generated. If each window responds to all of the events that are generated each time the mouse passes over the window, then the response time of the system will be slowed down. Each window will "wake up" when the mouse passes over it on the way to somewhere else on the screen.

If you want a window to receive all events, even if the mouse is just passing over the window without stopping, enable WIN_IN_TRANSIT_EVENTS, with a call such as:

```
window_set(canvas, WIN_CONSUME_PICK_EVENTS,
        WIN_IN_TRANSIT_EVENTS, 0);
```

[35] Note that the canvas package expects to receive these events, and will not function properly if you disable them.

Setting the Input Mask as a Whole

The attributes WIN_KBD_INPUT_MASK and WIN_PICK_INPUT_MASK allow you to get or set an entire input mask. Let's take the example of a subroutine that provides interactive feedback. You can save the input mask on entry to the subroutine, set up the mask as appropriate, and restore the original mask before returning as follows:

```
do_feedback()
{
    Inputmask *saved_mask;

    saved_mask = (Inputmask *)
        window_get(win, WIN_KBD_INPUT_MASK);
    ...
    window_set(win, WIN_KBD_INPUT_MASK, saved_mask, 0);
}
```

Keep in mind that the inputmask pointer returned by window_get() points to a static structure which is shared by all windows in the application. Getting either the keyboard or pick input masks for another window will cause the static structure to be overwritten.

Querying the Input Mask State

You can use window_get() with WIN_CONSUME_PICK_EVENT and WIN_CONSUME_KBD_EVENT to query the state of the input masks. For example, the following call will find out whether or not a canvas is accepting LOC_DRAGs:

```
flag = (int)window_get(canvas, WIN_CONSUME_PICK_EVENT, LOC_DRAG);
```

6.8. Querying and Setting the Event State

You can query the state associated with an event using the following macros, all of which take as their only argument a pointer to an `Event`.

Table 6-5 *Macros to Get the Event State*

Macro	*Returns*
`event_action()`	The identifying code of the event. The codes are discussed in the previous section.[36]
`event_is_up()`	TRUE if the event is a button or key event and the state is up.
`event_is_down()`	TRUE if the event is a button or key event and the state is down.
`event_x()`	The x coordinate of the locator in the window's coordinate system at the time the event occurred.
`event_y()`	The y coordinate of the locator in the window's coordinate system at the time the event occurred.
`event_shiftmask()`	The value of predefined shift-keys (described in kbd(5)). Possible values: `#define CAPSMASK 0x0001` `#define SHIFTMASK 0x000E` `#define CTRLMASK 0x0030` `#define META_SHIFT_MASK 0x0040`
`event_time()`	The event's timestamp, formatted as a `timeval` struct, as defined in `<sys/time.h>`.
`event_shift_is_down()`	TRUE if one of the shift keys are down.
`event_ctrl_is_down()`	TRUE if the control key is down.
`event_meta_is_down()`	TRUE if the meta key is down.
`event_is_button()`	TRUE if the event is a mouse button.
`event_is_ascii()`	TRUE if the event is in the ASCII range (0 thru 127).
`event_is_meta()`	TRUE if the event is in the META range (128 thru 255).
`event_is_key_left()`	TRUE if the event is any `KEY_LEFT(i)`.
`event_is_key_right()`	TRUE if the event is any `KEY_RIGHT(i)`.
`event_is_key_top()`	TRUE if the event is any `KEY_TOP(i)`.

In addition to the above macros, which tell about the state of a particular event, you can query the state of any button or key via the `WIN_EVENT_STATE` attribute. For example, to find out whether or not the first right function key is down you would call:

```
k1_down = (int)
        window_get(canvas, WIN_EVENT_STATE, KEY_RIGHT(1));
```

The call will return non-zero if the key is down, and zero if the key is up.

The following macros are provided to let you set some of the states associated with an event.

[36] `event_id()` is replaced by `event_action()` However, for compatibility, `event_id()` will still be supported.

Table 6-6 *Macros to Set the Event State*

Macro	*Effect*
`event_set_action(event, code)`	set `event`'s id to `code`.
`event_set_shiftmask (event, shiftmask)`	set `event`'s shiftmask to `shiftmask`. Possible values: `#define CAPSMASK 0x0001` `#define SHIFTMASK 0x000E` `#define CTRLMASK 0x0030` `#define META_SHIFT_MASK 0x0040`
`event_set_x(event, x)`	set `event`'s x coordinate to `x`.
`event_set_y(event, y)`	set `event`'s y coordinate to `y`.
`event_set_time(event, time)`	set `event`'s timestamp to `time`.
`event_set_up(event)`	set state of a button event to up.
`event_set_down(event)`	set state of a button event to down.

6.9. Releasing the Event Lock

If an operation generated by an input event is going to take over 5 seconds, then call this routine to allow other processes to get input:[37]

```
void
window_release_event_lock(window)
    Window window;
```

6.10. Reading Events Explicitly

There are times when it is appropriate to go get the next event yourself, rather than waiting for it to come through the normal event stream from the Notifier. In particular, when tracking the mouse with an image which requires significant computation, it may be desirable to read events until a particular action, such as a mouse button up, is detected. To read the next input event for a window, bypassing the Notifier, use the function:

```
int
window_read_event(window, event)
    Window  window;
    Event   *event;
```

`window_read_event()` fills in the event structure, and returns `0` if all went well. In case of error, it sets the global variable `errno` and returns `-1`.

`window_read_event()` can be used in either a blocking or non-blocking mode, depending on how the window has been set up.[38]

[37] For more details see the section on synchronization in the *Workstations* chapter of the *SunView 1 System Programmer's Guide.*

[38] window_read_event() is the high-level library standard function equivalent of input_readevent() in the low-level library. For further information, see Section 5.6, *Reading Input* in the *SunView 1 System Programmer's Guide.*

Note that if you read events in a canvas subwindow yourself, you must translate the event's location to canvas space by calling `canvas_event()`:

```
event_in_canvas_space = canvas_event(canvas, event);
```

7

Imaging Facilities: Pixwins

7

Imaging Facilities: Pixwins

Material Covered

This chapter describes the *pixwin* which is the construct you use to draw or render images in SunView. The most basic use of pixwins is to draw in a canvas subwindow.

In addition to basic pixwin usage, this chapter covers:

- How to boost your rendering speed by *locking* and *batching*
- How to use *regions* for clipping
- How to manipulate the *colormap*
- How to use the *plane groups*

Related Documentation

This chapter is addressed primarily to programmers who write simple applications using canvas subwindows. For lower level details, see the chapter on *Advanced Imaging* in the *SunView System Programmers Guide.*

The pixwin drawing operations do not directly support high-level graphics operations such as shading, segments, 3-D, etc. If your application requires these, then you should consider some graphics package such as SunGKS, SunCore, or SunCGI. All of these will run in windows (see the *SunCore Reference Manual* and *SunCGI Reference Manual* for more information).

Header Files

The definitions necessary to use pixwins are in the header file `<sunwindow/pixwin.h>`, which is included by `<sunwindow/window_hs.h>`, which in turn is included by default when you include `<suntool/sunview.h>`.

Summary Listing and Tables

To give you a feeling for what you can do with pixwins, the following page contains a list of the available pixin functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the pixwin summary tables in Chapter 19, *SunView Interface Summary*:

- the *Pixwin Drawing Functions and Macros* table begins on page 356;
- the *Pixwin Color Manipulation Functions* table begins on page 360.

Pixwin Drawing Functions and Macros
pw_batch(pw, n)
pw_batch_off(pw)
pw_batch_on(pw)
pw_batchrop(pw, dx, dy, op, items, n)
pw_char(pw, x, y, op, font, c)
pw_close(pw)
pw_copy(dpw, dx, dy, dw, dh, op, spw, sx, sy)
pw_get(pw, x, y)
pw_get_region_rect(pw, r)
pw_line(pw, x0, y0, x1, y1, brush, tex, op)
pw_lock(pw, r)
pw_pfsysclose()
pw_pfsysopen()
pw_polygon_2(pw, dx, dy, nbds, npts, vlist, op, spr, sx, sy)
pw_polyline(pw, dx, dy, npts, ptlist, mvlist, brush, tex, op)
pw_polypoint(pw, dx, dy, npts, ptlist, op)
pw_put(pw, x, y, value)
pw_read(pr, dx, dy, dw, dh, op, pw, sx, sy)
pw_region(pw, x, y, width, height)
pw_replrop(pw, dx, dy, dw, dh, op, pr, sx, sy)
pw_reset(pw)
pw_rop(pw, dx, dy, dw, dh, op, sp, sx, sy)
pw_set_region_rect(pw, r, use_same_pr)
pw_show(pw)
pw_stencil(dpw, dx, dy, dw, dh, op, stpr, stx, sty, spr, sx, sy)
pw_text(pw, x, y, op, font, s)
pw_traprop(pw, dx, dy, t, op, pr, sx, sy)
pw_ttext(pw, x, y, op, font, s)
pw_unlock(pw)
pw_vector(pw, x0, y0, x1, y1, op, value)
pw_write(pw, dx, dy, dw, dh, op, pr, sx, sy)
pw_writebackground(pw, dx, dy, dw, dh, op)

Pixwin Color Manipulation Functions	
pw_blackonwhite(pw, min, max)	pw_getcolormap(pw, index, count, red, green, blue)
pw_cyclecolormap(pw, cycles, index, count)	pw_getdefaultcms(cms, map)
pw_dbl_access(pw)	pw_putattributes(pw, planes)
pw_dbl_flip(pw)	pw_putcolormap(pw, index, count, red, green, blue)
pw_dbl_get(pw, attribute)	pw_reversevideo(pw, min, max)
pw_dbl_release()	pw_setcmsname(pw, cmsname)
pw_dbl_set(pw, attributes)	pw_whiteonblack(pw, min, max)
pw_getattributes(pw, planes)	
pw_getcmsname(pw, cmsname)	

7.1. What is a Pixwin?

An image in SunView, whether on the screen or in memory, is composed of dots called *pixels* and is represented internally as a rectangle of such pixels. The *pixrect* structure is the construct used at a low level to access an image and operate on it. You can program at the pixrect level to draw on the screen; this is covered in the *Pixrect Reference Manual.*

However, in SunView drawing operations are displayed in a window coexisting on the screen with other, possibly overlapping windows. Except in certain circumstances, drawing operations should be "well-behaved," meaning that they should not spill over into other windows and they should not be visible in portions of the window which are covered by other windows. The *pixwin* is the interface through which you operate on the pixels in a particular window. It guarantees that the above two conditions will be met.

Each pixel has a value. On a monochrome display the value is 1 or 0, since the pixel can only be on or off, black or white. Such pixels are said to be *1 bit deep.* On a color display each pixel can have several values corresponding to different colors.

7.2. Accessing a Pixwin's Pixels

This section summarizes the functions provided for accessing the pixels of a pixwin. Most of the `pw_*` functions described in this section are based on corresponding `pr_*` routines, which are fully documented in the *Pixrect Reference Manual.* For full discussion of the semantics of a given pixwin function, refer to the discussion of the corresponding pixrect function in the *Pixrect Reference Manual* and/or the errata/addenda section of the most recent *Release Manual.*

In particular the pixrect manual gives useful values for the `op` argument which determines what the result of combining the source and destination pixels will be.

The procedures described in this section will maintain the memory pixrect for a retained pixwin. That is, they perform their operation on the data in memory, as well as on the screen.

Obtaining the Window's Pixwin

All of these procedures require the pixwin of the window you are drawing in as an argument. To draw in a canvas, you use the pixwin that is returned by the procedure:

```
Pixwin *pw;
     canvas_pixwin(canvas);
     Canvas canvas;
```

Look at the example in Section 5.1, *Creating and Drawing into a Canvas*, to see how `canvas_pixwin()` is used.

The pixwin is also available as the value of the `CANVAS_PIXWIN` attribute of the canvas subwindow.[39]

[39] Aside from the canvas pixwin, all windows, regardless of type, have a pixwin which is available as the value of `WIN_PIXWIN`. However, most applications should not need to explicitly write pixels into other types of windows.

Write Routines

The following routines allow you to draw areas, backgrounds, vectors, text, polygons, lines, and polylines in a pixwin.

Basic RasterOp Operations

The following are the basic low-level raster operations that draw on the screen. They are common to many imaging systems.

```
pw_write(pw, dx, dy, dw, dh, op, pr, sx, sy)
—or—
pw_rop(pw, dx, dy, dw, dh, op, pr, sx, sy)
    Pixwin   *pw;
    int       dx, dy, dw, dh, op, sx, sy;
    Pixrect *pr;
```

pw_write() and pw_rop() are different names for the same procedure. They perform the indicated rasterop (op) from the source pixrect to the destination in the pixwin. Pixels are written to the rectangle defined by dx, dy, dw, and dh in the pixwin pw using rasterop function op. dx and dy are the position of the top left-hand corner of the rectangle, and dw and dh are the width and height of the rectangle. They are copied from the rectangle with its origin at sx, sy in the source pixrect pointed to by pr.

pw_write() is essential for many window system operations such as scrolling a window, drawing frames and borders, and drawing an icon on the screen.

Other Raster Operations

The routines in this section are variations on the basic rasterop routine.

```
pw_writebackground(pw, dx, dy, dw, dh, op)
    Pixwin   *pw;
    int       dx, dy, dw, dh, op;
```

pw_writebackground() uses a conceptually infinite set of pixels, all of which are set to zero, as the source. It is often used to clear a canvas pixwin before drawing a new image.[40]

The following routine draws a pixel of value at (x, y) in the addressed pixwin:

```
pw_put(pw, x, y, value)
    Pixwin *pw;
    int     x, y, value;
```

Using this routine to draw is very slow and should be avoided. If you use it, be sure to read the later sections on *batching* and *locking*.

[40] Canvases will automatically clear damaged areas if they are set not to be retained, or if the attribute CANVAS_AUTO_CLEAR is set. See Chapter 5, *Canvases*, for more information.

There is a similar routine to draw many pixels in a single call.

```
pw_polypoint(pw, dx, dy, npts, ptlist, op)
    Pixwin          *pw;
    int              dx, dy, npts;
    struct pr_pos   *ptlist;
    int              op;
```

All npts points in the array ptlist are drawn in the pixwin pw starting at the offset dx, dy under the control of the op argument.

The next routine draws a vector of pixel value from (x0, y0) to (x1, y1) in the addressed pixwin using rasterop op:

```
pw_vector(pw, x0, y0, x1, y1, op, value)
    Pixwin *pw;
    int     x0, y0, x1, y1, op, value;
```

To replicate a pattern in a pixrect onto a pixwin, use:

```
pw_replrop(pw, dx, dy, dw, dh, op, pr, sx, sy)
    Pixwin  *pw;
    int      dx, dy, dw, dh, op, sx, sy;
    Pixrect *pr;
```

pw_replrop() replicates a small "patch" of pattern in a pixrect onto an entire pixwin. It is often used to draw a patterned background in a window, such as the root gray pattern in sunview(1). Standard patterns, created by iconedit(1), may be found in /usr/include/images/square_*.pr.

Text Routines

The following two routines write a string of characters and a single character, respectively, to a pixwin, using rasterop op as above:

```
pw_text(pw, x, y, op, font, s)
    Pixwin  *pw;
    int      x, y, op;
    Pixfont *font;
    char    *s;

pw_char(pw, x, y, op, font, c)
    Pixwin  *pw;
    int      x, y, op;
    Pixfont *font;
    char     c;
```

These text rendering routines are distinguished by their own coordinate system: the destination is given as the left edge and *baseline* of the first character. The left edge does not take into account any *kerning* (character position adjustment depending on its neighbors), so it is possible for a character to have some pixels to the left of the x-coordinate. The baseline is the y-coordinate of the lowest pixel of characters without descenders, 'L' or 'o' for example, so pixels will frequently occur both above and below the baseline in a string.[41]

`font` may be `NULL` in which case the *system font* is used.

The system font is reference counted and shared between software packages. The following routines are provided to open and close the system font:[42]

```
Pixfont *
pw_pfsysopen()

pw_pfsysclose()
```

The following routine:

```
pw_ttext(pw, x, y, op, font, s)
    Pixwin   *pw;
    int       x, y, op;
    Pixfont *font;
    char     *s;
```

is just like `pw_text()` except that it writes *transparent* text. Transparent text writes the shape of the letters without disturbing the background behind it. This is most useful with color pixwins. Monochrome pixwins can use `pw_text()` and a PIX_SRC | PIX_DST op, which is faster.

Batching and Stenciling Routines

Applications such as displaying text perform the same operation on a number of pixrects in a fashion that is amenable to global optimization. The batchrop procedure is provided for these situations:

```
pw_batchrop(pw, dx, dy, op, items, n)
    Pixwin           *pw;
    int               dx, dy, op, n;
    struct pr_prpos  items[]; 43
```

Stencil operations are like raster ops except that the source pixrect is written through a stencil pixrect which functions as a pixel–by–pixel write enable mask. The indicated raster operation is applied only to destination pixels where the stencil pixrect `stpr` is non-zero; other destination pixels remain unchanged.

---

41 A font to be used in `pw_text()` is required to have the same `pc_home.y` and character height for all characters in the font.

42 The system font can also be obtained by calling `pf_default()`.

43 The structure of `pr_prpos` is given in Appendix C of the *Pixrect Reference Manual*.

```
pw_stencil(dpw, dx, dy, dw, dh, op, stpr, stx,
           sty, spr, sx, sy)
    Pixwin  *dpw;
    Pixrect *stpr, *spr;
    int      dx, dy, dw, dh, op, stx, sty, sx, sy;
```

Drawing Polygons

The following macro draws a polygon within a pixwin:

```
pw_polygon_2(pw, dx, dy, nbds, npts, vlist, op, spr, sx, sy)
    Pixwin        *pw;
    int            dx, dy, nbds, op, sx, sy;
    int            npts[];
    struct pr_pos *vlist;
    Pixrect       *spr;
```

You can create a polygon filled with a solid or textured pattern.

Drawing Curved Shapes

`pw_traprop()` is a pixwin operation analogous to `pw_rop()`, which operates on a *trapezon* rather than a rectangle:

```
pw_traprop(pw, dx, dy, t, op, pr, sx, sy)
    Pixwin          *pw;
    struct pr_trap   t;
    Pixrect         *pr;
    int              dx, dy, op, sx, sy;
```

`pw_traprop()` writes the source pixrect `pr` into the destination pixwin `pw` via the operation `op`. The output is clipped to the trapezon `t`.

Drawing Lines

The following routine draws a solid or textured line between two points with a "brush" of a specified width:

```
pw_line(pw, x0, y0, x1, y1, brush, tex, op)
    Pixwin             *pw;
    int                 x0, y0, x1, y1, op;
    struct pr_brush    *brush;
    struct pr_texture  *tex;
```

There is a similar routine to draw several noncontiguous line segments between a set of points:

```
pw_polyline(pw, dx, dy, npts, ptlist, mvlist, brush, tex, op)
    Pixwin             *pw;
    int                 dx, dy, npts, op;
    struct pr_pos      *ptlist;
    u_char             *mvlist;
    struct pr_brush    *brush
    struct pr_texture  *tex;
```

Read and Copy Routines

The following routines use the pixwin as a source of pixels. To get the value of the pixel at (x, y) in pixwin pw call:

```
int
pw_get(pw, x, y)
    Pixwin *pw;
    int     x, y;
```

To read pixels from a pixwin into a pixrect call:

```
pw_read(pr, dx, dy, dw, dh, op, pw, sx, sy)
    Pixwin  *pw;
    int      dx, dy, dw, dh, op, sx, sy;
    Pixrect *pr;
```

This routine reads pixels from pw starting at offset (sx, sy), using rasterop op. The pixels are stored in the rectangle with its origin at dx, dy of width dw and height dh in the pixrect pointed to by pr.

When the destination, as well as the source, is a pixwin, use:

```
pw_copy(dpw, dx, dy, dw, dh, op, spw, sx, sy)
    Pixwin *dpw, *spw;
    int     dx, dy, dw, dh, op, sx, sy;
```

dpw and spw must be the same pixwin. Also, only horizontal or vertical copies are supported.

These read and copy routines fail if they try to read from a portion of a non-retained pixwin which is hidden, and therefore has no pixels. Therefore it is considered advanced usage to call them on a non-retained pixwin; refer to the section entitled *Handling Fixup* in the *SunView 1 System Programmer's Guide.*

7.3. Rendering Speed

Making correct and judicious use of explicit display locking and/or batching is important for getting the best display speed possible.

There are two major impediments to you getting the best possible display rendering speed. The first is *display locking*, which prevents window processes from interfering with each other in several ways:

- Raster hardware may require several operations to complete a change to the display; one process' use of the hardware should be protected from interference by others during this critical interval.
- Changes to the arrangement of windows must be prevented while a process is painting, lest an area be removed from a window as it is being painted.
- A software cursor that the window process does not control (the kernel is usually responsible for the cursor) may have to be removed so that it does not interfere with the window's image.

Display locking is relatively expensive compared to the time it takes to do simple display operations. Thus you can reduce your display time by reducing the number of times that you have to acquire the display lock. The subsection below titled *Locking* explains how to do this.

The second major impediment to maximum display speed is the use of retained pixwins. It is obvious that if you have to write to the screen and to memory for every display operation that it will take longer than writing to only one place. Thus, there is a mechanism, called pixwin *batching* which allows you to write only to memory and then refresh the screen with a quick raster operation from memory. The subsection entitled *Batching* explains how to use batching.

Locking

Locking allows a client program to obtain exclusive use of the display. If the client program does not obtain an explicit lock, the window system will. For example, if your application is going to draw one hundred lines it can either explicitly lock the display once, draw the lines, and unlock explicitly, or it can ignore locking and simply draw the lines. In the latter case, the window system will perform locking and unlocking around each drawing operation, acquiring and releasing the lock one hundred times instead of once.

NOTE *For efficiency's sake, application programs should lock explicitly around a body of screen access operations.*

You can acquire a lock by calling the macro:

```
pw_lock(pw, r)
    Pixwin *pw;
    Rect   *r;
```

`pw` is the pixwin to be used for the output; `r` is the rectangle in the pixwin's coordinate system that bounds the area to be affected. See *The* `Rect` *Structure* in Chapter 4, *Using Windows*, for an explanation of the `Rect` structure. `pw_lock()` blocks if the lock is unavailable (if, for example, another process currently has the display locked).

When the cursor is on the surface where drawing occurs, if the pixwin is locked with `pw_lock()`, sometimes the region in which the cursor rect resides is not drawn to. This results in an empty region (16 x 16 pixels) when the cursor is moved. The image is put to its correct state when it is redisplayed.

Lock operations for a single pixwin may be nested; inner lock operations merely increment a count of locks outstanding and are thus very lightweight. Their affected rectangles must lie within the rectangles affected by the original lock.

To decrement the lock count, call:

```
pw_unlock(pw)
    Pixwin *pw;
```

When the lock count reaches 0, the lock is actually released.

Since locks may be nested, it is possible for a client procedure to find itself, especially in error handling, with a lock which may require an indefinite number of unlocks. To handle this situation cleanly, another routine is provided. The following macro sets `pw`'s lock count to 0 and releases its lock:

```
pw_reset(pw)
    Pixwin *pw;
```

Acquisition of a lock has the following effects:

- If the cursor is in conflict with the affected rectangle, it is removed from the screen. While the screen is locked, the cursor will not be moved in such a way as to disrupt any screen accessing.
- Access to the display is restricted to the process acquiring the lock.
- Modification of the database that describes the positions of all the windows on the screen is prevented.
- The clipping information for the pixwin is validated and, if necessary, updated.
- In the case of a non-retained pixwin with only a single rectangle visible, the internals of the pixwin mechanism can be set up to bypass the pixwin software by going directly to the pixrect level on subsequent display operations.

While it has the screen locked, a process should *not*:

- do any significant computation unrelated to displaying its image.
- invoke any system calls, including other I/O, which might cause it to block.
- invoke any pixwin calls except `pw_unlock()` and those described in the previous section, *Accessing a Pixwin's Pixels*. In any case, the lock should not be held longer than about a quarter of a second, even following all these guidelines.

When a display lock is held for more than two seconds of process virtual time, the lock is broken. However, the offending process is not notified by signal, because a process shouldn't be aborted for this infraction. Instead, a message is displayed on the console.

Batching

Batching allows you to write only to the memory pixrect of a retained pixwin and then refresh the screen with the memory pixrect's contents at specific times. If you do not explicitly batch when using a retained pixwin, the window system will write to both the display and memory on every display operation.

Considering the same example used for locking above, if your application program has a retained pixwin and is going to draw one hundred lines, it can either explicitly start a batch, draw the lines, and end the batch explicitly, or it can ignore batching and simply draw the lines. In the latter case, the window system will draw the lines two hundred times instead of one hundred times.

NOTE *For efficiency's sake, application programs should batch explicitly around a body of screen access operations when using a retained pixwin.*

Two macros are provided to control batching:

```
pw_batch_on(pw)
    Pixwin *pw;

pw_batch_off(pw)
    Pixwin *pw;
```

`pw_batch_on()` starts a batch; `pw_batch_off()` refreshes the screen with the portion of the memory pixrect that has changed. While batching, the pixwin internally maintains a rectangle that describes which pixels in the memory pixrect need to be transferred to the screen at the end of the batch.

NOTE *Don't turn batching on and leave it on, as this causes problems with scrolling. The recommended use is* `batch_on()` *(draw something in window)* `batch_off()`.

While in the middle of batching, your code might reach a point at which you would like the screen to be updated. The following macro refreshes the screen, but otherwise doesn't change the batching mode:

```
pw_show(pw)
    Pixwin *pw;
```

Unlike locking operations, batch operations for a single pixwin do not nest. Thus, each batching routine in this section affects the batching mode/status.

These three macros — `pw_batch_on()`, `pw_batch_off()` and `pw_show()` — all call the routine `pw_batch()` which actually implements the batching mechanism. You can call `pw_batch()` directly to tell the batching mechanism to refresh the screen after every *n* display operations.

```
pw_batch(pw, kind)
    Pixwin        *pw;
    Pw_batch_type  kind;
```

Because the routine does more than one kind of thing, calling it is a little tricky. `kind` is the kind of batching requested. You use the following macro to convert *n*,the number of display operations you want to be batched before a refresh, to a `Pw_batch_type`:

```
#define PW_OP_COUNT(n)   ((Pw_batch_type)(n))
```

So, to have batching and ensure the image on-screen is refreshed after every `n` operations, call:

```
pw_batch(pw, PW_OP_COUNT(n));
```

Clients with a group of screen updates to do can gain noticeably by doing the group as a batch. Also, the locking overhead, discussed above, will only be incurred when the screen is refreshed. An example of such a group is displaying a screen full of text, or a series of vectors with pre-computed endpoints.

In considering how to do batching, it's a good idea to be sensitive to how long the user is staring at a blank screen or an old image, and adjust the rate of screen refresh accordingly.

Locking and Batching Interaction

There are situations in which batching around locking calls makes sense. Consider that

- while batching, locking calls are a no-op;
- if a pixwin is not retained, batching calls are a no-op.

Thus, if your application has a switch to run retained or not, it makes good sense to batch around locking calls. If you batch around locking calls then your application gets the benefit of batching if running retained and the benefit of locking if running non-retained.

Locking around batches, on the other hand, is not very efficient.

7.4. Clipping With Regions

You can use pixwins to clip rectangular regions within a window's own rectangular area. The *region* operation creates a new pixwin that refers to an area within an existing pixwin:

```
Pixwin *
pw_region(pw, x, y, w, h)
    Pixwin *pw;
    int     x, y, w, h;
```

pw is the source pixwin; x, y, w and h describe the rectangle to be included in the new pixwin. The upper left pixel in the returned pixwin is at coordinates (0,0); this pixel has coordinates (x, y) in the source pixwin.

If the source pixwin is retained, the new region will be retained as well. However, the region refers back to the bits of memory pixrect of the source pixwin when accessing the image.

To change the size of an existing region, call:

```
int
pw_set_region_rect(pw, r, use_same_pr)
    Pixwin   *pw;
    Rect     *r;
    unsigned  use_same_pr;
```

The position and size of the region pw are set to the rect *r; a return value of -1 indicates failure. This is more efficient then destroying the old region and creating a new one. The use_same_pr flag should be set to 0 if you want a new retained pixrect allocated for the region that is the size of the region.

To determine the size of an existing region, call:

```
int
pw_get_region_rect(pw, r)
    Pixwin *pw;
    Rect   *r;
```

`*r` is set to the size and position of the region `pw`.

When finished with a region, you should release it by calling: to:

```
pw_close(pw)
    Pixwin *pw;
```

This routine frees any dynamic storage associated with the pixwin, including its retained memory pixrect, if any. If the pixwin has a lock on the screen, it is released.

NOTE You should close any regions before closing the pixwin containing the regions.

7.5. Color

The dicussion which follows is divided into three sections:

- *Introduction to Color*, which introduces the concepts of the colormap and colormap segments,
- *Changing the Colormap*, which describes how to change a colormap segment, and
- *Using Color*, which describes how to make color applications compatible with monochrome and grayscale screens, and how to perform smooth animation by using double buffering.

Introduction to Color

Just as there must be arbitration between different windows to decide what is displayed on the screen when several windows overlap, there must likewise be some process of allocation when several windows want to display different sets of many colors all at once. To understand how this works you need to know how color is handled.

The pixels on a color display are not simply on or off; they take many different values for different colors. On all current Sun color displays[44] each pixel has 8 bits. Such an "8 bit deep" pixel can have any value from 0 to 255. The value in each pixel helps to determine what color appears in that dot on the screen, but it is not in a one-to-one correspondence with the color displayed; otherwise Sun color displays would only be able to display 256 different colors.

The Colormap

Instead, the value of the pixel serves as an index into the *colormap* of the display. The colormap is an array of 256 *colormap entries*. The colormap entry for each index drives the color that is actually displayed for the corresponding pixel value. A colormap entry consists of 8 bits of red intensity, 8 bits of green intensity and 8 bits of blue, packaged into the following structure:

```
struct  singlecolor {
    u_char  red, green, blue;
};
```

Hence a Sun color display is capable of displaying over 16 million colors (because each colormap entry has 24 bits) but can only display 256 colors *simultaneously* (because there are only 256 colormap entries).

[44] See `cgone`(4S), `cgtwo`(4S) and `cgfour`(4S) in the *UNIX Interface Overview* manual.

A Colormap Example

Suppose that in a group of pixels on the screen, some have the value 0 while others have the value 193. All pixels with the same value will be displayed in the same color. The colormap determines what that color will be. If entry 0 in the colormap of the screen is

```
red = 250; green = 0; blue = 3;
```

then the pixels with a value of 0 will come out bright red. If entry 0 in the colormap is changed to

```
red = 1; green = 8; blue = 2;
```

then the pixels with a value of 0 will immediately change color to an almost-black green. Similarly, entry 193 in the colormap determines what color the pixels with a value of 193 will have.

Changing the Colormap

Because changing the colormap is much faster than redrawing many thousands of pixels with a new value, manipulating the colormap is the basis of many graphics and animation techniques. For examples of programs that manipulate the colormap, run `/usr/demo/suncube` or `/usr/demo/flight`.

Try running **`spheresedemo -g`** plus another color program at the same time. You will notice that as you move the mouse into the `spheresdemo` window, the colors in the other windows on the display change dramatically. This is because hardware is only capable of displaying 256 colors at once. When two programs that each want to display 256 different colors are run simultaneously, the window system itself must manipulate the colormap. When the cursor enters one of the windows, the window system changes the colormap to use the colors of that window.

Colormap Segments

The window system allows each window to claim a portion of the total available colormap entries, called a *colormap segment.* The colormap segment need not be the same in all windows of a tool: frames and subwindows can have different colormaps, or can share colormaps (see *Sharing Colormap Segments* below). If the total number of entries in all the colormap segments being requested exceeds the limit of 256 at any given time, the window system gives priority to the window under the cursor, and removes segments belonging to other windows as necessary.

The window system loads colormap segments at arbitrary locations within the colormap. To the application program, this indirection is transparent. The routines that access a pixwin's pixels do not distinguish between windows which use colormap segments and those which use the entire colormap.

NOTE *While you can have multiple pixwins within a window, there is only* one colormap segment per window. A separate colormap for each pixwin in a window is not supported. This limitation should only be of interest if you are using pixwin regions (described in the *SunView System Programmer's Guide*).

Background and Foreground

Every colormap segment has two distinguished values, its *background* and *foreground.* The background color is defined as the value at the first position of a colormap segment; the foreground color is the value at the last position.

Default Colormap Segment

The first pixwin created for a window sets the background and foreground of the window to be those of the *default colormap segment.* This is the monochrome colormap segment defined in

`<sunwindow/cms_mono.h>`. Subsequent pixwins created for the window inherit the background and foreground of the window.

Changing Colors from the Command Line

The user can modify the default colormap for all applications by invoking - `sunview` with the **-F** and **-B** command line arguments.[45] The user can also change the default colormap segment on a per-application basis by invoking the application with certain flags. The **-Wf** flag sets the foreground color, **-Wb** sets the background color, and **-Wg** specifies that the colormap of the frame will be inherited by the frame's subwindows.

The equivalent frame attributes for these flags are `FRAME_FOREGROUND_COLOR`, `FRAME_BACKGROUND_COLOR`, and `FRAME_INHERIT_COLORS`.

Sharing Colormap Segments

It is possible for different processes to share a single colormap segment. For some applications, you want to guarantee that your colormap segment is not shared by another process. For example, a colormap segment to be used for animation, as described later in the section on *Double Buffering*, should not be shared. The way to ensure that a colormap segment will not be shared by another window is to give it a unique name. A common way to generate a unique name is to append the process' id to a more meaningful string that describes the usage of the colormap segment.

If a colormap segment's usage is static in nature, then it pays to use a shared colormap segment definition, since colormap entries are scarce. Windows, in the same or different processes, can share the same colormap by referring to it by the same name.

There are three basic types of shared colormap segments:

- A colormap segment used by a single program. Sharing occurs when multiple instances of the same program are running. An example of such a program is a color terminal emulator in which the terminal has a fixed selection of colors.
- A colormap segment used by a group of highly interrelated programs. Sharing occurs whenever two or more programs of this group are running at the same time. An example of such a group is a series of CAD/CAM programs in which it is common to have multiple programs running at the same time.

[45] This is not true for a Sun-3/110 and other machines with `cgfour` frame buffers, due to their use of an overlay plane to implement most monochrome windows.

- A colormap segment used by a group of unrelated programs. Sharing occurs whenever two or more programs of this group are running. An example of such a colormap segment is the default colormap, CMS_MONOCHROME, defined in <sunwindow/cms_mono.h>. Other common useful colormap segment definitions that you can use and share with other windows include cms_rgb.h, cms_grays.h, cms_mono.h, and cms_rainbow.h, found in <sunwindow/cms_*.h>.

Example: *showcolor*

The program on the following page shows the actual colors in the display's colormap. It should help you see how the window system manages the colormap. Run this program soon after bringing up sunview, then run several color graphics programs such as the demos mentioned earlier. Try bringing up different windows with different foreground and background colors, as in:

```
% shelltool -Wf 23 182 48 -Wb 255 200 230 -Wg
```

```
/*
 *                       showcolor.c
 *    Draw a grey ramp that graphically shows the colormap
 *    segment activity of the environment when the cursor
 *    is NOT in the canvas of this tool.
 */

#include <suntool/sunview.h>
#include <suntool/canvas.h>

#define CMS_SIZE        256
#define CAN_HEIGHT      10

main(argc, argv)
        char    **argv;
{
    Frame               frame;
    Canvas              canvas;
    register Pixwin     *pw;
    register int        i;
    u_char              red[CMS_SIZE],
                        green[CMS_SIZE],
                        blue[CMS_SIZE];

    /* Create frame and canvas */
    frame = window_create(0, FRAME,
                          FRAME_LABEL, argv[0],
                          FRAME_ARGS,  argc, argv,
                          0);
    canvas = window_create(frame, CANVAS,
                           WIN_HEIGHT, CAN_HEIGHT,
                           WIN_WIDTH,  2 * CMS_SIZE,
                           0);
    window_fit(frame);
    pw = canvas_pixwin(canvas);

    /* Initialize colormap to grey ramp */
```

```
    for (i = 0; i < CMS_SIZE; i++)
        red[i] = green[i] = blue[i] = i;
    pw_setcmsname(pw, "showcolor");
    pw_putcolormap(pw, 0, CMS_SIZE, red, green, blue);

    /* Draw ramp of colors */
    for (i = 0; i < CMS_SIZE; i++)
        pw_rop(pw, i*2, 0, 2, CAN_HEIGHT,
               PIX_SRC | PIX_COLOR(i), (Pixrect *)0, 0, 0);
    window_main_loop(frame);
    exit(0);
}
```

Manipulating the Colormap

The following sections document the routines that implement the techniques described above.

To change a window's colormap segment, you must:

1. Name the colormap segment with `pw_setcmsname()`.
2. Set the size of the segment by loading the colors with `pw_putcolormap()`.

It is important that these two steps happen in order and together. The call to `pw_setcmsname()` does not take effect until you write at least one color value into the colormap with `pw_putcolormap()`.

You set and retrieve the name of a colormap segment with these two functions:

```
pw_setcmsname(pw, name)
    Pixwin *pw;
    char    name[CMS_NAMESIZE];

pw_getcmsname(pw, name)
    Pixwin *pw;
    char    name[CMS_NAMESIZE];
```

If you set the foreground and background colors (which are entries `count` - 1 and 0 in the colormap segment, respectively) to the same color, the system will change them to the foreground and background colors of `sunview`. In other words, you are prevented from making the foreground and background colors of a pixwin indistinguishable.

Setting the name resets the colormap segment to a `NULL` entry. After calling `pw_setcmsname()`, you must immediately call `pw_putcolormap()` to set the size of the colormap segment and load it with the actual colors desired. `pw_putcolormap()` and the corresponding routine to retrieve the colormap's state, `pw_getcolormap()`, are defined as follows:

```
pw_putcolormap(pw, index, count, red, green, blue)
    Pixwin          *pw;
    int              index, count;
    unsigned char    red[], green[], blue[];

pw_getcolormap(pw, index, count, red, green, blue)
    Pixwin          *pw;
    int              index, count;
    unsigned char    red[ ], green[ ], blue[ ];
```

`pw_putcolormap` loads the `count` elements of the pixwin's colormap segment starting at `index` (zero origin) with the first `count` values in the three arrays.

The first time `pw_putcolormap()` is called after calling `pw_setcmsname()`, the `count` parameter defines the size of the colormap segment. The size of a colormap segment must be a power of 2, and can't be changed unless `pw_setcmsname()` is called with another name. You can call `pw_putcolormap()` subsequently to modify a subrange of the colormap — use a larger value for `index` and a smaller value for `count`.

NOTE *If you attempt to install a colormap segment that is not a power of 2, your colormap* segment has a high likelyhood of taking up too much space. This means that the screen will flash when you move the cursor into the window with this odd sized colormap.

In Appendix A, *Example Programs*, there is a program called *coloredit* which uses `pw_putcolormap()` to change the colors of its subwindows as the user adjusts sliders for red, green and blue.

Cycling the Colormap

A utility is provided to make it easy to cycle colormap entries:

```
pw_cyclecolormap(pw, cycles, index, count)
    Pixwin *pw;
    int     cycles, index, count;
```

Starting at `index`, the `count` entries of the colormap associated with the pixwin's window are rotated among themselves for `cycles`. A cycle is defined as number of shifts it takes one entry to move through every position once.

To see an example of colormap cycling, run `jumpdemo` (6) with the **-c** option.

If you are are going to cycle one of the common colormap segment definitions, you should give the colormap a unique name, otherwise the colormap of other applications will change as well.

Miscellaneous Utilities

The following utilities are provided as convenient ways to set the forground and background colors to common settings. `min` should be the first entry in the colormap segment, representing the background color. `max` should be the last entry, representing the forground color.

```
pw_reversevideo(pw, min, max)
    Pixwin     *pw;
    int         min, max;

pw_blackonwhite(pw, min, max)
    Pixwin     *pw;
    int         min, max;

pw_whiteonblack(pw, min, max)
    Pixwin     *pw;
    int         min, max;
```

On a monochrome display, these calls don't take effect until you write to the pixwin. On a color display, they take effect immediately.

Using Color

This section gives some notes on the use of color by cursors and menus, how to make color applications compatible with monochrome and grayscale screens, and how to use double buffering for smooth animation.

Cursors and Menus

Cursors appear in the foreground color, the last color in the pixwin's colormap.

Menus and prompts use *fullscreen access*, covered in Chapter 12, *Menus and Prompts*, of the *SunView 1 System Programmer's Guide*. Fullscreen access saves the colors in the first and last entries of the *screen*'s colormap, puts in the foreground and background colors, and displays the menu or prompt. This means that depending on where your application's colormap segment resides in the screen's colormap, some colors in your tool may change whenever menus or prompts are put up. You can allow for this by making the background and foreground colors in your colormap segment the same as the screen's background and foreground.

There are other menu/cursor "glitches" that occur when running applications on frame buffers which support multiple plane groups. These are covered in the later section on *Multiple Plane Groups*.

Is My Application Running on a Color Display?

None of the colormap manipulations described in this chapter causes an error if run on a monochrome display. All colors other than zero map to the foreground color, so if your application displays colored objects on a background of zero, they will appear as black objects on a white foreground on a monochrome display[46]. The window system detects and prevents the foreground and background being the same color on color displays.

However, you may may want to determine at run time whether your application has a color or monochrome display available to it. For example, when displaying a chart, you may want to use patterns if colors are not available. You can determine whether the display is color or monochrome by finding out how deep the pixels are. Each pixwin includes a pointer to a pixrect which represents its pixels on the screen. Pixrects, in turn, have a depth field which holds the number of bits

[46] Unless you are running with black and white inverted, using the `-i` option to `sunview`.

per screen pixel. Thus

```
Pixwin *pw;

int depth = pw->pw_pixrect->pr_depth;
```

will have a value of 1 for windows displayed on monochrome devices, and a value greater than 1 for color screens. Currently, all Sun color displays have 8 bits per pixel.

Simulating Grayscale on a Color Display

There is no way to tell if your application is running on a grayscale monitor, since it runs off the same color board. The grayscale monitor is usually driven from the red output of the color board, so if two colors have different green and blue values but the same red value, they will show up the same on a greyscale display.

To see how your color application will look on a grayscale monitor, temporarily set your colormap segment so that the green and blue components of each colormap entry are the same as the red component. This will simulate the grayscale display on a color monitor.

Software Double Buffering

Sometimes you want to rapidly display different images in an application. If you just use the pixwin write operations to display the new image, the redrawing of the pixels will be perceptible to the user, even though the operations are fast. Instead, you can use a technique called *software double-buffering*.

As we have seen, on a color display, there are 8 bits associated with each pixel. If you are not using 256 shades at once, then some of these bits are unused. What you would like to do is to store values for two or more different images in these 8 bits, but only display one set of values at a time.

The first goal can easily be accomplished using the `pw_putattributes()` routine to restrict writes to a particular set of planes:

```
pw_putattributes(pw, planes)
    Pixwin *pw;
    int    *planes;
```

`planes` is a bitplane access enable mask. Only those bits of the pixel corresponding to a 1 in the same bit position of `*planes` will be affected by pixwin operations. If `planes` is `NULL`, that attribute value will not be written.

A corresponding routine is provided to retrieve the value of the access enable mask:

```
pw_getattributes(pw, planes)
    Pixwin *pw;
    int    *planes;
```

NOTE *Use* `pw_putattributes()` *with care, as it changes the internal state of the pixwin.* The correct usage is to first save the existing bitplane mask by calling `pw_getattributes()`, then call `pw_putattributes()`, then, when done, restore the initial state by calling `pw_putattributes()` with the saved mask.

The second goal — only displaying what is in some of the planes — is trickier. There is no way to tell the hardware to only look at the values in some of the planes to determine the colors to show.

What you do instead is modify the colormap so that only values in certain planes of the colormap change the color on the display, so in effect only those planes are visible. For example, to display two different four-color images you could use the colormap shown in the following table.

Table 7-1 *Sample Colormap to Isolate Planes*

Pixel Value	Colormap A *(Only upper planes are "visible")*	Colormap B *(Only lower planes are "visible"*
0 0 0 0	blue	blue
0 0 0 1	blue	red
0 0 1 0	blue	green
0 0 1 1	blue	pink
0 1 0 0	red	blue
0 1 0 1	red	red
0 1 1 0	red	green
0 1 1 1	red	pink
1 0 0 0	green	blue
1 0 0 1	green	red
1 0 1 0	green	green
1 0 1 1	green	pink
1 1 0 0	pink	blue
1 1 0 1	pink	red
1 1 1 0	pink	green
1 1 1 1	pink	pink

From the above table, you can see that if colormap A is set (using `pw_putcolormap()`), then no matter what the value in the two lower planes, the color displayed is the same; the value in the upper two planes alone controls the color. So, if you use this colormap while only enabling the two lower planes (by passing `pw_putattributes()` the value `3`), then the values you write into the lower planes won't change what is shown.

When you switch to colormap B, the situation is reversed. Only the values in the lower planes affect what is visible. You would then pass `pw_putattributes()` the value `12` to write to the upper two planes. The two sets of colors need not be the same, so you can switch between two different-colored images.

You would use the same technique to switch between more images and/or to display more colors. You can display two different images, each with 16 different colors, or 8 different monochrome images, or values in between.

Using Software Double Buffering For Smooth Animation

One application of the above technique is to provide smooth animation. To move an image across the screen, you must draw it in one location, erase it, and redraw it in another. Even on a fast system, the erasing and redrawing is visible. You'd like the object to immediately appear in its new position, without disappearing momentarily. You can do this by alternating two colormaps so that the object disappears in its old location and reappears in a new one. This is called *software double-buffering*, because you are using the display planes as alternating buffers; as you write to one set of planes, the other set of planes is displayed.

The colormaps in the table on the preceding page come from the software program *animatecolor* in Appendix A, *Example Programs*. This program uses software double buffering to animate some squares. The routines it uses to create the two colormaps and swap between them are complicated, but can be reused in more sophisticated graphics applications.

Hardware Double-Buffering

The following routines will allow programs to do true hardware double-buffering on the Thecg5board. on the device driver interface, refer the the cgtwo(4S) manual page. [47] color framebuffer and on future framebuffers that support double-buffering.

Double-buffering is treated as an even scarcer resource than colormaps, since only one window can be truly double-buffered at any one time. The cursor controls which window will flip the display buffers. Applications are able to run the same code on non-double-buffered displays and it will be as if the double-buffering calls were never made. The following code fragment contains prototypical application code.

```
Rect     rectangle;
Pixwin   *pw;
rectangle.r_left= ...;
...
if (!pw_dbl_get (pw, PW_DBL_AVAIL))
{ ... if program cares ... }
pw_dbl_access (pw);
while (rendering_frames) {
     ... calculate one frame ...
     pw_lock (pw, &rectangle);
     ... render one frame ...
     ... may include unlocks and locks ...
     pw_dbl_flip (pw);
     pw_unlock (pw);
}
pw_dbl_release (pw);
```

[47] The cg5 board is binary compitable with both the Sun-3 Color Board and the Sun-2 Color Board. cg5 is necessary for hardware double-buffering.

The notion of the "active" double-buffering window is important. There is at most one active window at a time. If the cursor is in a double-buffering window, then the window is the active double-buffering window. If the cursor leaves the active window, that window remains active until the cursor enters another double-buffering window. If the active double-buffering window dies, goes iconic, or becomes totally obscured, and the cursor is not left in a double-buffering window, then the top-most visible double-buffering window becomes the active window (if there is one).

Only the active window will be allowed to write to a single buffer. All other windows write to both buffers, so that when the display flips to the other buffer, their contents remain unchanged. The notion of active will change only during a `pw_dbl_flip()` call.

`pw_dbl_access()` which resets the window's data structure so that first frame will be rendered to the background. The very first double buffer sets both `READ` and `WRITE` to the backgound. `pw_dbl_access()` should only be called when ready to actively animate:

```
pw_dbl_access (pw)
    Pixwin *pw;
```

If the pixwin's window has not been accessed for double-buffering then there is no change, and both buffers will be written to.

If the window is marked as accessible for double-buffering and the window is "active" , then the frame double-buffering control to whatever this window requested with its last `pw_dbl_set()` call. If there was no `pw_dbl_set()` call, then set `WRITE` and `READ` to the background. Change the frame buffer double-buffering control bits to reflect this.

If the window is accessible for double-buffering then potentially flip the display. The display is flipped only if the window is "active" : `pw_dbl_flip()` determines if its window has become active:

```
pw_dbl_flip(pw)
    Pixwin *pw;
```

The flip can be done inside or outside of a lock region although it may be preferable to place inside a lock region just before an unlock so that calculations for the next frame can proceed even if another window momentarily grabs the lock. The flip from one buffer to another is synchronized with the display's vertical retrace.

The procedure

```
pw_dbl_release(pw)
    Pixwin *pw;
```

signifies the end of double-buffering by the window associated with the pixwin. Call `pw_dbl_release()` as soon as your program has completed a section of active animation. This procedure will copy the foreground buffer to the background. Because of this, it is important to leave the animation loop after a `pw_dbl_flip()` has been done and before drawing the next frame has started. Otherwise, the window will contain an incomplete buffer image after the release.

SunView provides the ability for an actively double-buffering window to write to both buffers. For example, the instrument gauge readings can be set in a real-time simulator. If pw is not the active double buffer, the frame buffer control bits are not changed. The procedure and the attributes that it may use are discussed below.

```
pw_dbl_set(pw, attributes)
    Pixwin    *pw;
    <attribute-list> attributes;
```

Table 7-2 *Pixwin-Level* set *Attributes*

Attribute	*Possible Values to set*
PW_DBL_WRITE	PW_DBL_FORE, PW_DBL_BACK, PW_DBL_BOTH
PW_DBL_READ	PW_DBL_FORE, PW_DBL_BACK

The attribute value returned from pw_dbl_get() does not reflect the true state of double buffering hardware. This is especially true if the active double buffer is not this pixwin. The procedure and the attributes that is uses are given below.

```
pw_dbl_get(pw, attribute)
    Pixwin           *pw;
    Pw_dbl_attribute  attribute;
```

Table 7-3 *Pixwin-Level* get *Attributes*

Attribute	*Possible Values Returned*
PW_DBL_AVAIL	PW_DBL_EXISTS
PW_DBL_DISPLAY	
PW_DBL_WRITE	PW_DBL_FORE, PW_DBL_BACK, PW_DBL_BOTH
PW_DBL_READ	PW_DBL_FORE, PW_DBL_BACK

7.6. Plane Groups and the cgfour Frame Buffer

The Sun-3/110, Sun-3/60, and Sun-4/110 color machines use the cgfour(4s)[48] frame buffer, which supports multiple "plane groups." Each displays either 24-bit color or black and white. In the former case its color is determined by a value in an 8-bit color buffer; in the latter case, a monochrome buffer called the *overlay plane*.

Whether the pixel displays in color or black/white is controlled by the value for the pixel in the *enable plane*, a third plane. If the value in the enable plane is not set, then the 8-bit deep value in the color buffer is passed to the circuitry that produces the color from the lookup table. If it is set, then the overlay plane determines the pixel's color (black or white). The effect is like having a color and monochrome display in one, with the enable plane determining which is shown in each pixel.

[48] Read the cgfour(4s) manual page for more information on this frame buffer architecture.

In fact, in the color Sun-3/60 and Sun-4/110 plane group implementations, you can set the colors in the overlay plane to other that black and white. There are only two colors in the overlay plane since it is only one-bit deep, but they can have colors other than black and white assigned to them.

Such sets of buffers are referred to as *plane groups*.

SunView and Plane Groups

At the pixrect level it is possible to manipulate the three plane groups of multiple plane group framebuffers directly. At the SunView level, some decisions have been made for you. Raster operations in the overlay plane are faster than in the color plane, so SunView objects which only use the foreground and background colors such as frames, text subwindows, panels, cursors, menus, etc. all try to run in the overlay plane. If you set the foreground and background explicitly using the techniques explained in *Changing Colors from the Command Line* above, or if you have told `sunview` to run in the color buffer only by giving it the command line argument **`-8bit_color_only`**, then these objects will run in the color plane.

However, canvases and graphics subwindows default to using the color plane group whenever possible, on the assumption that you want to draw in color. If this is not the case, then you may find that your application runs faster if you hint to these subwindows to use the overlay plane:

- For canvases, set the attribute `CANVAS_FAST_MONO`, either when creating the canvas or later, as in:

```
window_set(canvas, CANVAS_FAST_MONO, TRUE, 0);
```

  If your application uses scrollbars, then you need to set `CANVAS_FAST_MONO` before you create the canvas' scrollbars, since they share the canvas' pixwin.

- For graphics subwindows in old-style SunWindows applications, use the pixwin call `pw_use_fast_monochrome(pw)` as follows:

```
pw_use_fast_monochrome(gfx->gfx_pixwin);
```

Both calls affect only multiple plane group displays, so it is safe and desirable to put them in any Sun application that uses monochrome canvases or graphics subwindows. Again, if the user gives the appropriate command line arguments, canvases and graphics subwindows will run in the color plane regardless of these calls.

"Glitches" Visible when Using Plane Groups

For performance reasons, the cursor image is only written in the plane group of the window under it. So, if the cursor's *hot spot* is in a black and white window in the overlay plane and there is an adjacent color window, that part of its image that would lie over the color window is invisible, since it is drawn in the overlay plane but the enable plane is still showing the value in the color buffer. The same disappearance applies in the reverse situation.

When menus are drawn, the enable plane is set so that they are visible.

`sunview` and Plane Groups

It is possible to direct `sunview(1)` to only use the color buffer or the overlay plane; it is also possible to start up a second copy of `sunview` in the other plane group, and switch between them using `switcher(1)` or `adjacentscreens(1)`. Consult these programs' manual pages for more information.

8

Text Subwindows

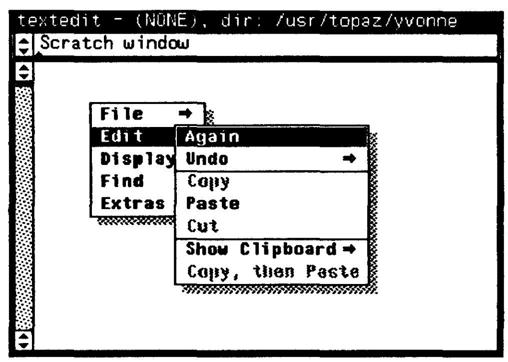
8

Text Subwindows

This chapter describes the text subwindow package, which you can use by including the file <suntool/textsw.h>.

Figure 8-1 is a text subwindow. A text subwindow allows a user or client to display and edit a sequence of ASCII characters. These characters are stored in a file or in primary memory. Its features range from inserting into a file to searching for and replacing a string of text or a character.

Figure 8-1 *Text Subwindow*



Summary Tables

To give you a feeling for what you can do with text subwindows, overleaf there is a list of the available text subwindow attributes and functions. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the text subwindow summary tables in Chapter 19, *SunView Interface Summary*:

- the *Text Subwindow Attributes* table begins on page 366;
- the `Textsw_action` *Attributes* table begins on page 370;
- the `Textsw_status` *Values* table begins on page 371;
- the *Text Subwindow Functions* table begins on page 372.

Text Subwindow Attributes	
TEXTSW_ADJUST_IS_PENDING_DELETE	TEXTSW_INSERT_FROM_FILE
TEXTSW_AGAIN_RECORDING	TEXTSW_INSERT_MAKES_VISIBLE
TEXTSW_AUTO_INDENT	TEXTSW_INSERTION_POINT
TEXTSW_AUTO_SCROLL_BY	TEXTSW_LEFT_MARGIN
TEXTSW_BLINK_CARET	TEXTSW_LENGTH
TEXTSW_BROWSING	TEXTSW_LINE_BREAK_ACTION
TEXTSW_CHECKPOINT_FREQUENCY	TEXTSW_LOWER_CONTEXT
TEXTSW_CLIENT_DATA	TEXTSW_MEMORY_MAXIMUM
TEXTSW_CONFIRM_OVERWRITE	TEXTSW_MENU
TEXTSW_CONTENTS	TEXTSW_MODIFIED
TEXTSW_CONTROL_CHARS_USE_FONT	TEXTSW_MULTI_CLICK_SPACE
TEXTSW_DISABLE_CD	TEXTSW_MULTI_CLICK_TIMEOUT
TEXTSW_DISABLE_LOAD	TEXTSW_NOTIFY_PROC
TEXTSW_EDIT_COUNT	TEXTSW_READ_ONLY
TEXTSW_FILE	TEXTSW_SCROLLBAR
TEXTSW_FILE_CONTENTS	TEXTSW_STATUS
TEXTSW_FIRST	TEXTSW_STORE_CHANGES_FILE
TEXTSW_FIRST_LINE	TEXTSW_STORE_SELF_IS_SAVE
TEXTSW_HISTORY_LIMIT	TEXTSW_UPDATE_SCROLLBAR
TEXTSW_IGNORE_LIMIT	TEXTSW_UPPER_CONTEXT

Textsw_action *Attributes*	
TEXTSW_ACTION_CAPS_LOCK	TEXTSW_ACTION_TOOL_CLOSE
TEXTSW_ACTION_CHANGED_DIRECTORY	TEXTSW_ACTION_TOOL_DESTROY
TEXTSW_ACTION_EDITED_FILE	TEXTSW_ACTION_TOOL_QUIT
TEXTSW_ACTION_EDITED_MEMORY	TEXTSW_ACTION_TOOL_MGR
TEXTSW_ACTION_FILE_IS_READONLY	TEXTSW_ACTION_USING_MEMORY
TEXTSW_ACTION_LOADED_FILE	

Text Subwindow Functions

```
textsw_add_mark(textsw, position, flags)
textsw_append_file_name(textsw, name)
textsw_delete(textsw, first, last_plus_one)
textsw_edit(textsw, unit, count, direction)
textsw_erase(textsw, first, last_plus_one)
textsw_file_lines_visible(textsw, top, bottom)
textsw_find_bytes(textsw, first, last_plus_one, buf, buf_len, flags)
textsw_find_mark(textsw, mark)
textsw_first(textsw)
textsw_index_for_file_line(textsw, line)
textsw_insert(textsw, buf, buf_len)
textsw_match_bytes(textsw, first, last_plus_one,
                   start_sym, start_sym_len, end_sym, end_sym_len, field_flag)
textsw_next(textsw)
textsw_normalize_view(textsw, position)
textsw_possibly_normalize(textsw, position)
textsw_remove_mark(textsw, mark)
textsw_replace_bytes(textsw, first, last_plus_one, buf, buf_len)
textsw_reset(textsw, x, y)
textsw_save(textsw, x, y)
textsw_screen_line_count(textsw)
textsw_scroll_lines(textsw, count)
textsw_set_selection(textsw, first, last_plus_one, type)
textsw_store_file(textsw, filename, x, y)
```

8.1. Text Subwindow Concepts

This section introduces the basic concepts of a text subwindow.

Creating a Subwindow

You create a text subwindow the same way that you create any SunView window object, by calling the window creation routine with the appropriate type parameter:

```
Textsw textsw;
textsw = window_create(base_frame, TEXTSW, attributes, 0);
```

The *attributes* in the above call constitute an attribute list which is discussed in a Section later in this chapter, titled *Attribute-based Functions*.

Attribute Order

Most attributes are orthogonal; thus you usually need not worry about their order. However, in a few cases the attributes in a list may interact, so you need to be careful to specify them in a particular order. Such cases are noted in the sections which follow.[49] In particular, you must pass `TEXTSW_STATUS` first in any call to `window_create()` or `window_set()` if you want to find the status after setting some other attribute in the same call.

Determining a Character's Position

The contents of a text subwindow are a sequence of characters. At any moment, each character can be uniquely identified by its position in the sequence (type `Textsw_index`). Editing operations, such as inserting and deleting text, cause the index of any particular character to change over time. The valid indices are 0 through *length*–1 inclusive, where *length* is the number of characters currently in the text subwindow, returned by the `TEXTSW_LENGTH` attribute.

The text subwindow has a notion of the current index after which the next character will be inserted at any given moment. This is called the *insertion point*. A caret is drawn on the screen immediately after this index to give the user a visual indication of the insertion point.

Getting a Text Selection

A text selection is made by the user, and it is indicated on the screen with reverse-video highlighting. A text subwindow function or procedure is not used to determine which window has the current selection or to retrieve information contained in a text subwindow. Instead, these functions are carried out by the Selection Service. For an example of how this is done, refer to Section 16, *The Selection Service*.

Editing a Text Subwindow

A text subwindow may be edited by the user, or by a client program. When you create a text subwindow, by default the user can edit it. By using the special attributes discussed in this section, the client program can edit the subwindow. These edits are then stored in `/tmp/text`*Process-id.Counter*.

The following five sections explain the functions and attributes that you will use to load, read, write, edit, and finally save a text file.

[49] For a discussion of attribute ordering in general, see Section 4.8, *Attribute Ordering*.

8.2. Loading a File

You can load a file into a textsw by using TEXTSW_FILE, as in:

```
window_set(textsw, TEXTSW_FILE, file_name, 0);
```

Keep in mind, that if the existing text has been edited, then these edits will be lost. To avoid such loss, first check whether there are any outstanding edits by calling:

```
window_get(textsw, TEXTSW_MODIFIED)
```

The above call to `window_set()` will load the new file with the text positioned so that the first character displayed has the same index as the first character that was displayed in the previous file — which is probably not what you want. To load the file with the first displayed character having its index specified by `position`, use the following:

```
window_set(textsw, TEXTSW_FILE, file_name,
              TEXTSW_FIRST, position, 0);
```

NOTE *The order of these attributes is important. Because attributes are evaluated in the order given, reversing the order would first reposition the existing file, then load the new file. This would cause an unnecessary repaint, and mis-position the old file, if it was shorter than* `position`. *For a full discussion of attribute ordering, see Section 8.5.*

Checking the Status of the Text Subwindow

Both of the above calls blindly trust that the load of the new file was successful. This is, in general, a bad idea. To find out whether the load succeeded, and if not, why not, use the following call:

```
window_set(textsw,
             TEXTSW_STATUS, &status,
             TEXTSW_FILE, file_name,
             TEXTSW_FIRST, position,
             0);
```

where `status` is declared to be of type `Textsw_status`.

NOTE *The* TEXTSW_STATUS *attribute and handle must appear in the attribute list before the operation whose status you want to determine.*

`Textsw_status` Value

The valid values for such a variable are enumerated in the following table, where the common prefix TEXTSW_STATUS_ has been removed. For example, OKAY in the table is actually TEXTSW_STATUS_OKAY.

Table 8-1 `Textsw_status` *Values*

Value	*Description*
TEXTSW_STATUS_OKAY	The operation encountered no problems.
TEXTSW_STATUS_BAD_ATTR	The attribute list contained an illegal or unrecognized attribute.
TEXTSW_STATUS_BAD_ATTR_VALUE	The attribute list contained an illegal value for an attribute, usually an out of range value for an enumeration.
TEXTSW_STATUS_CANNOT_ALLOCATE	A call to calloc(2) or malloc(2) failed.
TEXTSW_STATUS_CANNOT_OPEN_INPUT	The specified input file does not exist or cannot be accessed.
TEXTSW_STATUS_CANNOT_INSERT_FROM_FILE	The operation encountered a problem when trying to insert from file.
TEXTSW_STATUS_OUT_OF_MEMORY	The operation ran out of memory while editing in memory.
TEXTSW_STATUS_OTHER_ERROR	The operation encountered a problem not covered by any of the other error indications.

8.3. Writing to a Text Subwindow

To insert text into a text subwindow at the current insertion point, call:

```
Textsw_index
textsw_insert(textsw, buf, buf_len)
    Textsw  textsw;
    char    *buf;
    int      buf_len;
```

The return value is the number of characters actually inserted into the text subwindow. This number will equal `buf_len` unless either the text subwindow has had a memory allocation failure, or the portion of text containing the insertion point is read only. The insertion point is moved forward by the number of characters inserted.

NOTE *This routine does not do terminal-style interpretation of the input characters.* Thus "editing" characters (such as CTRL-H or DEL for character erase, etc.) are simply inserted into the text subwindow rather than performing edits to the existing contents of the text subwindow. In order to do terminal-style emulation, you must pre-scan the characters to be inserted, and invoke `textsw_edit()` where appropriate, as described in the next section.

Insertion Point

The attribute TEXTSW_INSERTION_POINT is used to interrogate and to set the insertion point. For instance, the following call determines where the insertion point is:

```
Textsw_index point;
point = (Textsw_index)window_get(textsw,
                                 TEXTSW_INSERTION_POINT);
```

whereas the following call sets the insertion point to be just before the third character of the text:

```
window_set(textsw, TEXTSW_INSERTION_POINT, 2, 0);
```

Positioning to End of Text

To set the insertion point at the end of the text, set TEXTSW_INSERTION_POINT to the special index TEXTSW_INFINITY.

NOTE *This call does not ensure that the new insertion point will be visible in the text subwindow, even if the* TEXTSW_INSERT_MAKES_VISIBLE *attribute is* TRUE. To guarantee that the caret will be visible afterwards, you should call textsw_possibly_normalize().

8.4. Reading from a Text Subwindow

Many applications that incorporate text subwindows never need to read the contents of the text directly from the text subwindow. Often, this is because the text subwindow is only being used to display text to the user.

Even when the user is allowed to edit the text, some applications simply wait for the user to perform some action that indicates that all of the edits have been made. They then use either textsw_save() or textsw_store_file() to place the text in the file. The text can then be read via the usual file input utilities, or the file itself can be passed off to another program.

It is, however, useful to be able to directly examine the text in the text subwindow. You can do this using the TEXTSW_CONTENTS attribute. The following code fragment illustrates how to use TEXTSW_CONTENTS to get a span of characters from the text subwindow. It gets the 1000 characters beginning at position 500 out of the text subwindow and places them into a null-terminated string.

```
#define TO_READ 1000

char         buf[TO_READ+1];
Textsw_index next_pos;

next_pos = (Textsw_index)
    window_get(textsw, TEXTSW_CONTENTS, 500, buf, TO_READ);

if (next_pos != 500+TO_READ) {
    Error case
} else
    buf[TO_READ] = '\0';
```

8.5. Editing the Contents of a Text Subwindow

The file or memory being edited by a text subwindow is referred to as the *backing store*. Several attributes and functions are provided to allow you to manipulate the backing store of a text subwindow.[50] This section describes the procedures and attributes that you can use to edit a text subwindow.

Removing Characters

You can remove a contiguous span of characters from a text subwindow by calling:

```
Textsw_index
textsw_delete(textsw, first, last_plus_one)
    Textsw        textsw;
    Textsw_index  first, last_plus_one;
```

`first` specifies the first character of the span that will be deleted, while `last_plus_one` specifies the first character after the span that will not be deleted. `first` should be less than, or equal to, `last_plus_one`. To delete to the end of the text, pass the special value `TEXTSW_INFINITY` for `last_plus_one`.

The return value is the number of characters deleted, and is `last_plus_one - first`, unless all or part of the specified span is read-only. In this case, only those characters that are not read-only will be deleted, and the return value will indicate how many such characters there were. If the insertion point is in the span being deleted, it will be left at `first`.

A side-effect of calling `textsw_delete()` is that the deleted characters become the contents of the global Clipboard. To remove the characters from the textsw subwindow without affecting the Clipboard, call:

```
Textsw_index
textsw_erase(textsw, first, last_plus_one)
    Textsw        textsw;
    Textsw_index  first, last_plus_one;
```

Again, the return value is the number of characters removed, and `last_plus_one` can be `TEXTSW_INFINITY`.

Both of these procedures will return 0 if the operation fails.

Emulating an Editing Character

You can emulate the behavior of an editing character, such as CTRL-H, with `textsw_edit()`:

```
Textsw_index
textsw_edit(textsw, unit, count, direction)
    Textsw    textsw;
    unsigned  unit, count, direction;
```

[50] Note that the edit log maintained by the text subwindow package is reset on each operation affecting the backing store. For a description of the edit log, see the discussion at the end of *Editing the Contents of a Text Subwindow*.

Depending on the value of unit, this routine will erase either a character, a word, or a line. Set unit to:

- TEXTSW_UNIT_IS_CHAR to erase individual characters,
- TEXTSW_UNIT_IS_WORD to erase the span of characters that make up a word (including any intervening white space or other non-word characters), or
- TEXTSW_UNIT_IS_LINE to erase all characters in the line on one side of the insertion point.

If the direction parameter is 0, the operation will affect characters after the insertion point, otherwise it will affect characters before the insertion point.

The number of times the operation will be applied is determined by the value of the count parameter. Set it to one to do the edit once, or to a value greater than one to do multiple edits in a single call. textsw_edit() returns the number of characters actually removed.

For example, suppose you want to interpret the function key F7 as meaning "delete word forward". On receiving the event code for the F7 key going up, you would make the call:

```
textsw_edit(textsw, TEXTSW_UNIT_IS_WORD, 1, 0);
```

Replacing Characters

While a span of characters may be replaced by calling textsw_erase() followed by textsw_insert(), character replacement is done most efficiently by calling:

```
Textsw_index
textsw_replace_bytes(textsw, first, last_plus_one, buf, buf_len)
    Textsw        textsw;
    Textsw_index  first, last_plus_one;
    char         *buf;
    int           buf_len;
```

The span of characters to be replaced is specified by first and last_plus_one, just as in the call to textsw_erase(). The new characters are specified by buf and buf_len, just as in the call to textsw_insert(). Once again, if last_plus_one is TEXTSW_INFINITY, the replace affects all characters from first to the end of the text. If the insertion point is in the span being replaced, it will be left at first + buf_len.

The return value is the net number of bytes inserted. The number is negative if the original string is longer than the one which replaces it. If a problem occurs when an attempt is made to replace a span, then it will return an error code of 0.

textsw_replace_bytes(), like textsw_erase(), does *not* put the characters it removes on the global Clipboard.

The Editing Log

All text subwindows allow the user to undo editing actions. In order to implement this feature, the text subwindow package keeps a running log of all the edits. If there is a file associated with the text subwindow, this log is kept in a file in the `/tmp` directory.

This file can grow until this directory runs out of space. To limit the size of the edit log and to avoid filling up all of `tmp` the user can set the tex wrap around size in the `defaultsedit(1)` *Tty/text_wraparound_size*. If there is no associated file, the edit log is kept in memory, and the maximum size of the log is controlled by the attribute `TEXTSW_MEMORY_MAXIMUM`, which defaults to 20,000 bytes.

Unfortunately, once an edit log kept in memory has reached its maximum size, no more characters can be inserted into or removed from the text subwindow. In particular, since deletions, as well as insertions, are logged, space cannot be recovered by deleting characters.

It is important to understand how the edit log works because you may want to use a text subwindow with no associated file to implement a temporary scratch area or error message log. If such a text subwindow is used for a long time, the default limit of 20,000 bytes may well be reached, and it will be impossible for either the user or your code to insert any more characters even though there may be only a few characters visible in the text subwindow. Therefore, it is recommended to set `TEXTSW_MEMORY_MAXIMUM` much higher, say to 200,000.

Which File is Being Edited?

To find out which file the text subwindow is editing, call:

```
int
textsw_append_file_name(textsw, name)
    Textsw  textsw;
    char   *name;
```

If the text subwindow is editing memory, then this routine will return a non-zero value. Otherwise, it will return 0, and append the name of the file to the end of `name`.

Interactions with the File System

If a text subwindow is editing a file called *myfile* and the user chooses 'Save Current File' from the subwindow's menu (or client code invokes `textsw_save()`), the following sequence of file operations occurs:

- `myfile` is copied to `myfile%`
- The contents of `myfile%` are combined with information from the edit log file (`/tmp/Text`*Process-id*`.`*Counter*) and written over `myfile` (thereby preserving all its permissions, etc).
- The edit log file is removed from `/tmp`.

If `myfile` is a symbolic link to *../some_dir*/`otherfile`, then the backup file is created as *../some_dir*/`otherfile%`.

Keep in mind that the user can change the current directory by selecting 'Load File' or 'Set Directory' from the text subwindow menu. If `myfile` is a relative path name, then the copy to `myfile%` *and* the save take place in the current directory.

8.6. Saving Edits in a Subwindow

To save any edits made to a file currently loaded into a text subwindow call:

```
unsigned
textsw_save(textsw, locx, locy)
    Textsw  textsw;
    int     locx, locy;
```

`locx` and `locy` are relative to the upper left corner of the text subwindow and are used to position the upper left corner of the alert should the save fail for some reason — usually they should be 0. The return value is 0 if and only if the save succeeded.

Storing Edits

The text subwindow may not contain a file, or the client may wish to place the edited version of the text (whether or not the original text came from a file) in some specific file. To store the contents of a text subwindow to a file call:

```
unsigned
textsw_store_file(textsw, filename, locx, locy)
    Textsw  textsw;
    char    *filename;
    int     locx, locy;
```

Again, `locx` and `locy` are used to position the upper left corner of the message box. The return value is 0 if and only if the store succeeded.

NOTE *By default, this call changes the file that the text subwindow is editing,* so that subsequent saves will save the edits to the new file. To override this policy, set the attribute `TEXTSW_STORE_CHANGES_FILE` to `FALSE`.

Discarding Edits

To discard the edits performed on the contents of a text subwindow, call:

```
void
textsw_reset(textsw, locx, locy)
    Textsw  textsw;
    int     locx, locy;
```

`locx` and `locy` are as above. Note that if the text subwindow contains a file which has not been edited, the effect of `textsw_reset` is to unload the file and replace it by memory provided by the text subwindow package; thus the user will see an absolutely empty text subwindow. Alternatively, if the text subwindow already was editing memory then another, untouched, piece of primary memory will be provided and the edited piece will be deallocated.

The rest of this chapter describes the other functions that are available for text subwindows. These features include setting the contents of a subwindow, setting the primary selection, and how to deal with multiple or split views.

8.7. Setting the Contents of a Text Subwindow

You may want to set the initial contents of a text subwindow that your application uses. For example, the SunView mailtool sets the initial contents of the composition window to come up with the headings To, Subject, and so on.

To set the initial contents of a text subwindow, use one of three attributes: TEXTSW_INSERT_FROM_FILE, TEXTSW_FILE_CONTENTS, and TEXTSW_CONTENTS. Each attribute is illustrated in code fragments given below.

TEXTSW_FILE_CONTENTS

The attribute TEXTSW_FILE_CONTENTS makes it possible for a client to initialize the text subwindow contents from a file yet still edit the contents in memory. The user can return a text subwindow to its initial state after an editing session by choosing 'Undo All Edits' in the text menu.

The following code fragment shows how you would use this attribute.

```
Textsw          textsw;
char           *filename;
Textsw_index     pos;

window_set(textsw,
           TEXTSW_FILE_CONTENTS, filename,
           TEXTSW_FIRST, pos,
           0);
```

When the client calls the undo routine and filename is not a null string, then it will initialize the memory used by the text subwindow with the contents of the file specified by filename.

When the client calls the undo routine and the filename is a null string, then it will initialize the memory used by the text subwindow with the previous contents of the text subwindow.

TEXTSW_CONTENTS

TEXTSW_CONTENTS lets you insert a text string from memory, instead of a file, into the text subwindow. The default for this attribute is NULL.

If you use window_create() with this attribute, then it will specify the initial contents for a non-file text subwindow.

If you use window_set() with this attribute it will set the contents of a window as in:

```
window_set(textsw, TEXTSW_CONTENTS, "text", 0);
```

If you use window_get() with this attribute, then you will need to provide additional parameters as in:

```
window_get(textsw, TEXTSW_CONTENTS, pos, buf, buf_len)
```

The return value is the next position to be read. The buffer array buf[0...buf_len-1] is filled with the characters from textsw beginning at the index pos, and is null-terminated only if there were too few characters to fill the buffer.

TEXTSW_INSERT_FROM_FILE

TEXTSW_INSERT_FROM_FILE allows a client to insert the contents of a file into a text subwindow at the current insertion point. It is the programming equivalent of a user choosing 'Include File' from the text menu.

The following code fragment is a sample of using this attribute.

```
Textsw          textsw;
Textsw_status   status;

window_set(textsw,
           TEXTSW_STATUS,  &status,
           TEXTSW_INSERT_FROM_FILE, filename,
           0);
```

Three status values may be returned for this attribute when the argument TEXTSW_STATUS is passed in the same call to window_create() or window_set():

- TEXTSW_STATUS_OKAY — the operation was successful.
- TEXTSW_STATUS_CANNOT_INSERT_FROM_FILE — the operation failed
- TEXTSW_STATUS_OUT_OF_MEMORY —the function cannot insert the text, because it ran out of memory

8.8. Positioning the Text Displayed in a Text Subwindow

Usually there is more text managed by the text subwindow than can be displayed all at once. As a result, it is often necessary to determine the indices of the characters that are being displayed, and to control exactly which portion of the text is being displayed.

Screen Lines and File Lines

When there are long lines in the text it is necessary to draw a distinction between two different definitions of "line of text."

A *screen line* reflects what is actually displayed on the screen. A line begins with the leftmost character in the subwindow and continues across until either a newline character or the right edge of the subwindow is encountered. A *file line*, on the other hand, can only be terminated by the newline character. It is defined as the span of characters starting after a newline character (or the beginning of the file) running through the next newline character (or the end of the file).

Whenever the right edge of the subwindow is encountered before the newline, if TEXTSW_LINE_BREAK_ACTION is TEXTSW_WRAP_AT_CHAR, the next character and its successors will be displayed on the next lower screen line. In this case there would be two screen lines, but only one file line. From the perspective of the display there are two lines; from the perspective of the file only one. If, on the other hand TEXTSW_LINE_BREAK_ACTION is TEXTSW_WRAP_AT_WORD, the entire word will be displayed on the next line.

Unless otherwise specified, all text subwindow attributes and procedures use the *file line* definition.

NOTE *Line indices have a zero-origin, like the character indices; that is, the first line has index 0, not 1.*

Absolute Positioning

Two attributes are provided to allow you to specify which portion of the text is displayed in the text subwindow.

Setting the attribute TEXTSW_FIRST to a given index causes the first character of the line containing the index to become the first character displayed in the text subwindow. Thus the following call causes the text to be positioned so that the first displayed character is the first character of the line which contains index 1000. This call only positions one view at a time:

```
window_set(textsw, TEXTSW_FIRST, 1000, 0);
```

To position all of the views in a text subwindow, use the attribute TEXTSW_FOR_ALL_VIEWS as in the following call:

```
window_set(textsw,TEXTSW_FOR_ALL_VIEWS, TRUE,
          TEXTSW_FIRST, 1000, 0);
```

Conversely, the following call retrieves the index of the first displayed character:

```
index = (Textsw_index)window_get(textsw, TEXTSW_FIRST);
```

A related attribute, useful in similar situations, is TEXTSW_FIRST_LINE. When used in a call on window_set() or window_get(), the value is a file line index within the text.

You can determine the character index that corresponds to a given line index (both zero-origin) within the text by calling:

```
Textsw_index
textsw_index_for_file_line(textsw, line)
    Textsw  textsw;
    int     line;
```

The return value is the character index for the first character in the line, so character index 0 always corresponds to line index 0.

Relative Positioning

To move the text in a text subwindow up or down by a small number of lines, call the routine:

```
void
textsw_scroll_lines(textsw, count)
    Textsw  textsw;
    int     count;
```

A positive value for count causes the text to scroll up, just as if the user had used the left mouse button in the scrollbar, while a negative value causes the text to scroll down, as if the user had used the right mouse button in the scrollbar.

How Many Screen Lines are in the Subwindow?

When calling `textsw_scroll_lines()` you may want to know how many screen lines are in the text subwindow. You can find this out by calling:

```
int
textsw_screen_line_count(textsw)
    Textsw  textsw;
```

Which File Lines are Visible?

Exactly which file lines are visible on the screen is determined by calling:

```
void
textsw_file_lines_visible(textsw, top, bottom)
    Textsw  textsw;
    int     *top, *bottom;
```

This routine fills in the addressed integers with the file line indices of the first and last file lines being displayed in the specified text subwindow.

Guaranteeing What is Visible

To ensure that a particular line or character is visible, call:

```
void
textsw_possibly_normalize(textsw, position)
    Textsw       textsw;
    Textsw_index position;
```

The text subwindow must be displayed on the screen, before this function will work.

If the character at the specified `position` is already visible, then this routine does nothing. If it is not visible, then it repositions the text so that it is visible and at the top of the subwindow.

If a particular character should always be at the top of the subwindow, then calling the following routine is more appropriate:

```
void
textsw_normalize_view(textsw, position)
    Textsw       textsw;
    Textsw_index position;
```

Ensuring that the Insertion Point is Visible

Most of the programmatic editing actions do not update the text subwindow to display the caret, even if `TEXTSW_INSERT_MAKES_VISIBLE` is set. If you want to ensure that the insertion point is visible, call something like

```
textsw_possibly_normalize(textsw,
    (Textsw_index) window_get(textsw, TEXTSW_INSERTION_POINT);
```

8.9. Finding and Matching a Pattern

A common operation performed on text is finding a span of characters that match some specification. The text subwindow provides several rudimentary pattern matching facilities. This section describes two functions that you may call in order to perform similar operations.

Matching a Span of Characters

To find the nearest span of characters that match a pattern, call:

```
int
textsw_find_bytes(textsw, first, last_plus_one, buf,
                  buf_len, flags)
    Textsw        textsw;
    Textsw_index *first, *last_plus_one;
    char         *buf;
    unsigned      buf_len;
    unsigned      flags;
```

The pattern to match is specified by buf and buf_len. The matcher looks for an exact and literal match — it is sensitive to case, and does not recognize any kind of meta-character in the pattern. first specifies the position at which to start the search. If flags is 0, the search proceeds forwards through the text, if 1 the search proceeds backwards. The return value is –1 if the pattern cannot be found, else it is some non-negative value, in which case the indices addressed by first and last_plus_one will have been updated to indicate the span of characters that match the pattern.

Matching a Specific Pattern

Another useful operation is to find delimited text. For example, you might want to find the starting brace and the ending brace in a piece of code. To find a matching pattern, call:

```
int
textsw_match_bytes(textsw, first, last_plus_one,
                   start_sym, start_sym_len,
                   end_sym, end_sym_len, field_flag)

    Textsw          textsw;
    Textsw_index   *first, *last_plus_one;
    char           *start_sym, *end_sym;
    int             start_sym_len, end_sym_len;
    unsigned        field_flag;
```

first stores the starting position of the pattern that you want to search for. last_plus_one stores the cursor position of the end pattern. Its value is one position past the text. start_sym and end_sym store the beginning position and ending position of the pattern respectively. start_sym_len and end_sym_len store starting and ending pattern's length respectively.

Use one of the three field flag values to search for matches: TEXTSW_DELIMITER_FORWARD, TEXTSW_DELIMITER_BACKWARD, and TEXTSW_DELIMITER_ENCLOSE.

- TEXTSW_DELIMITER_FORWARD begins from first and searches forward until it finds start_sym and matches it forward with end_sym.

- TEXTSW_DELIMITER_BACKWARD begins from first and searches backward for end_sym and matches it backward with start_sym .
- TEXTSW_DELIMITER_ENCLOSE begins from first and expands both directions to match start_sym and end_sym of the next level.

If no match is found, then textsw_match_bytes() will return a value of -1. If a match is found, then it will return the index of the first match.

The following code fragment is an example of finding delimited text. Notice that the field_flag value is TEXTSW_DELIMITER_FORWARD.

```
Textsw_index     first, last_plus_one, pos;

first = (Textsw_index) window_get(textsw, TEXTSW_INSERTION_POINT);
pos = textsw_match_bytes(textsw, &first, &last_plus_one,
                  "/*", strlen("*/"),
                  "/*", strlen("*/"), TEXTSW_DELIMITER_FORWARD);
if (pos > 0) {
     textsw_set_selection(textsw, first, last_plus_one, 1);
     window_set(textsw, TEXTSW_INSERTION_POINT, last_plus_one, 0);
} else
    (void) window_bell(textsw);
```

This code searches forward from first until it finds the starting */ and matches it forward with the next */. If no match is found, a bell will ring in the text subwindow.

8.10. Marking Positions

Often a client wants to keep track of a particular character, or group of characters that are in the text subwindow. Given that arbitrary editing can occur in a text subwindow, and that it is very tedious to intercept and track all of the editing operations applied to a text subwindow, it is often easier to simply place one or more marks at various positions in the text subwindow. These marks are automatically updated by the text subwindow to account for user and client edits. There is no limit to the number of marks you can add.

A new mark is created by calling:

```
Textsw_mark
textsw_add_mark(textsw, position, flags)
    Textsw        textsw;
    Textsw_index  position;
    unsigned      flags;
```

The flags argument is either TEXTSW_MARK_DEFAULTS or TEXTSW_MARK_MOVE_AT_INSERT. The latter causes an insertion that occurs at the marked position to move the mark to the end of the inserted text, whereas the former causes the mark to not move when text is inserted at the mark's current position. As an example, suppose that the text managed by the text subwindow consists of the two lines

```
this is the first line
not this, which is the second
```

Assume a mark is set at position 5 (just before the *i* in *is* on the first line) with `flags` of `TEXTSW_MARK_MOVE_AT_INSERT`.

When the user selects just before the *is* (thereby placing the insertion point before the *i*, at position 5) and types an `Bh`, making the text read

```
this his the first line
not this, which is the second
```

the mark moves with the insertion point and they both end up at position 6.

However, if the `flags` had been `TEXTSW_MARK_DEFAULTS`, then the mark would remain at position 5 after the user typed the *h*, although the insertion point moved on to position 6.

Now, suppose instead that the user had selected before the *this* on the first line, and typed **Kep**, making the text read

```
Kepthis is the first line
not this, which is the second
```

In this case, no matter what `flags` the mark had been created with, it would end up at position 8, still just before the *i* in *is*.

If a mark is in the middle of a span of characters that is subsequently deleted, the mark moves to the beginning of the span. Going back to the original scenario, with the original text and the mark set at position 5, assume that the user deletes from the *h* in *this* through the *e* in *the* on the first line, resulting in the text

```
te first line
not this, which is the second
```

When the user is done, the mark will be at position 1, just before the *e* in *te*.

The current position of a mark is determined by calling:

```
Textsw_index
textsw_find_mark(textsw, mark)
    Textsw       textsw;
    Textsw_mark  mark;
```

An existing mark is removed by calling:

```
void
textsw_remove_mark(textsw, mark)
    Textsw       textsw;
    Textsw_mark  mark;
```

Note that marks are dynamically allocated, and it is the client's responsibility to keep track of them and to remove them when they are no longer needed.

8.11. Setting the Primary Selection

The primary selection may be set by calling:

```
void
textsw_set_selection(textsw, first, last_plus_one, type)
    Textsw        textsw;
    Textsw_index  first, last_plus_one;
    unsigned      type;
```

A value of 1 for type means *primary selection*, while a value of 2 means *secondary selection*, and a value of 17 is *pending delete* Note that there is no requirement that all or part of the selection be visible; use `textsw_possibly_normalize()` (described previously in Section 8.5, *Editing the Contents of a Text Subwindow*) to guarantee visibility.

8.12. Dealing with Multiple Views

By using the 'Split View' menu operation, the user can create multiple views of the text being managed by the text subwindow. Although these additional views are usually transparent to the client code controlling the text subwindow, it may occasionally be necessary for a client to deal directly with all of the views. This is accomplished by using the following routines, and the information that split views are simply extra text subwindows that happen to share the text of the original text subwindow.

```
Textsw
textsw_first(textsw)
    Textsw textsw;
```

Given an arbitrary view out of a set of multiple views, `textsw_first()` returns the first view (currently, this is the original text subwindow that the client created). To move through the other views of the set, call:

```
Textsw
textsw_next(textsw)
    Textsw textsw;
```

Given any view of the set, `textsw_next()` returns some other member of the set, or `NULL` if there are none left to enumerate. The following loop is guaranteed to process all of the views in the set:

```
for (textsw=textsw_first(any_split);
     *textsw;
     textsw=textsw_next(textsw)) {
    processing involving textsw;
}
```

When you create a text subwindow take into account that your user may split the window. If you do something like try to enlarge the window, you will run into problems.

8.13. Notifications from a Text Subwindow

The text subwindow notifies its client about interesting changes in the subwindow's or text's state by calling a notification procedure. It also calls this procedure in response to user actions. If the client does not provide an explicit notification procedure by using the attribute TEXTSW_NOTIFY_PROC, then the text subwindow provides a default procedure. The declaration for this procedure looks like:

```
void
notify_proc(textsw, avlist)
    Textsw       textsw;
    Attr_avlist  avlist;
```

avlist contains attributes that are the members of the Textsw_action enumeration.

Your notification procedure must be careful to either process all of the possible attributes that it can be called with or to pass through the attributes that it does not process to the standard notification procedure. This is important because among the attributes that can be in the *avlist* are those that cause the standard notification procedure to implement the *Front*, *Back*, *Open*, *Close*, and *Quit* accelerators of the user interface.

Here is an example of a client notify procedure, and a code fragment demonstrating how it would be used:

```
int (*default_textsw_notify)();

void
client_notify_proc(textsw, attributes)
    Textsw          textsw;
    Attr_avlist     attributes;
{
    int  pass_on    = FALSE;
    Attr_avlist     attrs;

    for (attrs = attributes; *attrs;
         attrs = attr_next(attrs)) {
        switch ((Textsw_action)(*attrs)) {
           case TEXTSW_ACTION_CAPS_LOCK:
          /* Swallow this attribute */
        ATTR_CONSUME(*attrs);
        break;
           case TEXTSW_ACTION_CHANGED_DIRECTORY:
         /* Monitor the attribute, don't swallow it */
        strcpy(current_directory, (char *)attrs[1]);
        pass_on = TRUE;
        break;
        default:
        pass_on = TRUE;
        break;
        }
    }
    if (pass_on)
        (void) default_textsw_notify(textsw, attributes);
}
```

```
default_textsw_notify =
    (void (*)())window_get(textsw, TEXTSW_NOTIFY_PROC);
window_set(textsw, TEXTSW_NOTIFY_PROC, client_notify_proc);
```

The `Textsw_action` attributes which may be passed to your notify procedure are listed in the following table (duplicated in Chapter 19, *SunView Interface Summary*). Remember that they constitute a special class of attributes which are passed to your textsw notification procedure. They are not attributes of the text subwindow in the usual sense, and can not be retrieved or modified using `window_get()` or `window_set()`.

Table 8-2 `Textsw_action` *Attributes*

Attribute	*Value Type*	*Description*
TEXTSW_ACTION_CAPS_LOCK	boolean	The user pressed the CAPS-lock function key to change the setting of the CAPS-lock (it is initially 0, meaning off).
TEXTSW_ACTION_CHANGED_DIRECTORY	char *	The current working directory for the process has been changed to the directory named by the provided string value.
TEXTSW_ACTION_EDITED_FILE	char *	The file named by the provided string value has been edited. Appears once per session of edits (see below).
TEXTSW_ACTION_EDITED_MEMORY	none	monitors whether an empty text subwindow has been edited.
TEXTSW_ACTION_FILE_IS_READONLY	char *	The file named by the provided string value does not have write permission.
TEXTSW_ACTION_LOADED_FILE	char *	The text subwindow is being used to view the file named by the provided string value.
TEXTSW_ACTION_TOOL_CLOSE	(no value)	The frame containing the text subwindow should become iconic.
TEXTSW_ACTION_TOOL_DESTROY	Event *	The tool containing the text subwindow should exit, without checking for a veto from other subwindows. The value is the user action that caused the destroy.
TEXTSW_ACTION_TOOL_QUIT	Event *	The tool containing the text subwindow should exit normally. The value is the user action that caused the exit.
TEXTSW_ACTION_TOOL_MGR	Event *	The tool containing the text subwindow should do the window manager operation associated with the provided event value.
TEXTSW_ACTION_USING_MEMORY	(no value)	The text subwindow is being used to edit a string stored in primary memory, not a file.

The attribute TEXTSW_ACTION_EDITED_FILE is a slight misnomer, as it is given to the notify procedure *after* the first edit to *any* text, whether or not it came from a file. This notification only happens once per session of edits, where notification of TEXTSW_ACTION_LOADED_FILE is considered to terminate the old session and start a new one.

NOTE *The attribute* TEXTSW_ACTION_LOADED_FILE *must be treated very carefully*. This is because the notify procedure gets called with this attribute in several situations: after a file is initially loaded, after any successful 'Save Current File' menu operation, after a 'Undo All Edits' menu operation, and during successful calls to textsw_reset(), textsw_save() and textsw_store().

The appropriate response by the procedure is to interpret these notifications as being equivalent to:

> "The text subwindow is displaying the file named by the provided string value; no edits have been performed on the file yet. In addition, any previously displayed or edited file has been either reset, saved, or stored under another name."

9

Panels

9

Panels

This chapter describes the panel subwindow package, which you can use by including the file `<suntool/panel.h>`.

Section 1 provides a non-technical introduction to panels. Section 2 introduces the basic concepts and routines needed to use panels. Scrollable panels are covered in Section 3. Sections 4 through 9 describe the different types of panel items in detail, including examples.

For examples of complete panels, see the programs *filer*, *image_browser_1* and *image_browser_2*, which are listed in Appendix A and discussed in Chapter 4, *Using Windows*.

Quick Reference, Listings and Summary Tables

For quick reference, the next two pages are a visual index to the different effects possible in panels. After that come lists of the available panel and panel item attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). Finally, tables that summarize the usage of panel attributes, functions and macros are in Chapter 19, *SunView Interface Summary*:

- the Panel Attributes table begins on page 346;
- the *Generic Panel Item Attributes* table begins on page 347;
- the *Choice and Toggle Item Attributes* table begins on page 349;
- the *Slider Attributes* table begins on page 351;
- the *Text Item Attributes* table begins on page 352;
- the *Panel Functions and Macros* table begins on page 353.

Page Description | **Example**

167 Messages

`This action will cause unsaved edits to be lost.`

168 Buttons

`[Reset]` `[Reset]`

173 Choice (default)

`Drawing Mode: ☐Points ■Line ☐Rectangle ☐Circle ☐Text`

173 Choice (custom marks)

`Drawing Mode:   Points ▶Line   Rectangle   Circle   Text`

173 Choice (inverted)

`Drawing Mode: Points Line Rectangle Circle Text`

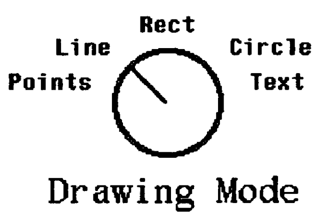
174 Choice (current)

`Drawing Mode: Line`

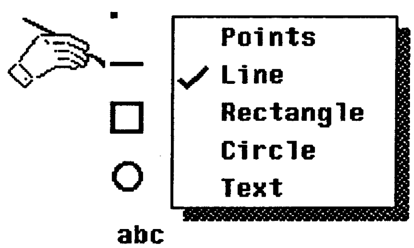
174 Choice (cycle)

`Drawing Mode: Line`

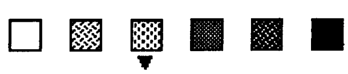
175 Choice (dial)



175 Choice (images, menu)



171 Choice (images)



Page Description | **Example**

177 Toggle (vertical)

```
Format Options:
☑ Long
☐ Reverse
☑ Show all files
```

178 Text

```
Name: Edward G. Robinson
```

179 Text (masked)

```
Password: ********
```

183 Text with menu

```
File: dervish.image
    ESC - Filename completion
 →  ^L - Load image from file
    ^S - Store image to file
    ^B - Browse directory
    ^Q - Quit
```

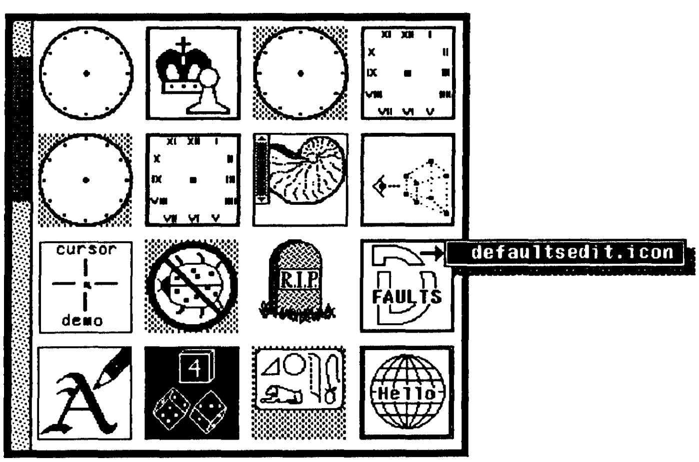
185 Slider

```
Brightness:  [75]   0 [██████████████░░░░░] 100
```

168 Button with menu

```
Introduction      Pixwins              Cursors
SunView Model     Text Subwindows      Icons
Windows         → Panels               Scrollbars
Canvases          TTY Subwindows       Selection Service
Input             Menus                Notifier
Sun
View
Manual
```

194 Buttons with menus on scrollable panel



Panel Attributes		
PANEL_ACCEPT_KEYSTROKE	PANEL_EVENT_PROC	PANEL_LABEL_BOLD
PANEL_BACKGROUND_PROC	PANEL_FIRST_ITEM	PANEL_LAYOUT
PANEL_BLINK_CARET	PANEL_ITEM_X_GAP	PANEL_SHOW_MENU
PANEL_CARET_ITEM	PANEL_ITEM_Y_GAP	

Generic Panel Item Attributes	
PANEL_ACCEPT_KEYSTROKE	PANEL_MENU_CHOICE_IMAGES
PANEL_CLIENT_DATA	PANEL_MENU_CHOICE_STRINGS
PANEL_EVENT_PROC	PANEL_MENU_CHOICE_VALUES
PANEL_ITEM_RECT	PANEL_MENU_TITLE_FONT
PANEL_ITEM_X	PANEL_MENU_TITLE_IMAGE
PANEL_ITEM_Y	PANEL_MENU_TITLE_STRING
PANEL_LABEL_X	PANEL_NEXT_ITEM
PANEL_LABEL_Y	PANEL_NOTIFY_PROC
PANEL_LABEL_BOLD	PANEL_PAINT
PANEL_LABEL_FONT	PANEL_PARENT_PANEL
PANEL_LABEL_IMAGE	PANEL_SHOW_ITEM
PANEL_LABEL_STRING	PANEL_SHOW_MENU
PANEL_LAYOUT	PANEL_VALUE_X
PANEL_MENU_CHOICE_FONTS	PANEL_VALUE_Y

Choice and Toggle Item Attributes	
PANEL_CHOICE_FONTS	PANEL_MARK_IMAGE
PANEL_CHOICE_IMAGE	PANEL_MARK_IMAGES
PANEL_CHOICE_IMAGES	PANEL_MARK_X
PANEL_CHOICE_STRING	PANEL_MARK_XS
PANEL_CHOICE_STRINGS	PANEL_MARK_Y
PANEL_CHOICE_X	PANEL_MARK_YS
PANEL_CHOICE_XS	PANEL_MENU_MARK_IMAGE
PANEL_CHOICE_Y	PANEL_MENU_NOMARK_IMAGE
PANEL_CHOICE_YS	PANEL_NOMARK_IMAGE
PANEL_CHOICES_BOLD	PANEL_NOMARK_IMAGES
PANEL_DISPLAY_LEVEL	PANEL_SHOW_MENU_MARK
PANEL_FEEDBACK	PANEL_TOGGLE_VALUE
PANEL_LAYOUT	PANEL_VALUE

Slider Item Attributes		
PANEL_MIN_VALUE	PANEL_SHOW_RANGE	PANEL_VALUE
PANEL_MAX_VALUE	PANEL_SHOW_VALUE	PANEL_VALUE_FONT
PANEL_NOTIFY_LEVEL	PANEL_SLIDER_WIDTH	

Text Item Attributes	
PANEL_MASK_CHAR	PANEL_VALUE_DISPLAY_LENGTH
PANEL_NOTIFY_LEVEL	PANEL_VALUE
PANEL_NOTIFY_STRING	PANEL_VALUE_FONT
PANEL_VALUE_STORED_LENGTH	

Panel Functions and Macros
panel_accept_key(object, event)
panel_accept_menu(object, event)
panel_accept_preview(object, event)
panel_advance_caret(panel)
panel_backup_caret(panel)
panel_begin_preview(object, event)
panel_button_image(panel, string, width, font)
panel_cancel_preview(object, event)
panel_create_item(panel, item_type, attributes)
panel_default_handle_event(object, event)
panel_destroy_item(item)
panel_each_item(panel, item)
panel_event(panel, event)
panel_get(item, attribute[, optional_arg])
panel_get_value(item)
panel_paint(panel_object, paint_behavior)
panel_set(item, attributes)
panel_set_value(item, value)
panel_text_notify(item, event)
panel_update_preview(object, event)
panel_update_scrolling_size(panel)
panel_window_event(panel, event)

9.1. Introduction to Panels and Panel Items

Panels contain *items* through which the user interacts with a program. Panels are quite flexible; you can use them to model a variety of things, including:

- a form consisting mainly of text items;
- a message window containing status or error messages;
- a complex control panel containing items and menus of many types.

Panels need not be limited to the size of the subwindow they appear in. By attaching *scrollbars* to a panel, you can show a large panel within a smaller subwindow. The user can then bring the area of interest into view by means of the scrollbars.

There are six basic types of panel items: messages, buttons, choices, toggles, text and sliders. Items are made up of one or more displayable components. One component shared by all item types is the *label*. An item label is either a string or a graphic image (i.e., a pointer to a pixrect). Button, choice, toggle, and text items also have a menu component. Thus the user may interact with most items in either of two ways: by selecting the item directly or by selecting from the item's menu.

Each item type is introduced briefly below.

Message Items

The only visible component of a message item is a label, which may be an image or a string in a specified font. Message items are useful for annotations of all kinds, including titles, comments, descriptions, pictures, and dynamic status messages.

Message items are selectable, and you may specify a *notify procedure* to be called when the item is selected.

Button Items

Button items allow the user of a program to initiate commands. Buttons, like message items, have a label, are selectable, and have a notify procedure. Button items differ from message items in that they have visible feedback for previewing and accepting the selection.

Choice Items

Choice items allow the user to select one choice from a list. The displayed form of a choice item can vary radically, depending on how you set its attributes. A choice item can be presented as:

- a horizontal or vertical list of choices, with all choices visible and the current choice indicated by a mark (such as a checkmark);
- a horizontal or vertical list of choices, with all choices visible and the current choice in reverse-video;
- a "cycle item", or list of choices with only the current choice visible. Selecting the item causes the next choice in the list to be selected and displayed;
- a dial, knob or switch with a pointer of some sort which turns to indicate one of several choices;
- a place holder for a pop-up menu, with only the label visible until the menu button is pressed.

Behind this flexibility of presentation lies a uniform structure consisting of a label, a list of choices, and, optionally, a corresponding lists of *on-marks* and *off-marks* used to indicate which choice is currently selected.

Toggle Items

In appearance and structure, toggle items are identical to choice items. The difference lies in the behavior of the two types of items when selected. In a choice item exactly one element of the list is selected, or *current*, at a time. A toggle item, on the other hand, is best understood as a list of elements which behave as toggles: each choice may be either on or off, independently of the other choices. Selecting a choice causes it to change state. There is no concept of a single current choice; at any given time all, some, or none of the choices may be selected.

Text Items

Text items are basically type-in fields with optional labels and menus. You can specify that your notify procedure be called on each character typed in, only on specified characters, or not at all. This allows an application such as a forms-entry program to process input on a per character, per field, or per screen basis.

Slider Items

Slider items allow the graphical representation and selection of a value within a range. They are appropriate for situations where it is desired to make fine adjustments over a continuous range of values. A familiar model would be a horizontal volume control lever on a stereo panel.

9.2. Basic Panel Routines

This section covers basic panel usage, including creating and sizing panels, creating and positioning panel items, modifying and retrieving the attributes for panels and panel items, and destroying panel items.

Creating and Sizing Panels

Like all windows in SunView, panels are created by calling the window creation routine with the appropriate type parameter:

```
Panel panel;
panel = window_create(frame, PANEL, 0);
```

The above call will produce a panel which extends to the bottom and right edges of the frame. You can specify the panel's dimensions explicitly in character units via `WIN_COLUMNS` and `WIN_ROWS`, or in pixel units via `WIN_WIDTH` and `WIN_HEIGHT`.[51]

[51] For a fuller discussion of subwindow sizing and layout see are in Chapter 4, *Using Windows*.

Often you want the panel to be just high enough to encompass all of the items within it. After creating all of the items, *and before creating any other subwindows* in the frame, set the height of the panel by calling the macro `window_fit_height()`. This macro will compute the lowest point occupied by any of the panel's items and set the panel height to that point plus a bottom margin of four pixels. The macros `window_fit_width()` to set the width, and `window_fit()` to set both the height and the width, are also provided.

Creating and Positioning Panel Items

To create a panel item, call:

```
Panel_item
panel_create_item(panel, item_type, attributes)
    Panel          panel;
    <item type>    item_type;
    <attribute-list> attributes;
```

Values for `item_type` must be one of `PANEL_MESSAGE`, `PANEL_BUTTON`, `PANEL_CHOICE`, `PANEL_CYCLE`, `PANEL_TOGGLE`, `PANEL_TEXT`, or `PANEL_SLIDER`.

Explicit Item Positioning

The position of items within the panel may be specified explicitly by means of the attributes `PANEL_ITEM_X` and `PANEL_ITEM_Y`.[52] `PANEL_ITEM_X` sets the left edge of the item's rectangle (the rectangle which encloses the item's label and value). `PANEL_ITEM_Y` sets the top edge of the item's rectangle.

All coordinate specification attributes interpret their values in pixel units. For simple panels and forms which do not make heavy use of images and have only one text font, it is usually more convenient to specify positions in character units — columns and rows rather than x's and y's. You can specify positions in character units with the `ATTR_ROW()` and `ATTR_COL()` macros,[53] which interpret their arguments as rows or columns, respectively, and convert the value to the corresponding number of pixels, based on the panel's font, as specified by `WIN_FONT`. Compare the two calls below:

```
panel_create_item(panel, PANEL_MESSAGE,
                  PANEL_LABEL_STRING, "Hi!",
                  PANEL_ITEM_X,       10,
                  PANEL_ITEM_Y,       20,
                  0);
```

[52] Many attributes, such as those relating to item positioning, apply across all of the item types; these are called *generic* attributes. A comprehensive summary of these generic attributes is given in the *Generic Item Attributes* table in are in Chapter 19, *SunView Interface Summary*.

[53] `ATTR_ROW()` and `ATTR_COL()` are described fully in Chapter 18, *Attribute Utilities*.

```
panel_create_item(panel, PANEL_MESSAGE,
                  PANEL_LABEL_STRING, "Hi!",
                  PANEL_ITEM_X,       ATTR_COL(10),
                  PANEL_ITEM_Y,       ATTR_ROW(20),
                  0);
```

The first will place the item at pixel location (10,20), while the second will place the item at row 20, column 10.

NOTE *The value computed for* `ATTR_ROW()` *includes the top margin, given by* `WIN_TOP_MARGIN`, and the value computed for `ATTR_COL()` includes the left margin, given by `WIN_LEFT_MARGIN`. The alternate macros `ATTR_ROWS()` and `ATTR_COLS()` are also provided, which compute values that do not include the margins.

Default Item Positioning

If you create an item without specifying its position, it is placed just to the right of the item on the "lowest row" of the panel, where lowest row is defined as the maximum y-coordinate (`PANEL_ITEM_Y`) of all the items. So in the absence of specific instructions, items will be placed within the panel in *reading order* as they are created: beginning four pixels in from the left and four pixels down from the top, items are located from left to right, top to bottom. If an item will not fit on a row, and more of the item would be visible on the next row, it will be placed on the next row. The number of pixels left blank between items on a row may be specified by `PANEL_ITEM_X_GAP`, which has a default value of `10`. The number of pixels left blank between rows of items may be specified by `PANEL_ITEM_Y_GAP`, which has a default value of `5`.

The default position for the next item is computed after an item is created. But if a client calls `panel_set()` after creating an item in such a way that the enclosing rectangle of the item is altered, the default position for the next item will *not* be recomputed. So, for example,

```
item = panel_create_item(panel, PANEL_MESSAGE, 0);
panel_set(item, PANEL_LABEL_STRING, "Hi", 0);

item1 = panel_create_item(panel, PANEL_MESSAGE,
                     PANEL_LABEL_STRING,  "There",
                     0);
```

will result in **There** overlapping **Hi**.

CAUTION **Choice items currently have problems with item "creep."** Each time the label of a choice item is set, the position of the item will be evaluated. If the value's position has not been fixed (with `VALUE_X/Y`), the value is positioned after the label. The problem is that the label is baseline-adjusted for a choice item. If the item position is not given when the label is set, the choice item will creep down because of the baseline adjustment.

Laying Out Components Within an Item

You may also specify the layout of the various components within an item, by means of the attributes PANEL_LABEL_X, PANEL_LABEL_Y, PANEL_VALUE_X, PANEL_VALUE_Y, etc. If the components are not explicitly positioned, then the value is placed either eight pixels to the right of the label, if PANEL_LAYOUT is PANEL_HORIZONTAL (the default), or four pixels below the label, if PANEL_LAYOUT is PANEL_VERTICAL.

Modifying Attributes

This section describes how to modify the values of attributes of panels or individual panel items which have already been created.

Since panels are a type of window, their attributes are set with `window_set()`. To set attributes of panel items, use:

```
panel_set(item, attributes)
    Panel_item item;
    <attribute-list> attributes;
```

A macro is provided to ease the syntax for the common operation of setting an item's value (attribute PANEL_VALUE):

```
panel_set_value(item, value)
    Panel_item item;
    caddr_t    value;
```

Several examples of setting attributes are given here; for a complete list of the attributes applying to panels and items, see the tables in are in Chapter 19, *SunView Interface Summary*.

To move a panel's caret to the text item `name_item`:

```
window_set(panel,
PANEL_CARET_ITEM,
name_item, 0);
```

To set the value of the choice item `format_item` to the third choice (choices are zero-based):

```
Panel_item format_item;
panel_set_value(format_item, 2);
```

The first call below creates a message which is initially "hidden" (not displayed on the screen); the second call displays the message:

```
warning = panel_create_item(panel, PANEL_MESSAGE,
    PANEL_LABEL_STRING, "Warning: file will be deleted.",
    PANEL_SHOW_ITEM,    FALSE,
    0);

...

panel_set(warning, PANEL_SHOW_ITEM, TRUE, 0);
```

NOTE *The values for string-valued attributes are dynamically allocated when they are* set (at creation time or later). If a previous value was present, it is freed after the new string is allocated. This is in contrast to the storage-allocation policy for retrieving attributes, described in the section titled *Retrieving Attributes*.

Panel-Wide Item Attributes

Some attributes which apply to items may be set for all items in the panel by setting them when the panel is created. Such attributes include whether items have menus, whether item labels appear in bold, whether items are laid out vertically or horizontally, and whether items are automatically repainted when their attributes are modified.[54] For example, the call:

```
panel = window_create(frame, PANEL
                       PANEL_SHOW_MENU,  FALSE,
                       PANEL_LABEL_BOLD, TRUE,
                       PANEL_LAYOUT,     PANEL_VERTICAL,
                       PANEL_PAINT,      PANEL_NONE,
                       0);
```

overrides the defaults for all the attributes mentioned: any items subsequently created in that panel will not have menus, will have their labels printed in bold and their components laid out vertically, and will not be repainted automatically when their attributes are modified.

NOTE *When you set the attribute* PANEL_LAYOUT, *it will only affect the components* in each item, not the items themselves. That is, all items in a panel will not be layed out vertically.

Keep in mind that he panel-wide item attributes mentioned above are only used to supply default values for items which are subsequently created. This means, for example, that you cannot change all the item labels to bold by first creating the items and then setting PANEL_LABEL_BOLD to TRUE for the panel.

Retrieving Attributes

Use window_get() to retrieve attributes for a panel. To retrieve attributes applying to panel items, use:

```
caddr_t
panel_get(item, attribute[, optional_arg])
    Panel_item      item;
    Panel_attribute attribute;
    Panel_attribute optional_arg;
```

A macro is provided to ease the syntax for the common operation of getting an item's value (attribute PANEL_VALUE):

[54] For a complete list of panel-wide item attributes, see the *Panel Attributes* table in are in Chapter 19, *SunView Interface Summary*.

```
caddr_t
panel_get_value(item, value)
    Panel_item item;
    caddr_t    value;
```

Since the `*_get()` routines are used to retrieve attributes of all types, you should coerce the value returned into the type appropriate to the attribute being retrieved, as in the examples below.

To find out whether an item is currently being displayed on the screen:

```
int displayed;
displayed = (int)panel_get(item, PANEL_SHOW_ITEM);
```

To find out whether the caret in a panel is blinking or non-blinking:

```
int blinking;
blinking = (int)window_get(panel, PANEL_BLINK_CARET);
```

To get the image for a choice item's third (counting from zero) choice:

```
Pixrect *image;
image = (Pixrect *)panel_get(item, PANEL_CHOICE_IMAGE, 2);
```

The above example illustrates the use of the `optional_arg` argument, which is used for only a few item attributes.

NOTE `panel_get()` *does not dynamically allocate storage for the values it returns.* If the value returned is a pointer, it points directly into the panel's private data. It is your responsibility to copy the information pointed to. The policy for setting attributes is different: the values for string-valued attributes are dynamically allocated (see the note above under *Modifying Attributes*).

Destroying Panel Items

To destroy a panel item (and free its associated dynamic storage), call:

```
panel_destroy_item(item);
    Panel_item item;
```

9.3. Using Scrollbars With Panels

A *scrollable* panel is a large panel which can be viewed through a smaller subwindow by means of scrollbars.

Creating Scrollbars

Scrollbars come in two orientations: vertical and horizontal. The call below creates a panel with both vertical and horizontal scrollbars (as would be desirable in a long, many-columned table, for example):

```
panel = window_create(frame, PANEL,
          WIN_VERTICAL_SCROLLBAR,   scrollbar_create(0),
          WIN_HORIZONTAL_SCROLLBAR, scrollbar_create(0),
          0);
```

The values of the attributes `WIN_VERTICAL_SCROLLBAR` and `WIN_HORIZONTAL_SCROLLBAR` are the scrollbars which are returned by the `scrollbar_create()` calls.[55]

Commonly the scrollbar will remain attached to the panel for the duration of the panel's existence, and there will be no need to modify the scrollbar's attributes. In this simple case, there is no need to save the handle returned by `scrollbar_create()`. If you desire to destroy the scrollbar, modify its attributes, or detach it from one panel and attach it to another, you must either save the handle or retrieve it from the panel.[56] For example, to destroy a panel's vertical scrollbar:

```
scrollbar_destroy(panel_get(panel, WIN_VERTICAL_SCROLLBAR));
panel_set(panel, WIN_VERTICAL_SCROLLBAR, NULL, 0);
```

Scrolling Panels Which Change Size

Often panels are used to display information for browsing. `iconedit(1)`, for example, uses a popup panel to allow the user to browse through the images in a directory. The easiest way to do this is to create the panel items anew each time different information is displayed. For example, the `iconedit` function which fills the browsing panel first destroys any existing panel items, then creates an item for each image found.

If you are going to change the size of the panel in this way, you must inform the scrollbar of the new size by calling the function:

```
panel_update_scrolling_size(panel)
    Panel panel;
```

---

[55] The call `scrollbar_create(0)` produces a default scrollbar. It is usually best to create a default scrollbar and let the user specify how it looks via *defaultsedit*. You can, of course, override the user's default settings by explicitly setting the scrollbar's attributes. For a complete list of scrollbar attributes see Chapter 19, *SunView Interface Summary*.

[56] In order to save the scrollbar's handle or reference any scrollbar attributes you must include the file `<suntool/scrollbar.h>`.

The correct time to call `panel_update_scrolling_size()` is after you have created all the items and given them labels. If you don't update the scrollbar's idea of the panel's size, the size of the scrollbar's bubble will be wrong.

Detaching Scrollbars from Panels

You may want the same panel to be scrollable at one time, and not scrollable at another. The code fragment below illustrates how this can be accomplished by attaching and detaching a scrollbar from a panel:

```
panel = window_create(frame, PANEL, 0);
    ...
    (create items, do any other processing...)
    ...
/* create scrollbar and attach it to panel */
sb = scrollbar_create(0);
panel_set(panel, WIN_VERTICAL_SCROLLBAR, sb, 0);
    ...
    (panel functions with scrollbar...)
    ...
/* now detach scrollbar from panel */
panel_set(panel, WIN_VERTICAL_SCROLLBAR, NULL, 0);
    ...
    (panel functions without scrollbar...)
    ...
scrollbar_destroy(sb);
```

Note that the two packages are to be considered from the application's viewpoint as independent packages which can be used together. The application, *not* the panel package, has the responsibility for creating any scrollbars. In order to free the application of the responsibility for destroying the scrollbar, panels, when they are destroyed, destroy any scrollbars attached to them. However, detaching a scrollbar from a panel, as in the above example, does not cause that scrollbar to be destroyed. The same scrollbar may be attached and detached from any number of panels any number of times.

The sections which follow discuss the six item types in detail.

9.4. Messages

Messages are the simplest of the item types. Their only visible component is their label. They have no value or menu.

Message items, like buttons, are selectable and can have notify procedures. The selection behavior of messages differs from that of buttons in that no feedback is given to the user when a message is selected.

Example

In the following example, two message items are used together to give a warning message:

This action will cause unsaved edits to be lost.

```
static short    stop_array[] = {
#include "stopsign.image"
};
mpr_static(stopsign, 64, 64, 1, stop_array);

panel_create_item(panel, PANEL_MESSAGE,
                  PANEL_LABEL_IMAGE, &stopsign,
                  0);

panel_create_item(panel, PANEL_MESSAGE,
    PANEL_LABEL_STRING,
    "This action will cause unsaved edits to be lost.",
    0);
```

You may change the label for a message item (as for any type of item) via `PANEL_LABEL_STRING` or `PANEL_LABEL_IMAGE`.

9.5. Buttons

Button items have a label and a menu, but no value.

Button Selection

When the left mouse button is pressed over a button item, the item's rectangle is inverted. When the mouse button is released over a button item, the item's rectangle is painted with a grey background, indicating that the item has been selected and the command is being executed. The grey background is cleared upon return from the notify procedure.

Button Notification

The procedure specified via the attribute `PANEL_NOTIFY_PROC` will be called when the item is selected. The form of the notify procedure for a button is:

```
button_notify_proc(item, event)
    Panel_item item;
    Event      *event
```

Button Image Creation Utility

A routine is provided to create a standardized, button-like image from a string:

```
Pixrect *
panel_button_image(panel, string, width, font)
    Panel    panel;
    char    *string;
    int      width;
    Pixfont *font;
```

where `width` indicates the width of the button, in character units. The value returned is a pointer to a pixrect showing the string with a border drawn around it. If `width` is greater than the length of `string`, the string will be centered in the wider border; otherwise the border will be just wide enough to contain the entire string (i.e., the string will not be clipped). The font is given by `font` — if `NULL`, the font for `panel` is used.

Examples

The first example renders the string in the default system font, found in `/usr/lib/fonts/fixedwidthfonts/screen.r.13`:

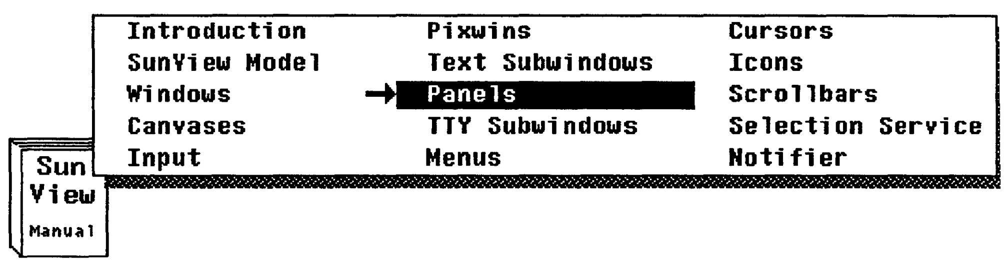

```
panel_create_item(panel, PANEL_BUTTON,
  PANEL_NOTIFY_PROC, quit_proc,
  PANEL_LABEL_IMAGE, panel_button_image(panel, "Reset", 0, 0),
  0);
```

The button below has a bold font and a seven character wide border:


```
bold = pf_open("/usr/lib/fonts/fixedwidthfonts/screen.b.12");
panel_create_item(panel, PANEL_BUTTON,
  PANEL_NOTIFY_PROC, quit_proc,
  PANEL_LABEL_IMAGE, panel_button_image(panel,"Reset",7,bold),
  0);
```

It is often useful to associate a menu with a button. Figure 9-1 illustrates a button representing an online manual. The menu over the button allows the user to bring up the text for the different chapters:

Figure 9-1 *Associating a Menu With a Button*



To do this, you must write your own event procedure, as described in Section 9.13, *Event Handling*. On receiving a right mouse button down event, display the menu and take the appropriate action depending on which menu item the user selects. For all other events, call the panel's default event procedure.

Here is the code to create the menu and the button, and the event procedure to display the menu:

```
static short    book_array[] = {
#include "book.image"
};
mpr_static(book, 64, 64, 1, book_array);

Menu menu = menu_create( MENU_NCOLS, 3, MENU_STRINGS,
     "Introduction",  "Pixwins",          "Cursors",
     "SunView Model", "Text Subwindows",  "Icons",
     "Windows",       "Panels",           "Scrollbars",
     "Canvases",      "TTY Subwindows",   "Selection Service",
     "Input",         "Menus",            "Notifier", 0,
     0);

panel_create_item(panel, PANEL_BUTTON,
                  PANEL_LABEL_IMAGE, &book,
                  PANEL_EVENT_PROC,  handle_panel_event,
                  0);

handle_panel_event(item, event)
    Panel_item item;
    Event *event;
{
    if (event_action(event) ==
        MS_RIGHT && event_is_down(event)) {
        int chapter = menu_show(book_menu, panel, event, 0);
        switch (chapter) {
            case 1:  /* Introduction */ break;
            case 2:  /* Pixwins      */ break;
                     ...
            case 15: /* Notifier     */ break;
        }
    } else
        panel_default_handle_event(item, event);
}
```

9.6. Choices

Choice items are the most flexible — and complex — item types.[57] Besides the label, they are composed of:

- a list of either image or string choices (specified via the attributes

  PANEL_CHOICE_IMAGES or PANEL_CHOICE_STRINGS).
- a list of *mark-images* — images to be displayed when the corresponding choice is selected (PANEL_MARK_IMAGES). The default mark is a push-button with the center inverted.
- a list of *nomark-images* — images to be displayed when the corresponding choice is not selected (PANEL_NOMARK_IMAGES). The default nomark image is a non-inverted push-button.

The choices are numbered beginning with zero, and there is no restriction on the number of choices a single choice item may have.

Displaying Choice Items

The attribute PANEL_DISPLAY_LEVEL determines which of an item's choices are actually displayed on the screen. The display level may be set to:

- PANEL_ALL, (the default) all choices are shown;
- PANEL_CURRENT, only the current choice is shown;
- PANEL_NONE, no choices are shown. Since the only way of selecting a choice is through the menu, this becomes a label with an associated pop up menu.

If the display level is PANEL_CURRENT or PANEL_ALL, the choices are placed by default horizontally after the label. You can lay them out vertically below the label by setting PANEL_LAYOUT to PANEL_VERTICAL. If you want to place the choices or marks more precisely — in order to model a switch or some other special form — you can do so by setting the appropriate attribute, such as PANEL_CHOICE_XS, PANEL_CHOICE_YS, PANEL_MARK_XS, PANEL_MARK_YS, etc.

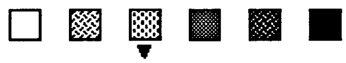
A few words about using the various lists in choice items. The list you give for PANEL_CHOICE_STRINGS (or PANEL_CHOICE_IMAGES) determines the item's choices.[58]

[57] For a complete list of the attributes applicable to choice items, see the *Choice Item Attributes* table in are in Chapter 19, *SunView Interface Summary*.

[58] You must specify at least one choice, so the least you can specify is a single choice consisting of the null string.

The parallel lists PANEL_CHOICE_FONTS, PANEL_MARK_IMAGES, PANEL_NOMARK_IMAGES, PANEL_MARK_XS, PANEL_MARK_YS, PANEL_CHOICE_XS, and PANEL_CHOICE_YS are interpreted with respect to the list of choices. For example, the first font given for PANEL_CHOICE_FONTS will be used to print the first string given for PANEL_CHOICE_STRINGS, the second font will be used for the second string, and so on.

The item below, taken from iconedit, shows how parallel lists can be abbreviated:



```
panel_create_item(iced_panel, PANEL_CHOICE,
    PANEL_MARK_IMAGES,          &down_triangle,0,
    PANEL_NOMARK_IMAGES,        0,
    PANEL_CHOICE_IMAGES,        &square_white, &square_25,
                                &square_root,  &square_50,
                                &square_75,    &square_black, 0,
    PANEL_VALUE,                2,
    PANEL_CHOICE_XS,            30, 60, 90, 120, 150, 180, 0,
    PANEL_MARK_XS,              34, 64, 94, 124, 154, 184, 0,
    PANEL_CHOICE_YS,            345, 0,
    PANEL_MARK_YS,              363, 0,
    PANEL_NOTIFY_PROC,          proof_background_proc,
    0);
```

The item has six choices, representing the six available background patterns for the proof area. Note, however, that three of the lists, — PANEL_MARK_IMAGES, PANEL_CHOICE_YS and PANEL_MARK_YS all have only one element. When any of the parallel lists are abbreviated in this way, the last element given will be used for the remainder of the choices. So, the 345, 0 in the example above serves as shorthand for 345, 345, 345, 345, 345, 345, 0. All the choice images will appear at *y* coordinate 345, all the mark images will appear at *y* coordinate 363, and all the choices will have down_triangle as their mark image.

NOTE *You can't specify that a choice or mark-image appear at x = 0 or y = 0 by using* the attributes PANEL_CHOICE_XS, PANEL_CHOICE_YS, PANEL_MARK_XS or PANEL_MARK_YS. Since these attributes take null-terminated lists as values, the zero would be interpreted as the terminator for the list. You may achieve the desired effect by setting the positions individually, with the attributes PANEL_CHOICE_X, PANEL_CHOICE_Y, PANEL_MARK_X, or PANEL_MARK_Y, which take as values the number of the choice or mark, followed by the desired position.

Choice Selection

The user can make a selection from a choice item either by selecting the desired choice directly, by selecting from the associated menu, or by selecting the label, which causes the current choice to advance to the next choice (or backup to the previous choice if the shift key is pressed while selecting);

Feedback for choice items comes in two flavors — *inverted*, in which the current choice is shown in reverse video, and *marked*, in which the current choice is indicated by the presence of a distinguishing mark, such as a check-mark or arrow. Specified the type of feedback you want by setting `PANEL_FEEDBACK` to either `PANEL_INVERTED` or `PANEL_MARKED`.

You may also disable feedback entirely, by setting `PANEL_FEEDBACK` to `PANEL_NONE`.

The default feedback is `PANEL_MARKED`, unless the item's display level is current, in which case the feedback is `PANEL_NONE`.

Choice Notification

The procedure specified via the attribute `PANEL_NOTIFY_PROC` will be called when the item is selected. Choice notify procedures are passed the item, the current value of the item, and the event which caused notification:

```
choice_notify_proc(item, value, event)
    Panel_item  item;
    int         value;
    Event      *event;
```

Choice Value

The value passed to the notify procedure is the ordinal number corresponding to the current choice (the choice which the user has just selected). The first choice has ordinal number zero.

Choice Menus

Choice and Toggle items are the only item types for which a menu appears by default. To disable the menu for a particular item, set `PANEL_SHOW_MENU` for that item to `FALSE`.

Choice item menus may be used to represent either a *simple* menu or a *checklist*. The former is a menu of commands, which gives no indication of which command was executed last; the latter is a menu of choices with a check-mark indicating the current choice. Set `PANEL_SHOW_MENU_MARK` to `FALSE` to obtain a simple menu, or `TRUE` to get a checklist.

NOTE The number of menu choices, if set by `PANEL_MENU_CHOICE_STRINGS` or `PANEL_MENU_CHOICE_IMAGES`, must be equal to the number of choices for the item.

Examples

As a basis for our examples we'll take the item in `iconedit` which allows the user to select the drawing mode. The item could have been presented in several different forms.

The simplest call would specify the label and choices as strings, and take the defaults for all other attributes. All the choices will be displayed, and the feedback will be marked, with push-buttons for the mark images:

Drawing Mode: Points Line Rectangle Circle Text

```
panel_create_item(panel, PANEL_CHOICE,
    PANEL_LABEL_STRING,   "Drawing Mode:",
    PANEL_CHOICE_STRINGS, "Points", "Line", "Rectangle",
                          "Circle", "Text", 0,
    0);
```

You can specify a custom mark, such as this small pointer, to indicate the current choice:

Drawing Mode: Points ▶ Line Rectangle Circle Text

```
static short pointer_array[] = {
#include "pointer.pr"
};
mpr_static(pointer, 16, 16, 1, pointer_array);

panel_create_item(panel, PANEL_CHOICE,
    PANEL_LABEL_STRING,   "Drawing Mode:",
    PANEL_MARK_IMAGES,    &pointer, 0,
    PANEL_NOMARK_IMAGES,  0,
    PANEL_CHOICE_STRINGS, "Points", "Line", "Rectangle",
                          "Circle", "Text", 0,
    0);
```

Setting `PANEL_FEEDBACK` to `PANEL_INVERTED` produces:

Drawing Mode: Points Line Rectangle Circle Text

Often space on the panel is limited, and it is appropriate to save space by only showing the currently selected choice. You can do that by disabling feedback and displaying only the current choice:

Drawing Mode: Line

```
panel_create_item(panel, PANEL_CHOICE,
    PANEL_LABEL_STRING,    "Drawing Mode:",
    PANEL_CHOICE_STRINGS, "Points", "Line", "Rectangle",
                          "Circle", "Text", 0,
    PANEL_DISPLAY_LEVEL,  PANEL_CURRENT,
    PANEL_FEEDBACK,       PANEL_NONE,
    0);
```

Such an item has the drawback of looking to the user like a text item. One solution to this problem is to provide a distinguishing mark which clearly indicates the item's type, as in:

Drawing Mode: Line

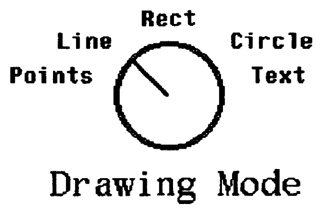
The double-arrow image suggests a cycling motion, indicating to the user that the item is a choice item with more choices available. To get the cycle image, use the special item type PANEL_CYCLE:[59]

```
panel_create_item(panel, PANEL_CYCLE,
    PANEL_LABEL_STRING,    "Drawing Mode:",
    PANEL_CHOICE_STRINGS, "Points", "Line", "Rectangle",
                          "Circle", "Text", 0,
    0);
```

[59] Note that a cycle item is simply a choice item with some attributes initialized — the display level is set to current and the on-mark is set to the cycle image. Once created, cycle items behave in exactly the same way as choice items.

With some effort, you can use a choice item to model a dial, as in Figure 9-2.

Figure 9-2 *A Dial-Like Choice Item*

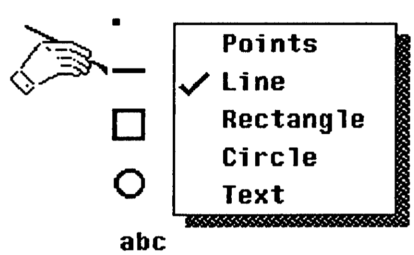


The way to make a such a dial is to make an image for each dial setting, and use these images as the on-marks. Place the on-marks and the choices explicitly — the on-marks in the center, forming the dial, and the choices around the dial's perimeter:

```
panel_create_item(panel, PANEL_CHOICE,
    PANEL_CHOICE_STRINGS, "Points", "Line", "Rect",
                          "Circle", "Text", 0,
    PANEL_MARK_IMAGES,    &dial_1, &dial_2, &dial_3,
                          &dial_4, &dial_5, 0,
    PANEL_NOMARK_IMAGES,  0,
    PANEL_CHOICE_XS,      7, 34, 82, 133, 145, 0,
    PANEL_CHOICE_YS,      53, 33, 20, 33, 53, 0,
    PANEL_MARK_XS,        66, 0,
    PANEL_MARK_YS,        40, 0,
    PANEL_LABEL_STRING,   "Drawing Mode",
    PANEL_LABEL_X,        30,
    PANEL_LABEL_Y,        65,
    PANEL_LABEL_FONT,
      pf_open("/usr/lib/fonts/fixedwidthfonts/gallant.r.19"),
    0);
```

The form which is actually used in shown `iconedit` is Figure 9-3. It employs vertical layout, images for the choices, and strings for the menu:

Figure 9-3 `iconedit`'*s Drawing Mode Choice Item*



```
panel_create_item(panel, PANEL_CHOICE,
    PANEL_LAYOUT,                PANEL_VERTICAL,
    PANEL_CHOICE_IMAGES,         &points, &line, &rectangle,
                                 &circle, &text, 0,
    PANEL_MENU_CHOICE_STRINGS,   "Points", "Line", "Rectangle",
                                 "Circle", "Text", 0,
    PANEL_MARK_IMAGES,           &drawing_hand, 0,
    PANEL_NOMARK_IMAGES,         0,
    0);
```

9.7. Toggles

Toggle items are identical in structure to choice items — they have a label and parallel lists of choices, on-marks and off-marks. They differ from choice items in certain aspects of their display options, their selection behavior and the interpretation of their value. These differences are highlighted below.

Displaying Toggles

Toggle items may have a PANEL_DISPLAY_LEVEL of either PANEL_ALL — all choices visible, or PANEL_NONE — no choices visible. The default is PANEL_ALL.

Since there is no notion of the *current* choice for a toggle item, a display level of PANEL_CURRENT is not allowed.

Toggle Selection

Toggle items, like choice items, may have either inverted or marked feedback, depending on the value of PANEL_FEEDBACK. The default is PANEL_MARKED. For inverted feedback, specify PANEL_INVERTED. PANEL_NONE is not allowed.

Toggle items may be selected by clicking on the desired choice or through the menu. Selecting a choice causes that choice to toggle on or off (change state); other choices are not affected.

If there is only one choice, it may be toggled by selecting the label; if there is more than one choice, selecting the label has no effect.

Toggle Notification

The parameters for the notify procedure are the same as for choice items except that the value passed is a bit mask instead of an integer:

```
toggle_notify_proc(item, value, event)
    Panel_item   item;
    unsigned int value;
    Event        *event;
```

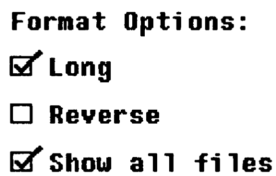
Toggle Value

The value passed to the notify procedure is a bit mask representing the state of the first 32 choices — if a bit is one, then the corresponding choice is on, if a bit is zero, then the corresponding choice is off. (The least significant bit is bit zero, which maps to choice zero.)

Example

Figure 9-4 illustrates an item which lets you set the *-l*, *-r*, or *-a* flags for the *ls* command:

Figure 9-4 *A Toggle Item*




```
format_item = panel_create_item(panel, PANEL_TOGGLE,
    PANEL_LABEL_STRING,   "Format Options:",
    PANEL_LAYOUT,         PANEL_VERTICAL,
    PANEL_CHOICE_STRINGS, "Long",
                          "Reverse",
                          "Show all files",
                          0,
    PANEL_TOGGLE_VALUE,   0, TRUE,
    PANEL_TOGGLE_VALUE,   2, TRUE,
    PANEL_NOTIFY_PROC,    format_notify_proc,
    0);
```

You can get or set the value of a particular choice — including choices beyond the first 32 — with PANEL_TOGGLE_VALUE. When used to set the value, this attribute takes two values: the index of the choice to set, and the desired value. In the above example, PANEL_TOGGLE_VALUE is used to initialize the first and third choices to TRUE. To find out the value of the third choice, you would call:

```
value = (int) panel_get(format_item, PANEL_TOGGLE_VALUE, 2);
```

You can also use the attribute PANEL_VALUE to set and get the state of a toggle's choices. As mentioned on the previous page, a toggle's value is a bit mask representing the state of the first 32 choices. To facilitate working with the value, you might first define names corresponding to each choices, and a macro to test for the corresponding bit in the value, like this:

```
#define LONG      0
#define REVERSE   1
#define SHOW_ALL  2

#define toggle_bit_on(value, bit)    ((value) & (1 << (bit)))
```

You can then use the value in the notify procedure, as in:

```
format_notify_proc(format_item, value, event)
    Panel_item format_item;
    unsigned int value;
    Event *event;
{
   if (toggle_bit_on(value, LONG)) {
      ...
   }
   if (toggle_bit_on(value, REVERSE)) {
      ...
   }
   if (toggle_bit_on(value, SHOW_ALL)) {
      ...
   }
}
```

Or you can retrieve the value outside of the notify procedure, as in:

```
unsigned value;
value = panel_get_value(format_item);
if (toggle_bit_on(value, LONG)) {
...
}
```

Toggle Menus

The menu has as many lines as choices, and each line toggles when selected. In other words, the mark indicating "on" (PANEL_MENU_MARK_IMAGE) is alternated with the mark signifying "off" (PANEL_MENU_NOMARK_IMAGE) each time the user selects a given line.

To disable the menu, set PANEL_SHOW_MENU to FALSE.

9.8. Text

Displaying Text Items

The value component of a text item is the string which the user enters and edits. It is drawn on the screen just after the label, as in:

Name: Edward G. Robinson

```
panel_create_item(panel, PANEL_TEXT,
                  PANEL_LABEL_STRING, "Name:",
                  PANEL_VALUE,        "Edward G. Robinson",
                  0);
```

If PANEL_LAYOUT is set to PANEL_VERTICAL, overriding the default of PANEL_HORIZONTAL, the value will be placed below the label.

The number of characters of the text item's value which are displayable on the screen is set via PANEL_VALUE_DISPLAY_LENGTH, which defaults to 80 characters. When characters are entered beyond this length, the value string is scrolled one character to the left, so that the most recently entered character is always visible. As the string scrolls to the left, the leftmost characters move out of the visible display area. The presence of these temporarily hidden characters is indicated by a small left-pointing triangle. So setting the display length to 12 in the above call would produce:

Name: ◂G. Robinson

As excess characters are deleted, the string is scrolled back to the right, until the actual length becomes equal to the displayed length, and the entire string is visible.

It is sometimes desirable to have a protected field where the user can enter confidential information. The attribute PANEL_MASK_CHAR is provided for this purpose. When the user enters a character, the character you have specified as the value of PANEL_MASK_CHAR will be displayed in place of the character the user has typed. So setting PANEL_MASK_CHAR to "'*'" would produce:

Password: *********

If you want to disable character echo entirely, so that the caret does not advance and it is impossible to tell how many characters have been entered, use the space character as the mask. You can remove the mask and display the actual value string at any time by setting the mask to the null character.

The maximum number of characters which can be typed into a text item (independently of how many are displayable) is set via the attribute PANEL_VALUE_STORED_LENGTH. Attempting to enter a character beyond this limit causes the field to overflow, and the character is lost. The value string is blinked to indicate to the user that the text item is not accepting any more characters.

The stored length, like the displayed length, defaults to 80 characters.

Text Selection

A panel may have several text items, exactly one of which is *current* at any given time. The current text item is the one to which keyboard input is directed, and is indicated by a caret at the end of the item's value. (If PANEL_BLINK_CARET is TRUE, the caret will blink as long as the cursor is in the panel.) Selection of a text item (i.e. pressing and releasing the left mouse button anywhere within the item's rectangle) causes that item to become current. A text item also becomes current if it is displayed after being hidden — i.e. if PANEL_SHOW_ITEM is set to TRUE.

You can find out which text item has the caret, or give the caret to a specified text item, by means of the panel attribute PANEL_CARET_ITEM. The call

```
window_set(panel, PANEL_CARET_ITEM, name_item, 0);
```

moves the caret to name_item, while

```
(Panel_item)window_get(panel, PANEL_CARET_ITEM);
```

retrieves the item with the caret.

You can rotate the caret through the text items with the following two routines:

```
panel_advance_caret(panel)
    Panel panel;

panel_backup_caret(panel)
    Panel panel;
```

Advancing past the last text item places the caret at the first text item; backing up past the first text item places the caret at the last text item.

Text Notification

The notification behavior of text items is rather more complex than that of the other item types. You can control whether your notify procedure is called on each input character or only on selected characters. If your notify procedure *is* called, then the value it returns tells the panel package what to do — whether to insert the character, advance to the next text item, etc.

When your notify procedure will be called is determined by the value of PANEL_NOTIFY_LEVEL. Possible values are given in the following table.

Table 9-1 *Text Item Notification*

Notification Level	*Causes Notify Procedure to be Called*
PANEL_NONE	Never
PANEL_NON_PRINTABLE	On each non-printable input character
PANEL_SPECIFIED	If the input char is found in the string given for the attribute PANEL_NOTIFY_STRING
PANEL_ALL	On each input character

PANEL_NOTIFY_LEVEL defaults to PANEL_SPECIFIED, and PANEL_NOTIFY_STRING defaults to \n\r\t (i.e., notification on line-feed, carriage-return and tab).

What happens when the user types a character? The panel package treats some characters specially. *Meta-C*,[60] *Meta-V*, and *Meta-X* are mapped to the SunView functions Copy, Paste, and Cut, respectively. When the user types these characters, the panel package notices them and performs the appropriate operation, without passing them on to your notify procedure.

The user's editing characters — *erase*, *erase-word* and *kill* — are also treated specially. If you have asked for the character by including it in PANEL_NOTIFY_STRING, the panel package will call your notify procedure.

[60] The *Meta* key is Left or Right on the Sun-2 and Sun-3 keyboards. On the type 4 keyboard, the *Meta* keys are marked with diamonds ◆.

After the notify procedure returns, the appropriate editing operation will be applied to the value string. (Note: the editing characters are never appended to the value string, regardless of the return value of the notify procedure.)

Characters other than the special characters described above are treated as follows. If your notify procedure is *not* called, then the character, if it is printable, is appended to the value string. If it is not printable, it is ignored. If your notify procedure *is* called, what happens to the value string, and whether the caret moves to another text item, is determined by the notify procedure's return value. The following table shows the possible return values:

Table 9-2 *Return Values for Text Item Notify Procedures*

Value Returned	*Action Caused*
`PANEL_INSERT`	Character is appended to item's value
`PANEL_NEXT`	Caret moves to next text item
`PANEL_PREVIOUS`	Caret moves to previous text item
`PANEL_NONE`	Ignore the input character

If a non-printable character is inserted, it is appended to the value string, but nothing is shown on the screen.

If you don't specify your own notify procedure, the default procedure `panel_text_notify()` will be called at the appropriate time, as determined by the setting of `PANEL_NOTIFY_LEVEL`. The procedure is shown below:

```
Panel_setting
panel_text_notify(item, event)
Panel_item item
Event *event
```

This procedure returns a panel setting enumeration which causes: 1) the caret to move to the next text item on [RETURN] or [TAB]; 2) the caret to move to the previous text item on [SHIFT] [RETURN] or [SHIFT] [TAB;] 3) printable characters to be inserted; and 4) all other characters to be discarded.

Writing Your Own Notify Procedure

By writing your own notify procedure, you can tailor the notification behavior of a given text item to support a variety of interface styles. On one extreme, you may want to process each character as the user types it in. For a different application you may not care about the characters as they are typed in, and only want to look at the value string in response to some other button. A typical example is getting the value of a filename field when the user presses the **Load** button.

Text item notify procedures are passed the item and the event which caused notification:

```
Panel_setting
text_notify_proc(item, event)
    Panel_item  item;
    Event       *event;
```

The input character is referenced by `event_action(event)`.

For example, suppose you want to be notified only when the user types [Esc] or [Control-C] into an item, but you still want them to be able to move to the next item, tab, or select [RETURN.] Create the item as shown below.

```
name_item = panel_create_item(panel, PANEL_TEXT,
        PANEL_LABEL_STRING,       "Enter Name Here:",
        PANEL_NOTIFY_LEVEL,       PANEL_SPECIFIED,
        PANEL_NOTIFY_STRING,      "\n\r\t\033\03",
        PANEL_NOTIFY_PROC,        name_proc,
        0);
```

Note that you must remember to return the appropriate value from your notify procedure. The easiest way to do this is to simply call the default text notify procedure, and return what it returns:

```
Panel_setting
name_proc(item, event)
    Panel_item  item;
    Event       *event;
{
    switch (event_action(event)) {
      case ' 33':               /* user pressed [Esc] */
         /* special processing of escape */
         return (PANEL_NONE);

      case ' 03':               /* user pressed [Ctrl-C] */
         /* special processing of ^C */
         return (PANEL_NONE);

      default:
         return (panel_text_notify(item, event));
    }
}
```

Text Value

As shown in the example under *Displaying Text Items*, you can set the value of a text item at any time via PANEL_VALUE. You can also use the panel_set_value() macro, as in:

```
panel_set_value(name_item, "Millard Fillmore");
```

The following call retrieves the value of name_item into name:

```
Panel_item name_item;
char       name[NAME_ITEM_MAX_LENGTH];
...
strcpy(name, (char *)panel_get_value(name_item));
```

Note that name_item should have been created with a PANEL_VALUE_STORED_LENGTH not greater than NAME_ITEM_MAX_LENGTH, so the buffer name will not overflow.

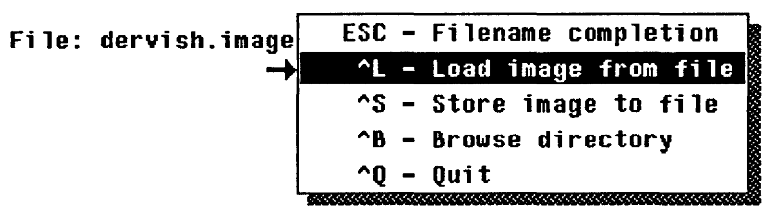
Text Menus

A menu may be associated with a text item by setting `PANEL_SHOW_MENU` to `TRUE`.

Example

One use of text item menus is to make any item-specific "accelerators", or characters which cause special behavior, visible to the user. This usage of accelerators may be seen in Figure 9-5 which is taken from `iconedit`. The item labelled **File:** holds the name of the file being edited. In addition to typing printable characters, which are appended to the value of the item, the user can type [Esc] for filename completion, [Control-L] to load an image from the file, [Control-S] to store an image to the file, or [Control-B] to browse the images in a directory.

Figure 9-5 *A Text Menu*




```
#define ESC 27
#define CTRL_L 12
#define CTRL_S 19
#define CTRL_Q 17
#define CTRL_B 2

filename_item = panel_create_item(panel, PANEL_TEXT,
    PANEL_LABEL_STRING,          "File:",
    PANEL_NOTIFY_LEVEL,          PANEL_ALL,
    PANEL_NOTIFY_PROC,           filename_proc,
    PANEL_VALUE_DISPLAY_LENGTH,  18,
    PANEL_SHOW_MENU,             TRUE,
    PANEL_MENU_CHOICE_STRINGS,   "ESC - Filename completion",
                                 " ^L - Load image from file",
                                 " ^S - Store image to file",
                                 " ^B - Browse Directory",
                                 " ^Q - Quit",
                                 0,
    PANEL_MENU_CHOICE_VALUES,    ESC,CTRL_L,CTRL_S,
                                 CTRL_B,CTRL_Q, 0,
    0);
```

The last two attributes specify the menu. `PANEL_MENU_CHOICE_STRINGS` is a null-terminated array of strings to appear as the selectable lines of the menu. The value that the menu returns for each of its lines is specified via `PANEL_MENU_CHOICE_VALUES`. So if the menu line '^L – Load image from file' is selected, the menu will return the value `CTRL_L`. The value returned by the menu is passed directly to the text item, just as if it had been typed at the keyboard.

9.9. Sliders

Displaying Sliders

A slider has four displayable components: the label, the current value, the slider bar, and the minimum and maximum allowable integral values (the range). When PANEL_SHOW_VALUE is TRUE, the current value is shown in brackets after the label. The font used to render the value is PANEL_VALUE_FONT.

The slider bar width in pixels is set with PANEL_SLIDER_WIDTH.[61] The minimum and maximum allowable values are set with PANEL_MIN_VALUE and PANEL_MAX_VALUE. The width of the slider bar corresponding to the current value is filled with grey. The slider bar is always displayed, unless the item is hidden (i.e., PANEL_SHOW_ITEM is FALSE). When PANEL_SHOW_RANGE is TRUE, the minimum value of the slider (PANEL_MIN_VALUE) is shown to the left of the slider bar and the maximum value (PANEL_MAX_VALUE) is shown to the right of the slider bar.

Slider Selection

Only the slider bar of a slider may be selected. When the left mouse button is pressed within the slider bar or the mouse is dragged into the slider bar with the left mouse button pressed, the grey shaded area of the bar will advance or retreat to the position of the cursor. If the mouse is dragged left or right within the slider bar, the grey area will be updated appropriately. If the cursor is dragged outside of the slider bar, the original value of the slider (i.e., the value before the left button was pressed) will be restored.

Slider Notification

Slider notify procedures are passed the item, the item's value at time of notification, and the event which caused notification:

```
slider_notify_proc(item, value, event)
    Panel_item item;
    int         value;
    Event      *event;
```

The notification behavior of a slider is controlled by PANEL_NOTIFY_LEVEL. When PANEL_NOTIFY_LEVEL is set to PANEL_DONE, the notify procedure will be called only when the select button is released within the slider bar. When PANEL_NOTIFY_LEVEL is set to PANEL_ALL, the notify procedure will be called whenever the value of the slider is changed. This includes:

- when the select button is first pressed within or dragged into the slider bar,
- each time the mouse is dragged within the slider bar,
- when the mouse is dragged outside the slider bar,
- when the select button is released.

[61] If you want to specify the width in characters, use the "column units" macro ATTR_COLS() described in Chapter 18, *Attribute Utilities*.

Slider Value

The value of a slider is an integer in the range PANEL_MIN_VALUE to PANEL_MAX_VALUE. You can retrieve or set a slider's value with the attribute PANEL_VALUE.

Example

Figure 9-6 illustrates a typical slider, which might be used to control the brightness of a screen:

Figure 9-6 *A Typical Slider*


```
panel_create_item(panel, PANEL_SLIDER,
                  PANEL_LABEL_STRING, "Brightness: ",
                  PANEL_VALUE,        75,
                  PANEL_MIN_VALUE,    0,
                  PANEL_MAX_VALUE,    100,
                  PANEL_SLIDER_WIDTH, 300,
                  PANEL_NOTIFY_PROC,  brightness_proc,
                  0);
```

9.10. Painting Panels and Individual Items

To repaint either an individual item or an entire panel, use:

```
panel_paint(panel_object, paint_behavior)
    <Panel_item or Panel> panel_object;
    Panel_setting    paint_behavior;
```

paint_behavior should be either PANEL_CLEAR, which causes the rectangle occupied by the panel or item to be cleared prior to repainting, or PANEL_NO_CLEAR, which causes repainting to be done without any prior clearing.

You don't have to call panel_paint() for items which you create at the same time as you create the panel — when the panel is initially displayed, each of its items will be painted. Note, however, that simply creating a panel item does not cause it to be painted. So items which you create *after* the panel has been initially displayed will not appear until you call panel_paint().

The special attribute PANEL_PAINT is provided to allow you to control the "repaint behavior" of an item when one of its attributes is set. PANEL_PAINT has three possible values:

- PANEL_CLEAR — the item will be automatically cleared and repainted after each call to panel_set().
- PANEL_NO_CLEAR — the item will be automatically repainted (without any prior clearing) after each panel_set() call.
- PANEL_NONE — no automatic repainting will be done.

The default value for PANEL_PAINT is PANEL_CLEAR. Thus, in the default case, you do not need to call panel_paint() after calling panel_set().

You can set the repaint behavior for an item when the item is created, or for all items in the panel when the panel is created. The item's repaint behavior may *not* be reset after the item is created. However, you may temporarily *override* an item's repaint behavior on any call to `panel_set()` by giving a different setting for `PANEL_PAINT`. The examples which follow show two possible repaint policies.

Example 1:

```
item1 = panel_create_item(panel, PANEL_TEXT,
            PANEL_LABEL_STRING,         "Enter Name:",
            PANEL_VALUE_DISPLAY_LENGTH, 10,
            PANEL_PAINT,                PANEL_NONE,
            0);

(begin processing events, etc...)

panel_set(item1, PANEL_ITEM_X, 10, PANEL_ITEM_Y, 50, 0);
panel_set(item1, PANEL_LABEL_IMAGE, &pixrect1, 0);
panel_set(item1, PANEL_VALUE_DISPLAY_LENGTH, 30, 0);
panel_paint(item1, PANEL_CLEAR);
```

Example 2:

```
item2 = panel_create_item(panel, PANEL_TEXT,
            PANEL_LABEL_STRING,          "Enter Name:",
            PANEL_VALUE_DISPLAY_LENGTH, 10,
            0);

(begin processing events, etc...)

panel_set(item2,
          PANEL_ITEM_X, 10,
          PANEL_ITEM_Y, 50,
          PANEL_PAINT,  PANEL_NONE,
          0);
panel_set(item2,
          PANEL_LABEL_IMAGE, &pixrect1,
          PANEL_PAINT,       PANEL_NONE,
          0);
panel_set(item2,
          PANEL_VALUE_DISPLAY_LENGTH, 30,
          0);
```

The above two examples each produce the same effect. In the first example, the item's repaint behavior is set to PANEL_NONE at creation time, so it is not repainted automatically after the panel_set() calls, and no repainting occurs until the call to panel_paint(). In the second example, the item's repaint behavior is the default, PANEL_CLEAR. This is overridden in the first two panel_set() calls, so no repainting occurs. However, it is not overridden in the third call to panel_set(), so repainting occurs before that call returns.

As mentioned above, the repaint behavior for all items in a panel can be set when the panel is created, e.g.:

```
window_create(frame, PANEL, PANEL_PAINT, PANEL_NONE, 0);
```

All items created in the above panel will have a repaint behavior of PANEL_NONE.

9.11. Iterating Over a Panel's Items

You can iterate over each item in a panel with the two attributes PANEL_FIRST_ITEM and PANEL_NEXT_ITEM. A pair of macros, panel_each_item() and panel_end_each are also provided for this purpose. For example, to destroy each item in a panel you would call:

```
Panel_item item;

panel_each_item(browser, item)
    panel_destroy_item(item);
panel_end_each
```

NOTE *Parentheses are not required around the statements to be executed on each iteration.* Also, a semicolon is not required after panel_end_each.

9.12. Panel Item Client Data

One attribute applicable to items of all types which should be mentioned is PANEL_CLIENT_DATA. You can use this attribute in a variety of ways.

Perhaps the most common use is to associate a unique identifier with each item. This is convenient in the case where you have many items, or where you are creating and destroying items dynamically. If you need to pick one item out of all the items, you can store an identifier (or a class) with it via PANEL_CLIENT_DATA, and then query the item directly to find out its identifier or class.

The *dctool* program in Appendix A, *Example Programs*, demonstrates this use of PANEL_CLIENT_DATA. The panel buttons for its number keys 0–9 share the same notify procedure. Each button's PANEL_CLIENT_DATA holds the ASCII digit displayed on the button; when a button is pushed, the PANEL_CLIENT_DATA is retrieved and displayed on the "screen" of the calculator. This saves having a different notify procedure for every button.

You can also use PANEL_CLIENT_DATA to associate a pointer to a private structure with an item. For one example of this usage, see the example in the next section under *Writing Your Own Event Handler*. Another application would be to link several items together into a list which is completely under your control.

9.13. Event Handling

This section describes how the panel package handles events.[62] If you require a behavior not provided by default, you can write your own event handling procedure for either an individual item or the panel as a whole.

Default Event Handling

Using the default event handling mechanism, events are handled for all the panel items in a uniform way. A single routine reads the events, updates an internal state machine, and maps the event to an *action* to be taken by the item. Actions fall into two categories: *previewing* and *accepting*. The previewing action gives the user visual feedback indicating what will happen when he releases the mouse button. The accepting action causes the item's value to be changed and/or its notify procedure to be called, with the event passed as the last argument.

The default event-to-action mapping is given in the following table:

Event	*Action*
Left button down or drag in w/left button down	Begin previewing
Drag with left button down	Update previewing
Drag out of item rectangle with left button down	Cancel preview
Left button up	Accept
Right button down	Display menu & accept user's selection
Keystroke	Accept keystroke if text item

What actually happens when an item is told to perform one of the above actions depends on the type of the item. For example, when asked to begin previewing, a button item inverts its label, a message item does nothing, a slider item redraws the shaded area of its slider bar, etc.[63]

Writing Your Own Event Handler

You may want to handle events in a way which is not supported by this default scheme. For example, there is no way to take any action on middle mouse button events. To do so you must extend the event handling functionality by replacing the default event-to-action mapping function for a panel or panel item. Three attributes have been defined for this purpose:

Table 9-3 *Panel Event Handling Attributes*

Attribute	*Argument Type*	*Default Value*
`PANEL_EVENT_PROC`	`int (*)()`	`panel_default_handle_event()`
`PANEL_BACKGROUND_PROC`	`int (*)()`	`panel_default_handle_event()`
`PANEL_ACCEPT_KEYSTROKE`	`boolean`	`FALSE`

An item's `PANEL_EVENT_PROC` is called when an event falls over the item. The event procedure for an item defaults to that for the panel. Thus you can change the event procedure for all the items in a panel by specifying your own `PANEL_EVENT_PROC` for the panel before the panel items are created. The arguments passed to the event procedure are the item (or panel) and the event.

[62] The general SunView input paradigm, including details on the various events, is covered in Chapter 6, `Handling Input`.

[63] For particulars, see the *Selection* subsection under each item type.

The default event procedure, which implements the default event-to-action mapping described on the previous page, is:

```
panel_default_handle_event(object, event)
    <Panel_item or Panel> object;
    Event                 *event;
```

The panel's PANEL_BACKGROUND_PROC is called when an event falls on the background of the panel (i.e. an event whose locator position does not fall over any item). The default panel background procedure is also panel_default_handle_event(); however, the various actions are no-ops for the panel. Note that this attribute only applies to a panel; it has no meaning for an individual panel item.

The attribute PANEL_ACCEPT_KEYSTROKE determines whether or not an item or panel is interested in keystroke events. If this is TRUE, the item or panel under the cursor is given keystroke events as they are generated. The default behavior sends all keystroke events to the text item with the caret, independent of the cursor position.

In addition to the three event related attributes, three event codes have been defined:

- PANEL_EVENT_DRAG_IN — the item or panel was entered for the first time with one or more buttons down.
- PANEL_EVENT_MOVE_IN — the item or panel was entered for the first time with no mouse buttons down.
- PANEL_EVENT_CANCEL — the item or panel is no longer "current" so any operations in progress should be canceled (e.g. cancel previewing).

The panel package will generate these events as appropriate and pass them to the item's event procedure or the panel's background procedure.

The event-to-action mapping is performed by means of a set of *action functions*. If you haven't specified an event procedure for the item, panel_default_handle_event() will map events to the appropriate actions by calling one of the action functions. These action functions have been made public so that, if you replace the event procedure for an item, you can ask the panel package to perform one of the default actions by calling the corresponding action function from your new event procedure.

The action functions are given in the table on the following page.

Table 9-4 *Panel Action Functions*

Definition	*Description*
`panel_accept_key(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells a text item to accept a keyboard event. Currently ignored by non-text panel items.
`panel_accept_menu(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells an item to display its menu and process the user's selection.
`panel_accept_preview(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells an item to do what it is supposed to do when selected, including completing any previewing feedback.
`panel_begin_preview(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells an item to begin any feedback which indicates tentative selection.
`panel_cancel_preview(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells an item to cancel any previewing feedback.
`panel_update_preview(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	Tells an item to update its previewing feedback (e.g. redraw the slider bar for a slider item).

In most of the action routines, only the event's location and shift state are of interest. When previewing, choices, toggles and sliders use the event's location to determine the current value. Choices use the shift state to determine whether to advance or backup the current choice. `panel_accept_key()` is the only action function to make use of the actual event code.

Example

Suppose you are implementing *dbxtool* and want to have the buttons in the command panel execute different commands depending on whether they were selected with the left or middle mouse button. For example, the button labeled **next** might behave as the **step** button if activated with the middle button. When the middle button is depressed, you want to preview an alternate label, and when it is released, you want to execute the dbx command corresponding to the previewed label.

You can get get this functionality by replacing the event procedure for each of the button items in the command panel. This could be done either by specifying a default event procedure for all the items when the panel is created:

```
panel = window_create(frame, PANEL,
                      PANEL_EVENT_PROC,  dbx_event_proc,
                      0);
```

or by specifying a the event procedure as each panel item is created:

```
panel_create_item(panel, PANEL_BUTTON,
                  PANEL_EVENT_PROC,     dbx_event_proc,
                  0);
```

Whenever one of the buttons gets an event, dbx_event_proc() will be called and can then map the events to actions as it sees fit. The code for the new event procedure is given below. Note the use of PANEL_CLIENT_DATA to store the images for the two labels for each item.

```
dbx_event_proc(item, event)
    Panel_item  item;
    Event       *event;
{
    struct dbx_data *dbx_data;  /* data stored with each item */
    Panel          panel;

    /* First get my private data for this item. */
    panel = (Panel) panel_get(item, PANEL_PARENT_PANEL);
    dbx_data = (struct dbx_data *) panel_get(item, PANEL_CLIENT_DATA);

    /* See if this is an event of interest. */
    switch (event_action(event)) {

      /* middle button went up or down */
      case MS_MIDDLE:
        if (event_is_down(event)) {
        /* middle button went down, so change the button's label
         * image to reflect its middle button action.
         */
            panel_set(item, PANEL_LABEL_IMAGE, dbx_data->middle_pr, 0);

        /* now begin the normal previewing */
        panel_begin_preview(item, event);
    } else {
        /* middle button went up, so accept the previewing */
        panel_accept_preview(item, event);

        /* now change the image back */
        panel_set(item, PANEL_LABEL_IMAGE, dbx_data->left_pr, 0);
    }
    break;

      /* drag into item with button down */
      case PANEL_EVENT_DRAG_IN:
        if (window_get(panel, WIN_EVENT_STATE, MS_MIDDLE)) {
        /* middle button is down, so treat this as begin preview.
        */
        panel_set(item, PANEL_LABEL_IMAGE, dbx_data->middle_pr, 0);
        panel_begin_preview(item, event);
    }
    else
        /* we weren't previewing, so
         * let the default event proc handle it.
         */
        panel_default_handle_event(item, event);
    break;
```

```
        /* cancel for some reason */
        case PANEL_EVENT_CANCEL:
          if (panel_get(item, PANEL_LABEL_IMAGE) ==
              dbx_data->middle_pr) {
              /* we were previewing -- cancel it.
              */
              panel_cancel_preview(item, event);
              panel_set(item, PANEL_LABEL_IMAGE, dbx_data->left_pr, 0);
          } else
              /* we weren't previewing, so
              * let the default event proc handle it.
              */
              panel_default_handle_event(item, event);
          break;

        /* some other event */
        default:
          /* we don't care about this event -- let the default
          * event proc handle it.
          */
          panel_default_handle_event(item, event);
    }
}
```

The final step is to modify the notify procedure for each button to perform different actions depending on which mouse button was released. The notify procedure for the step/next button, for example, would look like:

```
next_step_notify_proc(item, event)
    Panel_item item;
    Event     *event;
{
    if (event_action(event) == MS_MIDDLE)
        /* do middle button command, "step" */
    else
        /* do left button command, "next" */
}
```

Translating Events from Panel to Window Space

In the case of a scrollable panel, the panel is larger than the subwindow in at least one dimension. If the panel has been scrolled, each point within the subwindow will have one location in the coordinate space of the panel and a different location in the coordinate space of the subwindow. Two functions are provided to translate event coordinates from panel space to window space, and *vice versa.*

If you read your own events with `window_read_event()`,[64] you must translate the events from window space to panel space with:

[64] `window_read_event()` is described in Chapter 6, *Handling Input.*

```
Event *
panel_event(panel, event)
    Panel panel;
    Event *event;
```

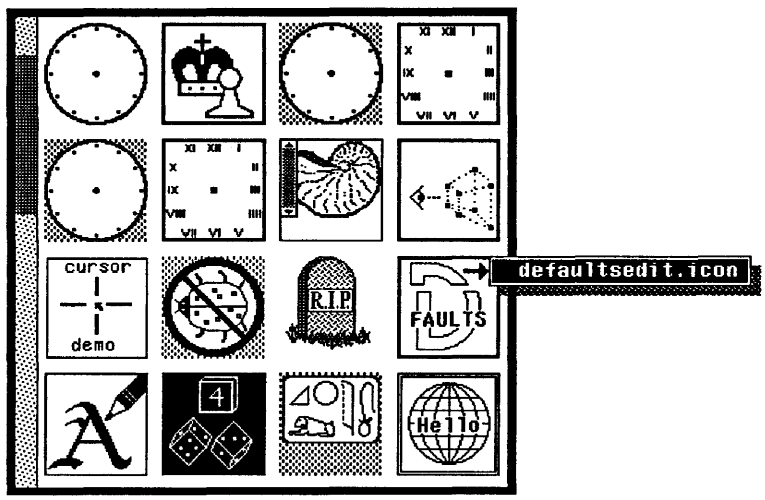
To go from panel space to window space, use:

```
Event *
panel_window_event(panel, event)
    Panel panel;
    Event *event;
```

Example

Figure 9-7 illustrates the image browser from `iconedit`. It serves as an example of when to use `panel_window_event()`. If the user presses the menu button over an image, then he gets a menu showing the name of the file containing the image:

Figure 9-7 *Image Browser Subframe Using* `panel_window_event()`



In order for the menu to be displayed in the correct place in a panel which has been scrolled, the menu's location must be specified in the coordinates of the subwindow, not of the panel.

The browser is implemented as a panel containing buttons having the images as their labels. The buttons are created each time the user wants to browse a different set of images. When each button is created, the name of the file containing the image is stored as the value of the button's PANEL_CLIENT_DATA.

Listed below is the event procedure shared by each button. There is a global menu containing a single menu item, image_menu_item. If the event is a right mouse button, the display string for this menu item is set to the file name which was previously stored as the button's PANEL_CLIENT_DATA.

Then the event is adjusted from panel space to window space, and the menu is displayed at the proper coordinates. If the user selects from the menu, the button's notify procedure, browser_items_notify_proc(), is called, so the effect is the same whether the item is selected through the menu or directly.

```
browser_items_event_proc(item, event)
    Panel_item item;
    Event *event;
{
    if (event_action(event) == MS_RIGHT) {

        Event *adjusted_event;

        menu_set(image_menu_item,
            MENU_STRING, panel_get(item, PANEL_CLIENT_DATA), 0);

        adjusted_event = panel_window_event(browser, event);

        if (menu_show(image_menu, browser, adjusted_event, 0)) {
            browser_items_notify_proc(item);
            return;
        }
    }
    panel_default_handle_event(item, event);
}
```

Note that for all events other than the right mouse button, the panel's default event procedure is called.

10

Alerts

10

Alerts

This chapter describes the alerts package, which you can use by including the file `<suntool/alert.h>` in your program.

This chapter is divided into three logical sections. Section 1 provides a brief introduction to alerts. Section 2 explains the components that make up alerts. Sections 3 gives program fragments that introduce most of the alert attributes.

10.1. Introduction to Alerts

An alert is a pop-up frame that contains a panel to notify a user of problems or changes that require their attention. An alert is easily identified visually by a large black arrow that sweeps into the alert window from the left. A SunView application can use alerts to notify a user that an event has taken place or to verify that a user requested some action. Each alert that pops up has full screen access. That is, the screen is frozen until the user responds to the alert.

Alerts are a replacement for the `menu_prompt()` facility. Some programs will use menu prompts instead of alerts if the user disables alerts in `defaultsedit`. Menu prompts offer a simple box with text, and a maximum of two choices.

Alerts, on the other hand, have a better user interface. Alerts provide an attention-getting alert arrow, buttons, fonts, beeps, a 3-D shadow, and so on. Using alerts, you can offer a user more than two choices of action.

Summary Listing and Tables

To give you a feeling for what you can do with alerts, the following page contains a list of the available alert attributes and functions. Many of these are discussed in the rest of this chapter as they occur in the examples and elsewhere (use the *Index* to check). All are briefly described with their arguments in the alert summary tables in Chapter 19, *SunView Interface Summary*:

- the *Alert Attributes* table begins on page 316;
- the *Alert Functions and Macros* table begins on page 318;

Alert Attributes	
ALERT_BUTTON	ALERT_MESSAGE_STRINGS_ARRAY_PTR
ALERT_BUTTON_FONT	ALERT_NO_BEEPING
ALERT_BUTTON_NO	ALERT_OPTIONAL
ALERT_BUTTON_YES	ALERT_POSITION
ALERT_MESSAGE_FONT	ALERT_POSITION
ALERT_MESSAGE_STRINGS	ALERT_TRIGGER

Alert Functions
alert_prompt(client_frame, event, attributes)

Uses of Alerts

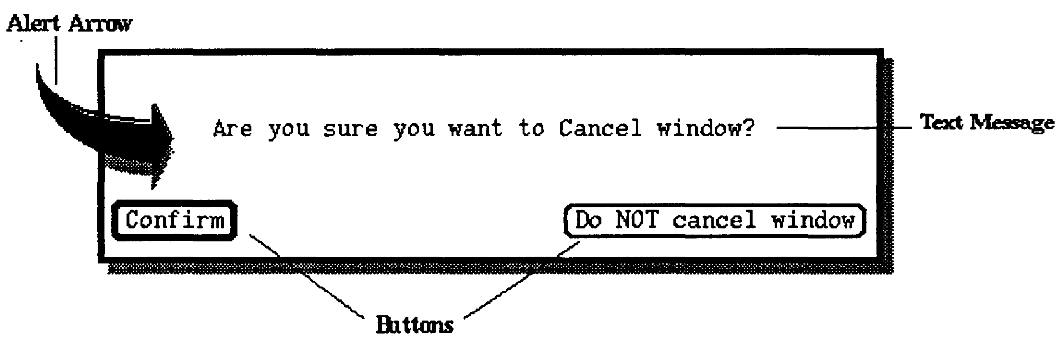
A SunView application uses alerts to display messages to the user, who can then either continue, cancel, or choose a different course of action. Possible uses of alerts include the following:

- Querying whether an action was intended: "Are you sure you want to Quit?"
- Notifying a user of a current state: "Unrecognized file name. No files match specified pattern."

10.2. The Components of an Alert

Figure 10-1 illustrates the visible components that make up an alert. Each component is described below.

Figure 10-1 *An Alert*



Alert Arrow

Each alert window is identifiable as an alert by the large black arrow that sweeps into the window from the left.

Multiple-Line Text Message

Do you really want to exit SunView?

A multiple-line text message describes why an alert appeared and what to do in order to continue. For example, if the user tries to quit SunView, an alert with the message, "Do you really want to exit SunView?", will pop up.

Buttons

Cancel

Buttons make it possible to give the user a choice of actions when warning them that an event has taken place. Each button is associated with a string that specifies an action.

Many alerts have a default button which is indicated by a double outline (as in the **Confirm** button above). If an alert has a default button, then the pointer will jump to this button when the alert appears, so that clicking LEFT will take the default action. The pointer is moved back to its original position when the alert goes away. The user can disable *pointer jumping* by setting *SunView/Alert_Jump_Cursor* to disabled in `defaultsedit`.

Positioning

You have three choices for alert placement. The alert may be screen-centered, client-centered, or client-offset.

Beeping

An alert may be specified to pop up with or without a beep. The default is to come up beeping the number of times that is specified in `defaultsedit`. You may set your alert to come up without a beep even if the user's default *SunView/Alert_Bell* entry in `defaultsedit` is to come up beeping.

10.3. `alert_prompt()`

There is only one function in the alert package, `alert_prompt()`; it creates an alert, pops it up on the screen, handles user interaction, then takes down the alert and returns a value.

```
int
alert_prompt(client_frame, event, attributes)
     Frame       client_frame;
     Event      *event
     <attribute-list> attributes;
```

`alert_prompt()` displays an alert whose appearance and behavior is specified by the attribute value list `attributes`. It does not return a value until the user pushes a button in the alert or the default trigger event or its accelerator is seen. By default the alert is positioned over the center of `client_frame`.

If you supply a pointer to an event as `event`, it will be filled in with the user event which dismissed the alert. For example, if the users pushes a button by clicking LEFT, `event_action(event)` will be `MS_LEFT`.[65]

The possible status values which `alert_prompt()` returns are:

- `ALERT_YES` — the user pushed the "yes" alert button
- `ALERT_NO` — the user pushed the "no" alert button
- `ALERT_FAILED` — the `alert_prompt()` failed for some reason
- `ALERT_TRIGGERED` — a triggered response occurred
- Some other integer — the user pushed some other button than "yes" or "no."

10.4. Building an Alert

This section contains code fragments that illustrate most of the attributes for the alerts package. For a complete list and explanation of the alert attributes, see Chapter 19, *SunView Interface Summary*. Each code fragment described below is organized as follows:

- Attributes introduced in the code are described
- An illustration of the alert box is given
- The code is listed and described.

[65] See Chapter 6, *Handling Input* for an explanation of the `Events`.

For a complete program example using alerts, see *filer* in Appendix A, *Example Programs.*

Example 1 — Messages and Simple Buttons

This section gives two code fragments in order to illustrate the different button attributes. The buttons allow the user to choose an action. Each alert may contain one or more buttons; the default is for no buttons.

Each button has a name and an associated value. When a user pushes a button, the value associated with the button is returned.

The following attributes are used in the first code fragment. STRINGS "" ALERT_MESSAGE_STRINGS

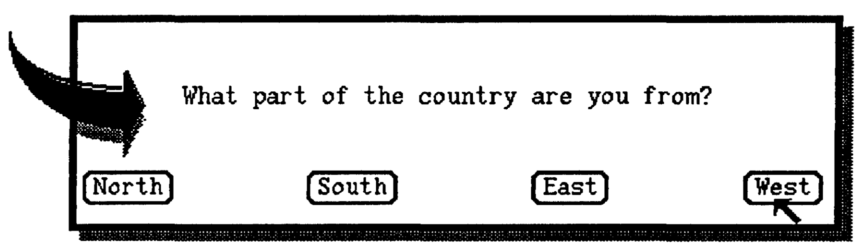
The ALERT_MESSAGE_STRINGS attribute specifies a string or strings to be displayed in the message area of the alert panel.

An example of the syntax for a message is:

```
ALERT_MESSAGE_STRINGS,
     "The text has been edited.",
     "Empty Document will discard these edits. Please confirm",
     0,
```

The ALERT_BUTTON attribute displays a string in a button and associates a value to it. The value specified with the string is returned when the button is pushed. The value may be any integer, but should not be one of the values predefined by the alerts package (ALERT_YES, ALERT_NO, ALERT_FAILED, or ALERT_TRIGGERED). Figure 10-2 illustrates an alert that was built using the attributes ALERT_BUTTON. It contains four buttons and one text string. This example asks the user what part of the country they are from. The program fragment is listed below.

Figure 10-2 *A Simple Alert*




```
result = alert_prompt(
    (Frame) client_frame,
    (Event*) NULL
    ALERT_MESSAGE_STRINGS
       "What part of the country are you from?",
       0,
    ALERT_BUTTON,    "North",    101,
    ALERT_BUTTON,    "East",     102,
    ALERT_BUTTON,    "West",     103,
    ALERT_BUTTON,    "South",    104,
```

```
    0);

switch (result) {
  case 101:
    /*handle case for someone from the North*/
    break;
  case 102:
    /*handle case for someone from the East*/
    break;
  case 103:
    /*handle case for someone from the West*/
    break;
  case 104:
    /*handle case for someone from the South*/
    break;
  case ALERT_FAILED:
    /*
     * Possibly out of memory or fds;
     *  attempt to get information another way
     */
    break;
};
```

Yes and No Buttons

Usually you will want to map your buttons to "yes" and "no" actions. To make this possible, two special buttons are triggered by predefined keyboard accelerators. Yes (confirm, do it) is mapped to the [Return] key. No (cancel, don't do it) is mapped to the [Stop] key (usually [L1]).

The SunView event name for yes is `ACTION_DO_IT`. The SunView event name for no is `ACTION_STOP`.

The following attributes are used in this example:

The `ALERT_BUTTON_YES` attribute associates a string with the accelerated YES button. The value `ALERT_YES` is returned by `alert_prompt()` if the user pushes this button, or types [Return]. Only one instance of this attribute is allowed; subsequent instances are ignored.

The YES button image will have a different button image than the other buttons. It will appear as a regular button image with a double outline.

An example of the syntax is:

```
ALERT_BUTTON_YES, "Confirm, discard edits",
```

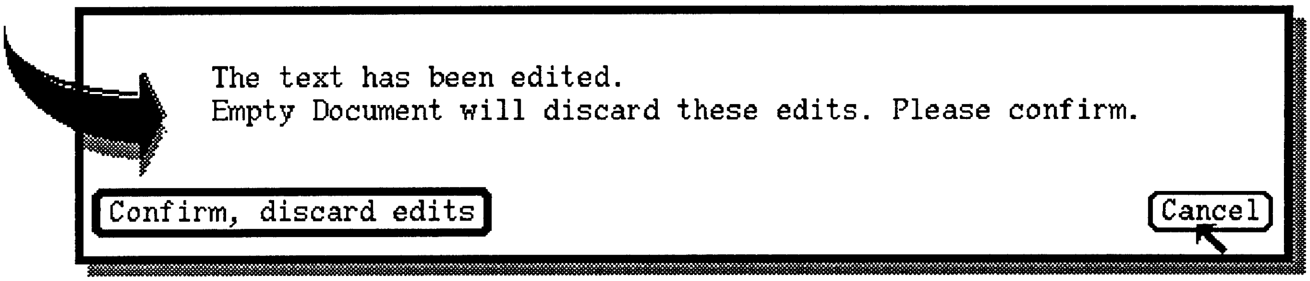
The `ALERT_BUTTON_NO` attribute associates a string with the accelerated NO button. The value returned if the user pushes this button, or types [Stop], will be `ALERT_NO`. Only one instance of this attribute is allowed; subsequent instances are ignored.

An example of the syntax is:

```
ALERT_BUTTON_NO, "Cancel",
```

Figure 10-3 illustrates the alert that is generated by the following code. It contains two buttons and two text strings. The buttons give the user two choices: to empty a document, discarding any edits they may have made, or to cancel the operation completely.

Figure 10-3 *A YES/NO Alert*




```
int  result;
result = alert_prompt(
    (Frame)window, (Event*)NULL,
    ALERT_MESSAGE_STRINGS,
      "The text has been edited.",
      "Empty Document will discard these edits.\
       Please confirm.",
      0,
    ALERT_BUTTON_YES,      "Confirm, discard edits",
    ALERT_BUTTON_NO,       "Cancel",
    0);
switch(result){
  case ALERT_YES:
    /*discard edits*/
    break;
  case ALERT_NO:
    /*cancel the Empty Document request */
    break;
  case ALERT_FAILED:
    break;
};
```

Example 2 — Changing Fonts

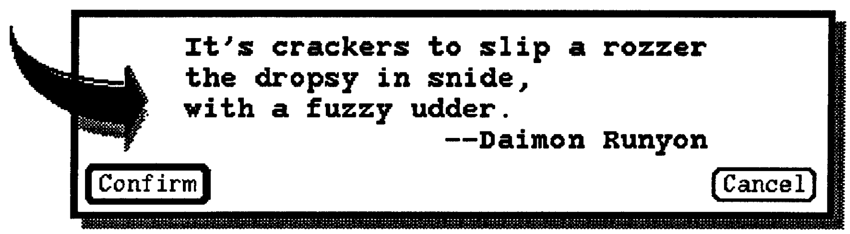
The default font used for alert message text is the Client Frame's font, if one has been specified; or else it is the same as *SunView/Font*. The default font for alert buttons is the same as that specified for menus in *Menus/Font* in defaultsedit, or screen.b.14, if no default is specified.

You may prefer to use different fonts within alerts. For example, you might want to set off the text in an alert box from the text in the Client's frame by using the **bold** version of the Client Frame's default font.

The ALERT_MESSAGE_FONT and ALERT_BUTTON_FONT attributes control the font setting for the alert message text and alert buttons, respectively.

Figure 10-4 illustrates an alert in which the message string is printed in courier.b.16. The code fragment shown below it illustrates how to set the attribute's value using the font library. It also illustrates the use of multiple message strings.

Figure 10-4 *An Alert with* **Boldface** *Message Strings*




```
Event  alert_event;
    int    result = alert_prompt(base_frame, &alert_event,
        ALERT_MESSAGE_STRINGS,
            "It's crackers to slip a rozzer",
            "the dropsy in snide,",
            "with a fuzzy udder.",
            "                --Daimon Runyon",
            0,
        ALERT_BUTTON_YES, "Confirm",
        ALERT_BUTTON_NO, "Cancel",
        ALERT_MESSAGE_FONT,
        pf_open("/usr/lib/fonts/fixedwidthfonts/cour.b.16),
        ALERT_POSITION, ALERT_CLIENT_CENTERED,
        0);
```

Example 3 — Using Triggers

Often you will want to give the user the choice of using mouse buttons or keyboard accelerators instead of push buttons to respond to an alert. Triggers give you this option by making it possible to specify an accelerator or mouse action for a choice.

For example, the text window uses an alert to ask the user where to split a window. A left mouse button click is the trigger that responds to this alert.

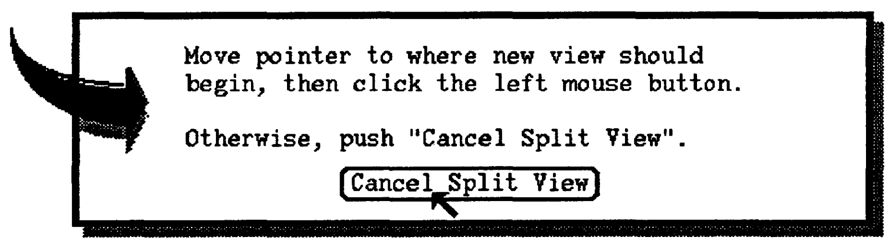
The following attribute is used when specifying a trigger:

The ALERT_TRIGGER attribute allows the application to specify a SunView event which should cause the alert to return. The default is not to return a value unless a button has been pushed or the other YES/NO accelerators are seen. When an event is triggered, the value returned will be ALERT_TRIGGER. An example of the message syntax is as follows.

```
ALERT_TRIGGER, event,
```

Figure 10-5 illustrates the alert that is generated by the following code. This alert contains one button and a triggered response. When this alert comes up, the user may split the existing window into two windows, or can dismiss the alert by pushing the **Cancel New Window** button. This example also shows how alerts can effectively use an event to collect information about the way a user reacted to an alert. See Chapter 6, *Handling Input*, for a full explanation and list of all possible events.

Figure 10-5 *An Alert Using Triggers and Events*



```
Event event;
int   result;

result = alert_prompt(
     (Frame)window,
     &event,
     ALERT_NO_BEEPING,              1,
     ALERT_MESSAGE_STRINGS,
          "Move pointer to where new window should",
          "appear, then click the left mouse button.",
          "Otherwise, push \"Cancel New Window.\"\,
          0,
     ALERT_BUTTON_NO,               "Cancel New Window",
     ALERT_TRIGGER,                 MS_LEFT,
     0);
switch (result) {
    case ALERT_TRIGGERED:
       (void) create_new_window_at_pos(event_x(&event),
                                        event_y(&event)),
      break;
    case ALERT_NO:
      break; /* don't create new window */
    case ALERT_FAILED:
      /* alert failed, possibly out of memory or fds */
}
```

You may specify in your code to have an alert pop up without a beep as shown above. Generally, beeping is reserved for any event which occurs unexpectedly. If the alert is in response to a user request, it should not beep.

The following attribute is used to specify no beeping for an alert.

The `ALERT_NO_BEEPING` attribute allows the SunView application to specify that no beeping should take place regardless of `defaultsedit` setting. The default for this option is `FALSE`; that is, beep as many times as the defaults database specifies.

11

TTY Subwindows

11

TTY Subwindows

The tty (or *terminal emulator*) subwindow emulates a standard Sun terminal, the principal difference being that the row and column dimensions of a tty subwindow can vary. You can run arbitrary programs in a tty subwindow; perhaps its main use is to run a shell within a window.

To see tty subwindows in use, run the standard tools `shelltool`(1) and `gfxtool`(1).

Header Files

Programs using tty subwindows must include the file `<suntool/tty.h>`.

Summary Listing and Tables

To give you a feeling for what you can do with tty subwindows, the following page contains lists of the available tty subwindow attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the tty subwindow summary tables in Chapter 19, *SunView Interface Summary*:

- the *TTY Subwindow Attributes* table begins on page 376;
- the *TTY Subwindow Functions* table begins on page 376;
- the *TTY Subwindow Special Escape Sequences* table begins on page 377.

TTY Subwindow Attributes	
TTY_ARGV	TTY_PAGE_MODE
TTY_CONSOLE	TTY_QUIT_ON_CHILD_DEATH

TTY Subwindow Functions	
ttysw_input(tty, buf, len)	ttysw_output(tty, buf, len)

11.1. Creating a TTY Subwindow

Like all SunView windows, you create a tty subwindow by calling `window_create()` with the appropriate type parameter, as in:

```
Tty tty;
tty = window_create(frame, TTY, 0);
```

By default, the tty subwindow will fork a shell. If you want to start the tty subwindow with another program, say *vi*, you can do so by specifying the name of the program to run via the `TTY_ARGV` attribute:

```
#include <suntool/sunview.h>
#include <suntool/tty.h>

char *my_argv[] = { "vi", 0 };

main()
{
    Tty tty;
    Frame frame;

    frame = window_create(0, FRAME, 0);
    tty = window_create(frame, TTY, TTY_ARGV, my_argv, 0);
    window_main_loop(frame);
}
```

NOTE *You can only have one tty subwindow per process.*

11.2. Driving a TTY Subwindow

You can drive the terminal emulator programmatically. There are procedures both to send input to the terminal emulator (as if the user had typed it in the tty subwindow) and to send output (as if a program running in the tty subwindow had output it). The two effects are similar to the `mapi` / `mapo` functions in `~/.ttyswrc` that permit a user to bind a character sequence to a function key.[66]

`ttysw_input()`

You can send input to a tty subwindow programmatically with the function:

```
int
ttysw_input(tty, buf, len)
    Tty   tty;
    char *buf;
    int   len;
```

`ttysw_input()` appends the character sequence in `buf` that is `len` characters long onto `tty`'s input queue. It returns the number of characters accepted. The characters are treated as if they were typed from the keyboard. `ttysw_input()` provides a simple way for a window program to send input to a program running in its ttysubwindow.

[66] See `shelltool`(1) in the *SunOS Reference Manual.*

ttysw_input()

Use ttysw_output() to output to a tty subwindow.

```
int
ttysw_output(tty, buf, len)
    Tty   tty;
    char *buf;
    int   len;
```

ttysw_output() runs the character sequence in buf that is len characters long through the terminal emulator of tty. It returns the number of characters accepted. The effect is similar to executing

```
echo character_sequence > /dev/ttyN
```

where ttyN is the pseudo-tty associated with the tty subwindow. One use of ttysw_output() is to send the escape sequences listed in the next section to the tty subwindow.

Example: *tty_io*

Appendix A, *Example Programs*, gives the listing for *tty_io*, a program which uses tty_output() to output strings of characters to a tty subwindow.

11.3. TTY Subwindow Escape Sequences

Standard ANSI Escape Sequences

The tty subwindow accepts the same ANSI escape sequences as the raw Sun console,[67] with the following few exceptions:

- The effect of the bell control character CTRL-G (0x07) in a tty subwindow depends on how the user has set the two options *Audible_Bell* and *Visible_Bell* in the *SunView* category in defaultsedit(1). If *Audible_Bell* is *Enabled*, the bell will ring. If *Visible_Bell* is *Enabled*, the window will flash.
- The graphics rendition sequences ESC[4m (underline) and ESC[1m (bold "extra-bright") operate correctly. On the Sun console, these sequence always invert subsequent characters, whereas the tty subwindow only inverts when sent ESC[7m (stand-out).
- The effect of the bold "extra-bright" graphics rendition sequence ESC[1m in a tty subwindow depends on the user's setting for the *Bold_style* option in the *Tty* category of defaultsedit.
- Unsupported graphics rendition mode escape sequences have the same effect as that chosen for bold "extra-bright". On the Sun console, everything inverts.
- The Set Scrolling sequence ESC[0r, which enables vertical wrap mode on the Sun terminal, has no effect in a tty subwindow.

[67] See the console(4s) manual page in the *SunOS Reference Manual* for a full list of escape sequences.

- You can modify `termcap(5)` if you need further control over what gets displayed in the different modes. The two-character `termcap` symbols for each of the modes are:

`so`	standout
`us`	underline
`md`	bold (extra bright)

Special Escape Sequences

Escape sequences have been defined by which the user can get and set attributes of both the tty subwindow and the frame which contains it. For example, the user can type an escape sequence to open, close, move or resize the frame, change the label of the frame or the frame's icon, etc. These escape sequences are described in Table 19-33, *TTY Subwindow Special Escape Sequences*, in Chapter 19, *SunView Interface Summary.*

Example: *tty_io*

For an example of setting the frame's label via a tty subwindow escape sequence, see the program *tty_io*, listed in Appendix A, *Example Programs*.

11.4. Reading and Writing to a TTY Subwindow

You cannot use the tty subwindow's file descriptor returned by `WIN_FD` to read and write characters to it. You can use `TTY_TTY_FD` attribute to get the file descriptor of the pseudo-tty associated with the tty subwindow. You can then use this to read and write to the pseudo-tty using standard UNIX I/O routines. Note that `TTY_TTY_FD` is the file descriptor of the pseudo-tty, not the file descriptor of the tty subwindow returned by `WIN_FD`. The latter is used for low-level window manipulation procedures.

11.5. The Program in the TTY Subwindow

You use the `TTY_ARGV` attribute to pass the name of the program to run to the tty subwindow. The program runs as a forked child in the tty subwindow.

`TTY_PID`

You can use `TTY_PID` to monitor the state of the child process running in the tty window via the Notifier using L notify_interpose_wait3_func() . The client's `wait3()` function gets called when the state of the process in the tty subwindow changes. The setup is something like this:

```
#include <sys/wait.h>
static Notify_value     my_wait3();

...
    ttysw = window_create(base_frame,       TTY,
               TTY_QUIT_ON_CHILD_DEATH,     FALSE,
               TTY_ARGV,                   my_argv,
               0);
    child_pid = (int)window_get(ttysw, TTY_PID);
    notify_interpose_wait3_func(ttysw, my_wait3, child_pid);
...
```

The `wait3()` function can then do something useful, such as destroying the tty window or starting up another process in the tty subwindow. Here is a code fragment that detects the death of its tty subwindow's child. It turns off the default behavior of a tty subwindow, which is to quit when the child process dies.

```
static Notify_value
my_wait3(ttysw, pid, status, rusage)
    Tty              ttysw;
    int              pid;
    union wait      *status;
    struct rusage   *rusage;
{
    int    child_pid;

    notify_next_wait3_func(ttysw, pid, status, rusage);
    if (! (WIFSTOPPED(*status))) {
        window_set(ttysw,
             TTY_QUIT_ON_CHILD_DEATH,     FALSE,
             TTY_ARGV,                    my_argv,
             0);
        child_pid = (int)window_get(ttysw, TTY_PID);
        notify_interpose_wait3_func(ttysw, my_wait3, child_pid);
    }
    return NOTIFY_DONE;
}
```

You can set `TTY_PID` as well as get it, but if you set it then you are responsible for setting the `notify_interpose_wait3_func()` to catch the child's death, and for making the standard input and standard output of the child go to the pseudo-tty.

Talking Directly to the TTY Subwindow

If you set `TTY_ARGV` to `TTY_ARGV_DO_NOT_FORK`, this tells the system not to fork a child in the tty subwindow. In combination with `TTY_FD`, this allows the tool to use standard I/O routines to read and write to the tty subwindow.[68] This simplifies porting terminal-oriented graphics programs, which interact with the user on the model of *write a prompt... read a reply*, to SunView. However, in most cases you should redesign programs to use a real windowing interface made up of SunView components.

An Example

The *typein* program in Appendix A, *Example Programs* reads and writes directly to its tty subwindow, using SunView's `window_main_loop()` control structure.

The following example preserves the flow of control of a typical UNIX application, using `notify_do_dispatch()` to ensure that the Notifier gets called. Read Section 17.6, *Porting Programs to SunView*, for more information on using the Notifier in this way.

```
#define BUFSIZE 1000
static int      my_done;
static Notify_value
my_notice_destroy(frame, status)
    Frame           frame;
    Destroy_status  status;
```

[68] This capability makes obsolete the work-around required in the 3.0 and 3.2 releases of SunView if you

```
{
    if (status != DESTROY_CHECKING) {
    my_done = 1;
    (void)notify_stop();
    }
    return (notify_next_destroy_func(frame, status));
}

main(argc, argv)
    int      argc;
    char     *argv[];
{
    Frame    base_frame;
    Tty      ttysw;
    int      tty_fd;
    char     buf[BUFSIZE];

    my_done = 0;
    base_frame = window_create(NULL, FRAME,
    FRAME_ARGC_PTR_ARGV,     &argc, argv,
    0);

    ttysw = window_create(base_frame,     TTYSW,
            TTY_ARGV,          TTY_ARGV_DO_NOT_FORK,
            0);
    tty_fd = (int)window_get(ttysw, TTY_TTY_FD);
    dup2(tty_fd, 0);
    dup2(tty_fd, 1);

    (void)notify_interpose_destroy_func(base_frame, my_notice_destroy);
    window_set(base_frame, WIN_SHOW, TRUE, 0);
    (void)notify_do_dispatch();

puts(prompt_to_user);
    while (gets(buf)) {
        if (my_done)  /* continue until destroyed */
        break;
        /*
     *  This is where the meat of the program
     *  would be if this were a real program.
     */
        puts(buf);
    }
    exit(0);
}
```

wanted a window program to read and write from its own tty subwindow.

12

Menus

12

Menus

The SunView menu package allows you to chain individual menus together into a collection known as a *walking menu*. A menu contains *menu items*, some of which may have a small arrow pointing to the right. This indicates to the user that if he or she slides the mouse to the right of that item, a *pull-right* menu will appear. Menus can be strung together in this fashion, so that the user "walks" to the right down the chain of menus in order to make a selection.

The definitions necessary to use walking menus are found in the file `<suntool/walkmenu.h>`, which is included by default when you include the file `<suntool/sunview.h>`.

The most useful sections to read first are the first three. Section 12.1, *Basic Menu Usage*, introduces the basic routines and gives some simple examples. Section 12.2, *Components of Menus & Menu Items*, outlines the components of menus and menu items and introduces common terms. Section 12.3, *Examples*, gives more examples of using menus. Section 12.7, *Callback Procedures*, is for advanced users who need to understand the subtleties of the callback mechanism.

The listing for *font_menu*, a program which builds on some of the examples given throughout the chapter, is given in Appendix A, *Example Programs*.

Summary Listing and Tables

To give you a feeling for what you can do with menus, the following two pages list the available menu attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the menu summary tables in Chapter 19, *SunView Interface Summary*:

- the *Menu Attributes* table begins on page 335;
- the *Menu Item Attributes* table begins on page 339;
- the *Menu Functions* table begins on page 341.

Menu Attributes	
MENU_ACTION_IMAGE	MENU_LAST_EVENT
MENU_ACTION_ITEM	MENU_LEFT_MARGIN
MENU_APPEND_ITEM	MENU_MARGIN
MENU_BOXED	MENU_NCOLS
MENU_CENTER	MENU_NITEMS
MENU_CLIENT_DATA	MENU_NROWS
MENU_COLUMN_MAJOR	MENU_NOTIFY_PROC
MENU_CLIENT_DATA	MENU_NTH_ITEM
MENU_DESCEND_FIRST	MENU_PARENT
MENU_DEFAULT	MENU_PULLRIGHT_DELTA
MENU_DEFAULT_ITEM	MENU_PULLRIGHT_IMAGE
MENU_DEFAULT_SELECTION	MENU_PULLRIGHT_ITEM
MENU_FIRST_EVENT	MENU_REMOVE
MENU_FONT	MENU_REMOVE_ITEM
MENU_GEN_PROC	MENU_REPLACE
MENU_GEN_PULLRIGHT_IMAGE	MENU_REPLACE_ITEM
MENU_GEN_PULLRIGHT_ITEM	MENU_RIGHT_MARGIN
MENU_IMAGE_ITEM	MENU_SELECTED
MENU_IMAGES	MENU_SELECTED_ITEM
MENU_INITIAL_SELECTION	MENU_SHADOW
MENU_INITIAL_SELECTION_EXPANDED	MENU_STAY_UP
MENU_INITIAL_SELECTION_SELECTED	MENU_STRINGS
MENU_INSERT	MENU_STRING_ITEM
MENU_INSERT_ITEM	MENU_TITLE_IMAGE
MENU_ITEM	MENU_TITLE_ITEM
MENU_JUMP_AFTER_NO_SELECTION	MENU_TYPE
MENU_JUMP_AFTER_SELECTION	MENU_VALID_RESULT

Menu Item Attributes	
MENU_ACTION_IMAGE†	MENU_INACTIVE
MENU_ACTION_ITEM†	MENU_INVERT
MENU_ACTION_PROC	MENU_LEFT_MARGIN†
MENU_APPEND_ITEM†	MENU_MARGIN†
MENU_BOXED†	MENU_PARENT†
MENU_CENTER†	MENU_PULLRIGHT
MENU_CLIENT_DATA†	MENU_PULLRIGHT_IMAGE†
MENU_FEEDBACK	MENU_PULLRIGHT_ITEM†
MENU_FONT†	MENU_RELEASE
MENU_GEN_PROC†	MENU_RELEASE_IMAGE
MENU_GEN_PROC_IMAGE	MENU_RIGHT_MARGIN†
MENU_GEN_PROC_ITEM	MENU_SELECTED†
MENU_GEN_PULLRIGHT	MENU_STRING†
MENU_GEN_PULLRIGHT_IMAGE†	MENU_STRING_ITEM†
MENU_GEN_PULLRIGHT_ITEM†	MENU_TYPE†
MENU_IMAGE	MENU_VALUE
MENU_IMAGE_ITEM†	

Menu Functions
`menu_create(attributes)`
`menu_create_item(attributes)`
`menu_destroy(menu_object)`
`menu_destroy_with_proc(menu_object, destroy_proc)` `    void (*destroy_proc)();`
`menu_find(menu, attributes)`
`menu_set(menu_object, attributes)`
`menu_show(menu, window, event, 0)`
`menu_return_item(menu, menu_item)`
`menu_return_value(menu, menu_item)`

12.1. Basic Menu Usage

The basic usage of menus is to first create the menu with `menu_create()`, then display it when desired with `menu_show()`:

```
Menu
menu_create(attributes)
    <attribute-list> attributes;

caddr_t
menu_show(menu, window, event, 0)
    Menu        menu;
    Window      window;
    Event      *event;
```

Like the creation routines for other SunView objects, `menu_create()` takes a null-terminated attribute list and returns an opaque handle. `menu_show()` displays the menu, gets a selection from the user, and, by default, returns the *value* of the menu item the user has selected. `window` is the handle of the window over which the menu is displayed; `event`[69] is the event which causes the menu to come up. The final argument is provided so that attributes may be passed in the future; at present it is ignored.

Use the routines `menu_set()` and `menu_get()` to modify and retrieve the values of attributes for both menus and menu items:

```
int
menu_set(menu_object, attributes)
    <Menu or Menu_item> menu_object;
    <attribute-list> attributes;

caddr_t
menu_get(menu_object, attribute[, optional_arg])
    <Menu or Menu_item>  menu_object;
    Menu_attribute attribute;
    caddr_t        optional_arg;
```

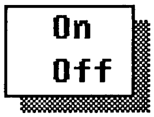
All the attributes applying to menus and menu items are listed in the two corresponding tables *Menu Attributes* and *Menu Item Attributes* in in Chapter 19, *SunView Interface Summary*. Common attributes applying to both menus and menu items appear in both tables.

The pages which follow contain three examples of basic menu usage.

[69] Canvases and panels have their own coordinate spaces separate from the window's coordinate space. Note that `event` is in the coordinate space of the window, not of the canvas or panel.

Example 1:

Let's take a very simple example — a menu with two selectable items represented by the strings 'On' and 'Off':




```
on_off_menu = menu_create(MENU_STRINGS, "On", "Off", 0,
                          0);
```

The attribute MENU_STRINGS takes a list of strings and creates an item for each string. Note that the first zero in the above call terminates the list of strings, and the second zero terminates the entire attribute list.

CAUTION **The menu package, in contrast to the panel package, does not save strings which you pass in.** So you should either pass in the address of a constant, as in the example above, or static storage, or storage which you have dynamically allocated.

Typically you call menu_show() from an event procedure,[70] upon receiving the event which is to cause display of the menu. In the code fragment below, we display the menu on right button down:

```
...
case MS_RIGHT:
    menu_show(on_off_menu, window, event, 0);
    break;
...
```

menu_show(), by default, returns the value of the item which was selected. If the item was created with MENU_STRINGS its value defaults to its ordinal position in the menu, starting with 1.[71] So in the above example, selecting 'On' would cause 1 to be returned, while selecting 'Off' would cause 2 to be returned.

You can specify that menu_show() return the item itself, rather than return the value of the selected item. Do this by setting MENU_NOTIFY_PROC to the predefined notify procedure[72] menu_return_item(), as in:

```
menu_set(on_off_menu,
         MENU_NOTIFY_PROC, menu_return_item,
         0);
```

[70] See Chapter 6, *Handling Input*, for a discussion of event procedures.

[71] The value of menu items not created with MENU_STRINGS defaults to zero. You can explicitly specify the values for menu items via the attributes MENU_IMAGE_ITEM, MENU_STRING_ITEM, or MENU_VALUE.

[72] Notify procedures are covered in detail in Section 12.7, *Callback Procedures*.

Example 2:

It's easy to build up more complex menus out of simple ones. The next example creates a menu with two items, 'Bold' and 'Italic', each of which shares the on-off menu from the previous example as a pull-right:

```
menu = menu_create(MENU_ITEM,
                     MENU_STRING,    "Bold",
                     MENU_PULLRIGHT, on_off_menu,
                     0,
                    MENU_ITEM,
                     MENU_STRING,    "Italic",
                     MENU_PULLRIGHT, on_off_menu,
                     0,
                    0),
```

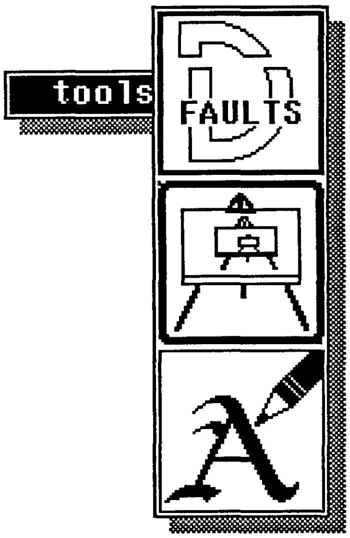
The most flexible way to create a menu item in-line in a `menu_create()` call is by using `MENU_ITEM`. In contrast to `MENU_STRINGS`, which allows you to specify only the display strings of the items, `MENU_ITEM` takes as its value a null-terminated attribute list which may contain any attributes applying to menu items.[73]

The value of `MENU_STRING` is the item's display string; the value of `MENU_PULLRIGHT` is the handle of the item's pull-right menu. (Note that you must already have created the menu before giving it as the value for `MENU_PULLRIGHT`.)

Example 3:

The menu package can accommodate images as well as strings. The example below creates a menu with a single item labelled 'tools'. When the user pulls right, he brings up a menu showing the icons of three SunView tools — `defaultsedit`, `iconedit`, and `fontedit`.

[73] For a complete list of such attributes, see the *Menu Item Attributes* table in in Chapter 19, *SunView Interface Summary*.



In order to pass an image into the menu package you need a pointer to a *memory pixrect* containing the image. One common way to create such an image is by first using *iconedit* to create the image and save it to a file. You then include the file in your program, and use the `mpr_static()` macro to create a memory pixrect:

```
static short d_defaults[] = {
#include <images/defaultsedit.icon>
};
mpr_static(defaults_pr, 64, 64, 1, d_defaults);

static short d_icon[] = {
#include <images/iconedit.icon>
};
mpr_static(icon_pr, 64, 64, 1, d_icon);

static short d_font[] = {
#include <images/fontedit.icon>
};
mpr_static(font_pr, 64, 64, 1, d_font);

tool_menu = menu_create(MENU_IMAGES,
                        &defaults_pr, &icon_pr, &font_pr, 0,
                        0);
menu = menu_create(MENU_ITEM,
                     MENU_STRING,    "tools",
                     MENU_PULLRIGHT, tool_menu,
                     0,
                   0);
```

The attribute `MENU_IMAGES` is analogous to `MENU_STRINGS`. It takes a list of images (pointers to pixrects) and creates a menu item for each image.

12.2. Components of Menus & Menu Items

This section gives an overview of the most important components of menus and menu items. Detailed discussion and examples follow later in the chapter.

Menus

Visual Components

The text for a menu is rendered in the menu's font, which you may specify via MENU_FONT. A menu has a *shadow*; you can specify the shadow's pattern, or disable the shadow entirely, via MENU_SHADOW. You can give a title to a menu via MENU_TITLE_IMAGE or MENU_TITLE_ITEM.[74] By default, a menu's items are laid out vertically; you can specify that the items be laid out horizontally or in a two-dimensional matrix via MENU_NCOLS and MENU_NROWS.

Generate Procedures

You may specify a *generate procedure* for a menu, which will be called just before the menu is displayed. This allows you to implement context-sensitive menus by dynamically modifying the menu, or even replacing it entirely.[75]

Notify Procedures

The menu's *notify procedure* is called after the user makes a selection. By using a notify procedure, you can perform an action or alter the resultor alter the result to be returned by menu_show()[76].

Client Data

The menu's *client data* field, accessible through MENU_CLIENT_DATA, is reserved for the application's use. You can use this attribute to associate a unique identifier, or a pointer to a private structure, with a menu.

Menu Items

A menu contains an array of items. To retrieve a menu's nth item, use MENU_NTH_ITEM. To retrieve the total number of items in a menu use MENU_NITEMS.

The same menu item can appear in more than one menu.

CAUTION **Menu items, unlike panel items, are counted starting with one.**

Menu Items

Representation on the Screen

A menu item is either displayed as a string or an image (a pointer to a pixrect). If the item has another menu associated with it using the MENU_PULLRIGHT attribute, then it is a pull-right item.

[74] The title is nothing more than an inverted, non-selectable item. It does not automatically appear at the top of the menu — it is your responsibility to position it where you want it.

[75] See example 8 in Section 12.7, *Callback Procedures*, later in the chapter.

[76] Notify procedures are discussed in detail in Section 12.7, *Callback Procedures*.

Item Values

Each menu item has a *value*. By default an item's value is the initial ordinal position of the item if it was created with MENU_STRINGS; otherwise the default value is zero. You can set an item's value explicitly when you create the item with MENU_STRING_ITEM or MENU_IMAGE_ITEM. You can also explicitly set an item's value with MENU_VALUE. However, if an item is a pull-right, then its MENU_VALUE is the value of its pull-right menu. This means that only "leaf" menu items without submenus have a true value.

As mentioned in Section 12.1, *Basic Menu Usage*, menu_show() by default returns the value of the item the user has selected. Since menu items are counted starting from one, a return value of zero from menu_show() would represent the null selection.[77] However, you may explicitly set the value of a menu item to zero. If you do, then a return value of zero could represent either a legal value for the selected item or an error. To tell whether or not the result was valid, call menu_get() with the boolean MENU_VALID_RESULT. A return value of TRUE means that the result was valid; FALSE means that the value is invalid.

Item Generate Procedures

As with the menu as a whole, you may specify a *generate procedure* for each menu item, to be called just before the item is displayed.

Item Action Procedures

The *action procedure* of a menu item is analogous to the notify procedure of a menu. This is your chance to do something immediately based on the user's selection.

Menu notify procedures and item action procedures differ in when they are called. If the user chooses an item in a pull-right menu, the notify procedures (if any) for the *menus* higher up in the chain leading to the pull-right will be called, whereas the *action* procedures (if any) for the chosen *menu item* and *menu items* under it ("to its right") will be called.[78]

Client Data

Each menu item has a *client data* field, accessible through MENU_CLIENT_DATA, which is reserved for the application's use. You can use this attribute to associate a unique identifier, or a pointer to a private structure, with each menu item.

---

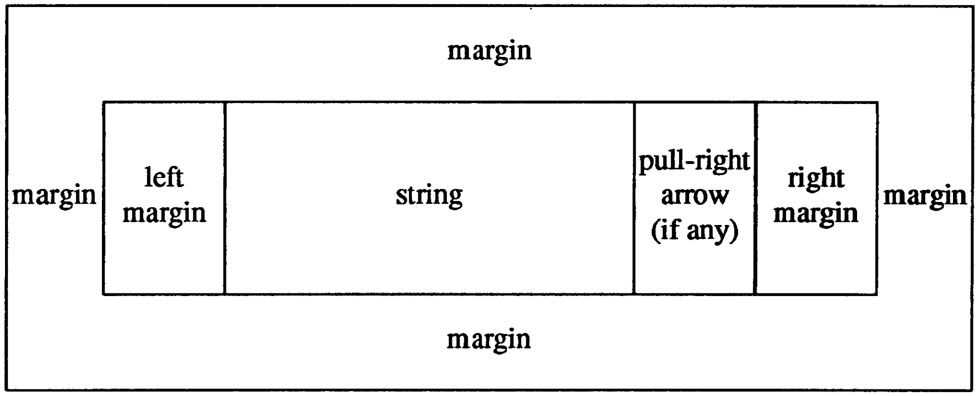
[77] This is why menu items are counted starting with one, rather than zero: so that a zero return value would represent the null selection whether the menu_show() was returning the value of the selected item or the item itself.

[78] Action procedures are discussed in detail in Section 12.7, *Callback Procedures.*

Item Margins

The diagram below illustrates the layout of a menu item:

Figure 12-1 *Layout of a Menu Item*



MENU_MARGIN represents the margin, in pixels, around an item in a menu. Its default value is 1.

You can set an individual item's margin by setting the menu item. To set the margins for all items in a menu, set the menu's margin.

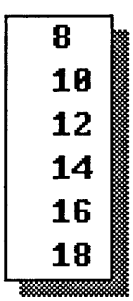
You can adjust the horizontal placement of text in menu items with MENU_LEFT_MARGIN and MENU_RIGHT_MARGIN.[79]

As with MENU_MARGIN, the left and right margins can be set either for an individual menu item or for the menu itself, in which case the settings will apply to all the items in the menu. (The attributes MENU_FONT and MENU_BOXED also work this way.)

12.3. Examples

Example 4:

Our next example will show several variations on a simple menu that could be used for selecting font point sizes. The default form is shown to the left.



You could create the items with MENU_STRINGS, as in the previous example. Alternately, you could create the menu with no items, then use menu_set() to append the items to the menu:[80]

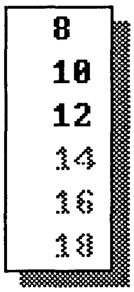
```
m = menu_create(0);
for (i = 8; i <= 18; i += 2)
    menu_set(m, MENU_STRING_ITEM, int_to_str(i), i, 0);
```

[79] The placement of images is currently not affected by the settings of the left and right margins.

[80] Note that using MENU_STRING_ITEM with menu_set() has the effect of an implicit append. Several attributes are provided to explicitly add items to a menu — see Table 12-1, ***Attributes to Add Pre-Existing Menu Items***, later in this section.

MENU_STRING_ITEM takes as values the item's string and its value.

Now let's see some of the ways in which the appearance of this basic menu can be altered.

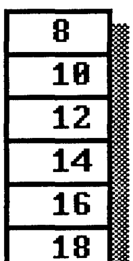


By setting MENU_INACTIVE to TRUE for an item, you can "gray out" the item to indicate to the user that it is not currently selectable.

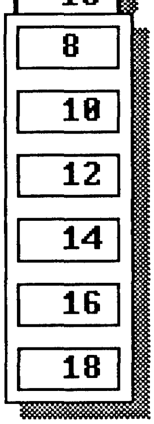
The menu to the left could be produced by:

```
for (i = 4; i <= 6; i++) {
    item = menu_get(m, MENU_NTH_ITEM, i);
    menu_set(item, MENU_INACTIVE, TRUE, 0);
}
```

Inactive items do not invert when the cursor passes over them.

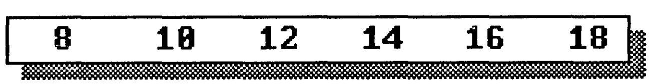


The call `menu_set(m, MENU_BOXED, TRUE, 0)` will cause a single-pixel box to be drawn around each item. With the default margin of 1 pixel, this will result in two-pixel lines between each item.

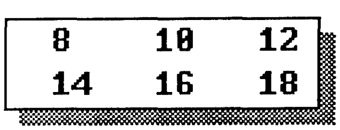


Increasing the margin, by setting MENU_MARGIN to 5, will cause the items to spread out evenly, and the boxes to appear as individual boxes rather than dividing lines.

You can control the layout of the items within a menu with the attributes MENU_NCOLS and MENU_NROWS. Suppose you wanted the menu to be laid out horizontally instead of vertically:



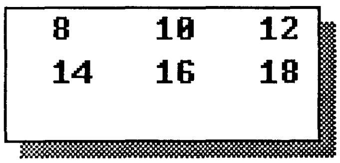
All you need do is specify at create time that the menu will have 6 columns with a call such as `menu_set(m, MENU_NCOLS, 6, 0)`.



You can use MENU_NCOLS or MENU_NROWS to create two-dimensional menus, as well. The call `menu_set(m, MENU_NCOLS, 3, 0)` will cause the menu package to begin a second row after the first three columns have been filled with items:

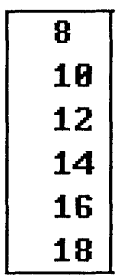
The previous example specified that the menu have 3 columns. Specifying that it have 2 rows via MENU_NROWS would have the same effect. Items are laid out from upper left to lower right, in "reading order," regardless of how the layout is specified.

The only time you need to specify both the number of rows and the number of columns is when you want to fix the size of the menu, regardless of how many items it contains. Setting MENU_NCOLS to 3 and MENU_NROWS to 3 would produce:

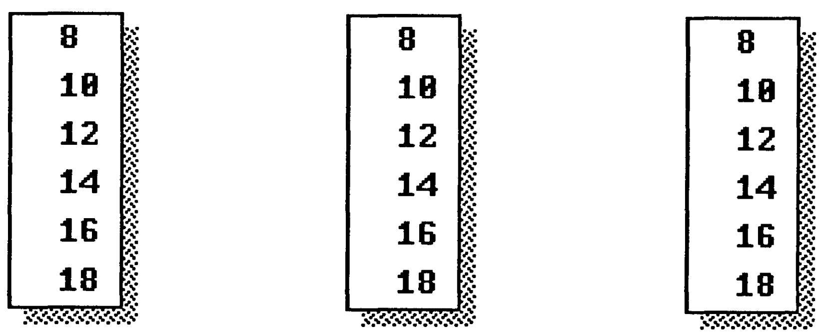


If both dimensions of the menu are fixed and more items are given than will fit, the excess items will not appear.

You can remove the menu's shadow by setting MENU_SHADOW to null:

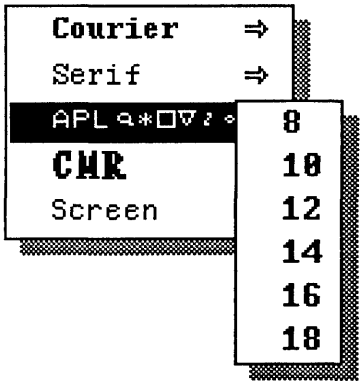


The menu package provides three predefined pixrects for the menu shadow. The call `menu_set(m, MENU_SHADOW, &menu_gray25_pr)` produces the 25 percent gray pattern shown on first menu below. Note that these are pixrects, *not* pixrect pointers. The other two patterns are produced by using `menu_gray50_pr` and `menu_gray75_pr`:



Example 5:

Let's take the size menu from the previous example and use it to create the more complex menu shown below, which the user could use to select both a font family and a point size within the family. This illustrates the multiple usage of a single menu. Pulling right over any of the items in the family menu will bring up the menu for selecting point size, as shown on the left.



By using MENU_ITEM, we can give each item in the font family menu its string, the font in which to render the string, and the size menu as a pull-right:

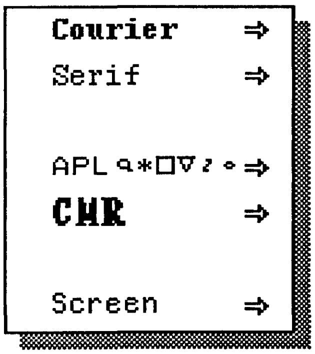
```
family_menu = menu_create(
    MENU_ITEM,
      MENU_STRING,    "Courier",   MENU_FONT, cour,
      MENU_PULLRIGHT, size_menu,   0,
    MENU_ITEM,
      MENU_STRING,    "Serif",     MENU_FONT, serif,
      MENU_PULLRIGHT, size_menu,   0,
    MENU_ITEM,
      MENU_STRING,    "aplAPLGIJ", MENU_FONT, apl,
      MENU_PULLRIGHT, size_menu,   0,
    MENU_ITEM,
      MENU_STRING,    "CMR",       MENU_FONT, cmr,
      MENU_PULLRIGHT, size_menu,   0,
    MENU_ITEM,
      MENU_STRING,    "Screen",    MENU_FONT, screen,
      MENU_PULLRIGHT, size_menu,   0,
0);
```

Suppose the font family menu had already been created, and we wanted to add the size menu as a pull-right to each item of the existing menu. We could do this using the attributes MENU_NITEMS and MENU_NTH_ITEM. The loop below iterates over each item in the menu, retrieving the item's handle and setting the pull-right for the item:

```
for (i = (int)menu_get(family_menu, MENU_NITEMS); i > 0; --i)
    menu_set(menu_get(family_menu, MENU_NTH_ITEM, i),
                        MENU_PULLRIGHT, size_menu, 0);
```

Example 6:

You can insert new items into an existing menu with `MENU_INSERT`. For example, suppose you want to insert blank lines into the font family menu, to indicate grouping:



You can do this by inserting non-selectable items into the menu:

```
menu_set(family_menu,
         MENU_INSERT,
           2,
           menu_create_item(MENU_STRING,    "",
                            MENU_FEEDBACK, FALSE,
                            0),
         0);

menu_set(family_menu,
         MENU_INSERT,
           5,
           menu_get(family_menu, MENU_NTH_ITEM, 3),
         0);
```

`MENU_INSERT` takes two values: the number of the item to insert after, and the new item to insert. Disabling `MENU_FEEDBACK` makes the item non-selectable.

The above example uses `menu_create_item()` to explicitly create the item to be inserted. Usually menu items are created implicitly, using the attributes described in Table 12-2, *Menu Item Creation Attributes*, in the next section.

NOTE `menu_create_item()` does *not* set the `MENU_RELEASE` attribute by default, so that the resulting item will not be automatically destroyed when its parent menu is destroyed. This is in contrast to implicitly created menu items — see Section 12.5, *Destroying Menus*.

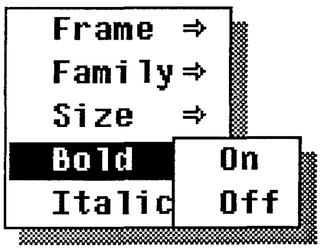
In addition to MENU_INSERT, there are several other attributes you can use to add pre-existing menu items to a menu.[81] They are summarized in the following table.

Table 12-1 *Attributes to Add Pre-Existing Menu Items*

Attribute	*Value Type*	*Description*
MENU_APPEND_ITEM	Menu_item	Append item to end of menu.
MENU_INSERT	int, Menu_item	Insert new item after nth item (use n=0 to prepend).
MENU_INSERT_ITEM	Menu_item(old), Menu_item(new)	Insert new item after old item.
MENU_REPLACE	int, Menu_item	Replace nth item with specified item.
MENU_REPLACE_ITEM	Menu_item(old), Menu_item(new)	Replace old item with new item in the menu (old item is not replaced in any other menus it may appear in).

[81] To delete items from a menu, use MENU_REMOVE or MENU_REMOVE_ITEM, described in the *Menu Attributes* table in in Chapter 19, *SunView Interface Summary*.

Example 7:



For the next example we will attach the on-off, family and size menus of the previous examples as pull-rights to a higher-level menu for selecting fonts:

```
font_menu = menu_create(
              MENU_PULLRIGHT_ITEM, "Frame",   frame_menu,
              MENU_PULLRIGHT_ITEM, "Family", family_menu,
              MENU_PULLRIGHT_ITEM, "Size",   size_menu,
              MENU_PULLRIGHT_ITEM, "Bold",   on_off_menu,
              MENU_PULLRIGHT_ITEM, "Italic", on_off_menu,
              0);
```

`MENU_PULLRIGHT_ITEM` takes a string and a menu as values. It creates an item represented by the string and with the menu as a pull-right.

Note that `on_off_menu` is used as a pull-right for both the bold and the italic menu items, and that the `size_menu` appears both as a pull-right from main level `font_menu` and from each item in `family_menu`. This demonstrates that a menu may have more than one parent. However, recursive menus are not allowed — if M1 is a parent of M2, M2 (or any of its children) may not have M1 as a child. Displaying such a recursive menu will probably result in a segmentation fault.

The 'Frame' item takes as its pull-right the menu which has been retrieved from the frame using `WIN_MENU`.

The program *font_menu*, printed in Appendix A, *Example Programs*, builds further on the above examples.

12.4. Item Creation Attributes

The attribute MENU_ITEM, introduced in Example 2, suffices to create any type of menu item. However, several attributes are provided for convenience as a shorthand way to create items with common attributes. These attributes, along with the types of values they take and the type of item they create, are summarized in the following table:

Table 12-2 *Menu Item Creation Attributes*

Attribute	*Value Type*	*Type of Item Created*
MENU_ACTION_IMAGE	image, action proc	Image item w/action proc.
MENU_ACTION_ITEM	char *, action proc	String item w/action proc.
MENU_GEN_PULLRIGHT_IMAGE	Pixrect *, proc	Image item with generate proc for pull-right.
MENU_GEN_PULLRIGHT_ITEM	char *, proc	String item with generate proc for pull-right.
MENU_IMAGE_ITEM	Pixrect *, value	Image item w/value.
MENU_IMAGES	list of Pixrect *	Multiple image items.
MENU_PULLRIGHT_IMAGE	Pixrect *, Menu	Image item w/pull-right.
MENU_PULLRIGHT_ITEM	char *, Menu	String item w/pull-right.
MENU_STRING_ITEM	char *, value	String item w/value.
MENU_STRINGS	list of char *	Multiple string items.

We could now create the menu in Example 2 more compactly by using MENU_PULLRIGHT_ITEM instead of MENU_ITEM:

```
m = menu_create(MENU_PULLRIGHT_ITEM, "Bold", on_off_menu,
                MENU_PULLRIGHT_ITEM, "Italic", on_off_menu,
                0),
```

12.5. Destroying Menus

Both menus and menu items are destroyed with the function:

```
void
menu_destroy(menu_object)
    <Menu or Menu_item>  menu_object;
```

CAUTION Watch out for dangling pointers when using a menu item in multiple menus. The attribute MENU_RELEASE (which takes no value) controls whether or not a menu item is automatically destroyed when its parent menu is destroyed. MENU_RELEASE is set to TRUE by default for menu items created in-line via the menu item creation attributes. This can lead to dangling pointers, if the same menu item appears multiple times, because calling menu_destroy() can lead to items being destroyed multiple times. This warning also applies to pull-rights which are used multiple times. To prevent this error, remove multiple occurrences of an item or pull-right before destroying a menu.

Calling menu_destroy_with_proc() instead of menu_destroy() when you want to destroy a menu lets you specify a procedure to be called as the menu or menu item is destroyed. lets you specify a procedure to be called every time a particular menu or menu item is about to be destroyed:

```
void
menu_destroy_with_proc(menu_object, destroy_proc)
    <Menu or Menu_item>  menu_object;
    void                 (*destroy_proc)();
```

Your destroy procedure should be of the form:

```
void
destroy_proc(menu_object, type)
    <Menu or Menu_item>  menu_object;
    Menu_attribute       type;
```

For menus, menu_object is the menu and the type parameter is MENU_MENU; for menu items, menu_object is the item and the type parameter is MENU_ITEM.

12.6. Searching for a Menu Item

The function menu_find() lets you search through a menu (and its children) to find a menu item meeting certain criteria:

```
Menu_item
menu_find(menu, attributes);
    Menu            menu;
    <attribute-list> attributes;
```

For example, the following call searches for the menu item whose string was "Load New File". menu_find() will return itNULLif

```
whose string was "Load New File":
```

By default, menu_find() uses a "deferred" search — searching all the items in a menu before descending into any pull-rights which may be present. By setting MENU_DESCEND_FIRST (which takes no value), you can force a depth-first search.

If multiple attributes are given, menu_find() will find the first item matching all the attributes.

The following attributes are recognized by menu_find():

Table 12-3 *Menu Attributes Recognized by* menu_find()

MENU_ACTION	MENU_INVERT
MENU_CLIENT_DATA	MENU_LEFT_MARGIN
MENU_FEEDBACK	MENU_MARGIN
MENU_FONT	MENU_PARENT
MENU_GEN_PROC	MENU_PULLRIGHT
MENU_GEN_PULLRIGHT	MENU_RIGHT_MARGIN
MENU_IMAGE	MENU_STRING
MENU_INACTIVE	MENU_VALUE

12.7. Callback Procedures

When you call `menu_show()`, the menu package displays the menu, gets a selection from the user, and undisplays the menu. The menu package allows you to specify *callback procedures* which will be called at various points during the invocation of the menu. These let you create and modify menus or respond to the user's actions, on the fly, at the time the user brings up the menu. There are three types of callback procedures: *generate procedures* (so named because they are called before the menu or item is displayed, allowing the application to *generate* or modify the menu on the fly), *notify procedures* (for menus) and *action procedures* (for menu items) which are called after the user has made a selection.

Flow of Control in `menu_show()`

The callback mechanism gives you a great deal of flexibility in creating, combining and modifying menus and menu items. This flexibility comes at the price of some complexity, however. To take advantage of it, it is necessary to understand when the callback procedures are called after you invoke `menu_show()`.

For purposes of explanation, the diagrams below divide the process of displaying a menu and getting the user's selection into two stages, the *display stage* and the *notification stage.*

Figure 12-2 *Display Stage of Menu Processing*

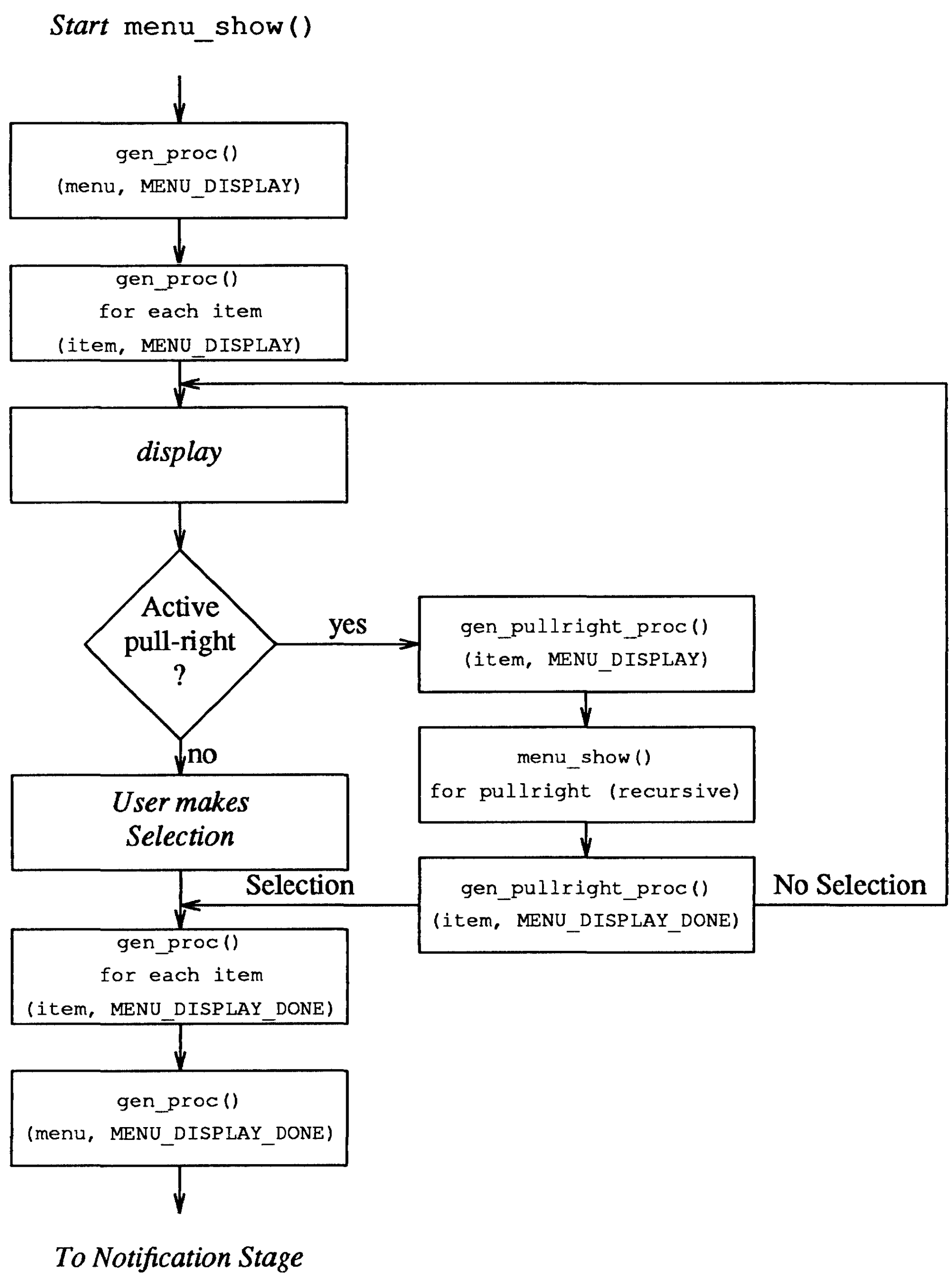
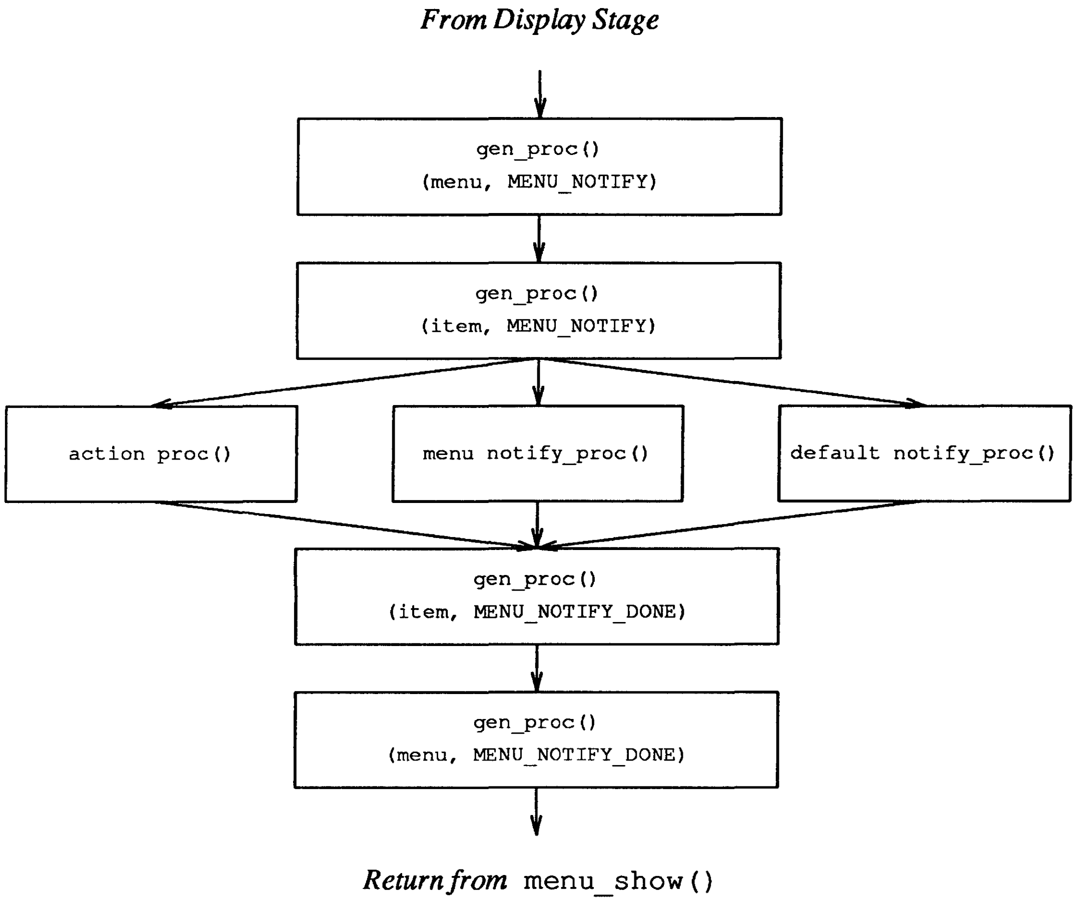


Figure 12-3 *Notification Stage of Menu Processing*



Generate Procedures

The first argument to a generate procedure is either a menu or menu item depending on whether it's a `MENU_GEN_PROC` or a `MENU_GEN_PROC_ITEM`. Also passed in is an *operation* indicating at which point in the processing of the menu the generate procedure is being called. The operation parameter is of type `Menu_generate`, and may be `MENU_DISPLAY`, `MENU_DISPLAY_DONE`, `MENU_NOTIFY` or `MENU_NOTIFY_DONE`.[82]

NOTE *The menu package uses the fullscreen access mechanism when displaying the menu. Writing to the screen while under fullscreen access will probably cause your program to deadlock, so your generate procedure should not access the screen when called with an operation of* `MENU_DISPLAY` *or* `MENU_DISPLAY_DONE`.

[82] For a detailed explanation of when the generate procedures are called in relation to the other callback procedures, see the diagrams in the next subsection, *Flow of Control in* `menu_show()`.

There are three types of generate procedures — *menu item generate procedures*, *menu generate procedures*, and *pull-right generate procedures*. A description and example of each is given below.

Menu Item Generate Procedure

A generate procedure attached to a menu item has the form:

```
Menu_item
menu_item_gen_proc(item, operation)
    Menu_item     item;
    Menu_generate operation;
```

You can specify a menu item generate procedure via MENU_GEN_PROC.

Example 8:

The most common use of menu item generate procedures is to modify the item's display string. The program listed below registers a generate procedure, toggle_proc(). If it has been called from the MENU_DISPLAY stage of processing, it toggles the text of the 'Redisplay' item on the frame menu.

```
#include <suntool/sunview.h>

Menu_item toggle_proc();
int toggle = 0;

main()
{
    Window frame    = window_create(NULL, FRAME, 0);
    Menu menu       = window_get(frame, WIN_MENU);
    Menu_item item = menu_find(menu,
                         MENU_STRING, "Redisplay", 0);

    menu_set(item , MENU_GEN_PROC, toggle_proc, 0);
    window_main_loop(frame);
}

Menu_item
toggle_proc(mi, op)
    Menu_item     mi;
    Menu_generate op;
{
    switch (op) {
        case MENU_DISPLAY:
            if (toggle) {
                menu_set(mi,
                         MENU_STRING, "Redisplay has been seen",
                         0);
            } else {
                menu_set(mi,
                         MENU_STRING, "Redisplay",
                         0);
            }
            toggle = !toggle;
            break;

        case MENU_DISPLAY_DONE:
        case MENU_NOTIFY:
```

```
        case MENU_NOTIFY_DONE:
            break;
    }
    return mi;  /* item handle always returned */
}
```

The 'Zoom'/'Unzoom' item in the SunView frame menu also uses this technique to toggle its display string. Note that since this item knows how to modify itself, you could put it in other menus and get the same behavior. A generate procedure for a menu item allows the application to be called even when it has no knowledge of or control over the call to `menu_show()`.

Menu Generate Procedure

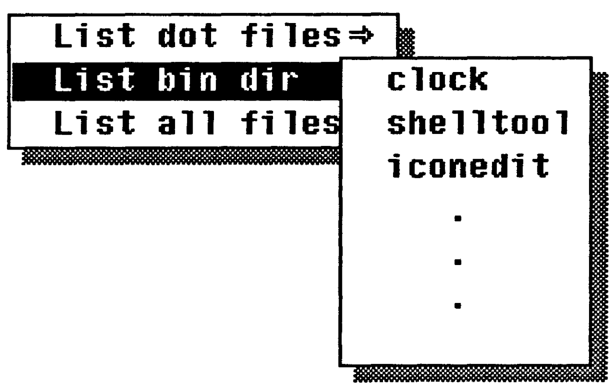
A generate procedure attached to a menu has the form:

```
Menu
menu_gen_proc(m, operation)
    Menu          m;
    Menu_generate operation;
```

You can specify a menu generate procedure via the attribute `MENU_GEN_PROC`.

Example 9:

We will take as an example a menu allowing the user to list different groups of files. When the user makes a selection, we generate a menu containing the correct set of files:



The relevant functions are listed on the next page. The first, `initialize_menu()`, creates the three menu items, giving each of them the generate procedure `list_files()`, and a unique identifier as `MENU_CLIENT_DATA`.

Remember that `list_files()` is called in four different situations by `menu_show()`:[83]

- When the `operation` is `MENU_DISPLAY`, the pull-right is being asked to display its menu, so `list_files()` calls the function `get_file_names()` (not shown) to get the appropriate list of file names,

[83] See the diagrams in the earlier subsection, *Flow of Control in* `menu_show()`.

and adds each name in the list to the menu.

- When `list_files()` is called with `operation` set to `MENU_DISPLAY_DONE`, the menu of generated file names is no longer being displayed. `list_files()` cleans up by destroying the old menu of file names, replacing it with a fresh menu with the same generate procedure. It returns the handle of this new menu.

- When `list_files()` is called with an `operation` of `MENU_NOTIFY` or `MENU_NOTIFY_DONE`, the menu is returned unaltered.

```
#define DOT  0
#define BIN  1
#define ALL  2

static void
initialize_menu(menu)
    Menu  menu;
{
    m = menu_create(MENU_GEN_PROC,    list_files,
                    MENU_CLIENT_DATA, DOT,
                    0);
    menu_set(menu,
             MENU_PULLRIGHT_ITEM, "List dot files", m,
             0);
    m = menu_create(MENU_GEN_PROC,    list_files,
                    MENU_CLIENT_DATA, BIN,
                    0);
    menu_set(menu,
             MENU_PULLRIGHT_ITEM, "List bin dir", m,
             0);
    m = menu_create(MENU_GEN_PROC,    list_files,
                    MENU_CLIENT_DATA, ALL,
                    0);
    menu_set(menu,
             MENU_PULLRIGHT_ITEM, "List all files", m,
             0);
}

static Menu
list_files(m, operation)
    Menu          m;
    Menu_generate operation;
{
    char **list;
    int    directory;
    int    i = 0;

    switch (operation) {
      case MENU_DISPLAY:
        directory = (int)menu_get(m, MENU_CLIENT_DATA);
        list = get_file_names(directory);
        while (*list)
            menu_set(m,
                     MENU_STRING_ITEM, *list++, i++,
                     0);
        break;
```

```
            case MENU_DISPLAY_DONE:
              /*
               * Destroy old menu and all its entries.
               * Replace it with a new menu.
               */
              directory = (int)menu_get(m, MENU_CLIENT_DATA);
              menu_destroy(m);
              m = menu_create(MENU_GEN_PROC,     list_files,
                              MENU_CLIENT_DATA, directory,
                              0);
              break;

            case MENU_NOTIFY:
            case MENU_NOTIFY_DONE:
              break;
          }

          /* The current or newly-created menu is returned */
          return m;
      }
```

Pull-right Generate Procedure

You can postpone the generation of a pull-right menu until the user actually pulls right by specifying a pull-right generate procedure. A pull-right generate procedure has the form:

```
Menu
pullright_gen_proc(mi, operation)
     Menu_item     mi;
     Menu_generate operation;
```

Note that the pull-right generate procedure is passed the item, and returns the menu to be displayed.

You can specify a menu item's pull-right generate procedure with a call such as

```
menu_set(menu_item, MENU_GEN_PULLRIGHT, my_pullright_gen, 0);
```

Alternatively, you can use the attributes `MENU_GEN_PULLRIGHT_IMAGE` or `MENU_GEN_PULLRIGHT_ITEM` to give a menu both an item and the item's generate procedure.

If you want to get the existing menu for an item which has a pull-right generate procedure, retrieve the value of the item, as in:

```
menu = menu_get(item, MENU_VALUE);
```

Notify/Action Procedures

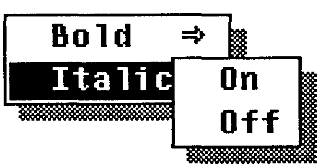
When the user selects a menu item by releasing the mouse button, the menu package calls back to any notify procedures or action procedures you have specified. Notify procedures and action procedures have the form:

```
caddr_t
notify_proc(m, mi)
    Menu      m;
    Menu_item mi;
```

The most common usage is to have action procedures for the items at the leaf nodes of the walking menu. The general mechanism described below is provided to allow your procedures to be called for non-leaf nodes as well.

Imagine a chain of menus expanded out. Lookup of the notify/action procedures starts with the "oldest" menu, the one passed to `menu_show()`. If it has a notify procedure, that notify procedure is called, otherwise the default notify procedure, `menu_return_value()`, is called. Likewise, for each menu down the chain, until the menu with the selected item is reached. If the selected item has an action procedure, that action procedure is called. If the selected item is not on a leaf node, then action procedures for any items farther down the chain are also called.

Let's see what happens in the example to the left (assume that 'On' is the default item for the first menu):



If 'Italic' was selected:

- *no* callback to the first menu's notify procedure since an item in it is selected,
- callback to the action procedure for the 'Italic' item,
- *no* callback to the second menu's notify procedure since it is further down the chain than the selected item,
- callback to the action procedure for the 'On' item.

If 'Off' was selected:

- callback to the notify procedure for the first menu, since an item in a menu further down the chain than it is selected,
- *no* callback to the action procedure for the 'Italic' item, since it is above the selected item in the chain,
- *no* callback to the second menu's notify procedure since an item in it is selected,
- callback to the action procedure for the 'Off' item.

NOTE *If you specify a notify procedure, it is your responsibility to propagate the notification to any menus further down in the chain.* You can do this by calling `menu_get(mi, MENU_VALUE)` from your notify procedure. This gets the value of the selected menu item, and since the value of a pull-right item is the value of its pull-right menu, this will make notify/action procedures further down the chain get called.

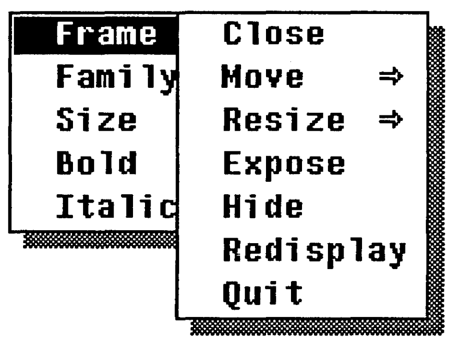
12.8. Interaction with Previously Defined SunView Menus

Walking Menus for frames and tty subwindows can be customized.[84] All menu items in these menus are "position-independent" — in other words the menus do not count on a given item having a certain position or being located in a particular menu. This makes it possible for you to safely add new items (including pull-right submenus) to an existing menu.

NOTE You should not use the client data field of items created by SunView packages, because the packages have pre-empted it for their own use.

Using an Existing Menu as a Pull-right

The program *font_menu*, listed in Appendix A, shows how you can replace an existing menu with your own menu which has the original menu as a pull-right. Making use of several of the examples given earlier in the chapter, it creates a font menu which allows the user to select the font family, point size, and whether or not the font is bold or italic. Meanwhile, the first item, labelled 'Frame', brings up the original frame menu:



[84] Remember that in order to have these packages use walking menus the user must have enabled the *Walking_Menus* option in *SunView* category of `defaultsedit(1)`; in SunOS Release 4.0, this is the default.

12.9. Initial and Default Selections

Two special menu items are the *default item* (MENU_DEFAULT_ITEM) and the *selected item* (MENU_SELECTED_ITEM). The default item is simply a distinguished item. The selected item is the item which was last selected.

Two attributes are provided to control the behavior of a menu in regard to its initial selection. If MENU_INITIAL_SELECTION_SELECTED is TRUE, the menu comes up with its initial selection selected — that is the selection is inverted and the cursor is positioned over it. If FALSE, the menu comes up with the cursor "standing off" to the left and no selection highlighted. If MENU_INITIAL_SELECTION_EXPANDED is TRUE, when the menu comes up, it automatically expands any pull-rights which are necessary to bring the initial selection up on the screen.

Each menu also has an *initial selection* (MENU_INITIAL_SELECTION) and a *default selection.* (MENU_DEFAULT_SELECTION).

The distinction between the initial selection and the default selection is subtle. Suppose MENU_INITIAL_SELECTION_EXPANDED was TRUE, and the initial selection was an item in a pull-right. When the menu comes up, it will be expanded to show the initial item as selected. However, if the user moves the cursor to the left, backing out of the pull-right, and then moves back to the right, bringing the pull-right up again, the item selected will be the default selection rather than the initial selection.

When the user selects a pull-right item without bringing up the associated menu, it is as if he had brought the pull-right up and selected the default item.

You can set the initial selection and the default selection independently — either can be set to the default item or the selected item.

12.10. User Customizable Attributes

The user can specify the values of certain menu attributes in the *Menu* category of `defaultsedit(1)`. When a menu is created, for attributes not explicitly specified by the application program, the menu package retrieves the values set by the user from the defaults database maintained by `defaultsedit`. This allows the user the ability to tailor, to some extent, the appearance and behavior of menus across different applications. For example, he may want to change the type of shadow, or expand the menu margin, and so on.

The attributes under `defaultsedit` control are listed in the following table.

Table 12-4 *User Customizable Menu Attributes*

Attribute	*Default*	*Description*
MENU_BOXED	FALSE	If TRUE, a single-pixel box will be drawn around each menu item.
MENU_DEFAULT_SELECTION	MENU_DEFAULT	MENU_SELECTED or MENU_DEFAULT.
MENU_FONT	screen.b.12	Menu's font.
MENU_INITIAL_SELECTION	MENU_DEFAULT	MENU_SELECTED or MENU_DEFAULT.
MENU_INITIAL_SELECTION_SELECTED	FALSE	If TRUE, menu comes up with its initial selection highlighted. If FALSE, menu comes up with the cursor "standing off" to the left.
MENU_INITIAL_SELECTION_EXPANDED	TRUE	If TRUE, when the menu pops up, it automatically expands to select the initial selection.
MENU_JUMP_AFTER_NO_SELECTION	FALSE	If TRUE, cursor jumps back to its original position after no selection made.
MENU_JUMP_AFTER_SELECTION	FALSE	If TRUE, cursor jumps back to its original position after selection made.
MENU_MARGIN	1	The margin around each item.
MENU_LEFT_MARGIN	16	For each string item, margin in addition to MENU_MARGIN on left between menu's border and text.
MENU_PULLRIGHT_DELTA	9999	# of pixels the user must move the cursor to the right to cause a pull-right menu to pop up.
MENU_RIGHT_MARGIN	6	For each string item, margin in addition to MENU_MARGIN on right between menu's border and text.
MENU_SHADOW	50% grey	Pattern for menu's shadow.

13

Cursors

13

Cursors

This chapter describes how to create and manipulate *cursors*.[85] A cursor is an image that tracks the mouse on the display. Each window in SunView has its own cursor, which you can change with the cursor package.

If it is installed on your system, you can run the demo `/usr/demo/cursor_demo` to see the effects of various cursor attributes. The source for this is in `/usr/src/share/sun/suntool/cursor_demo.c`.

Header Files

The definitions necessary to use cursors are found in the include file `<sunwindow/win_cursor.h>`, which is included by default when you include the file `<suntool/sunview.h>`.

Summary Listing and Tables

To give you a feeling for what you can do with cursors, the following page contains a list of the available cursor attributes and functions. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the cursor summary tables in Chapter 19, *SunView Interface Summary*:

- the *Cursor Attributes* table begins on page 321;
- the *Cursor Functions* table begins on page 323.

[85] The cursor is called the "pointer" in user-level documentation.

Cursor Attributes	
CURSOR_CROSSHAIR_BORDER_GRAVITY	CURSOR_OP
CURSOR_CROSSHAIR_COLOR	CURSOR_SHOW_CROSSHAIRS
CURSOR_CROSSHAIR_GAP	CURSOR_SHOW_CURSOR
CURSOR_CROSSHAIR_LENGTH	CURSOR_SHOW_HORIZ_HAIR
CURSOR_CROSSHAIR_OP	CURSOR_SHOW_VERT_HAIR
CURSOR_CROSSHAIR_THICKNESS	CURSOR_VERT_HAIR_BORDER_GRAVITY
CURSOR_FULLSCREEN	CURSOR_VERT_HAIR_COLOR
CURSOR_HORIZ_HAIR_BORDER_GRAVITY	CURSOR_VERT_HAIR_GAP
CURSOR_HORIZ_HAIR_COLOR	CURSOR_VERT_HAIR_LENGTH
CURSOR_HORIZ_HAIR_GAP	CURSOR_VERT_HAIR_OP
CURSOR_HORIZ_HAIR_LENGTH	CURSOR_VERT_HAIR_THICKNESS
CURSOR_HORIZ_HAIR_OP	CURSOR_XHOT
CURSOR_HORIZ_HAIR_THICKNESS	CURSOR_YHOT
CURSOR_IMAGE	

Cursor Functions	
cursor_copy(src_cursor)	cursor_get(cursor, attribute)
cursor_create(attributes)	cursor_set(cursor, attributes)
cursor_destroy(cursor)	

13.1. Creating and Modifying Cursors

The basic usage of the cursor package is to first create a cursor with `cursor_create()`, and then use this cursor as the value of the `WIN_CURSOR` attribute in your call to `window_create()`.

```
Cursor
cursor_create(attributes)
    <attribute-list> attributes;
```

Once you have created a cursor, you can alter its attributes with `cursor_set()` and read back its attributes with `cursor_get()`:

```
void
cursor_set(cursor, attributes)
    Cursor cursor;
    <attribute-list> attributes;

caddr_t
cursor_get(cursor, attribute)
    Cursor cursor;
    Cursor_attribute attribute;
```

If you want to change the cursor of a window that has already been created, you can first get the cursor from the window using `window_get()` of `WIN_CURSOR`, then use `cursor_set()` to change the cursor, and then use `window_set()` of `WIN_CURSOR` to re-attach the cursor to the window.

13.2. Copying and Destroying Cursors

A copy of an existing cursor can be made with `cursor_copy()`:

```
Cursor
cursor_copy(src_cursor)
    Cursor src_cursor;
```

A cursor can be destroyed and its resources freed with `cursor_destroy()`:

```
void
cursor_destroy(cursor)
    Cursor cursor;
```

Example 1: Creating a Window with a Custom Cursor

A common use for cursors might be to create a canvas subwindow and have it use the cursor of your choice, rather than the default arrow cursor:

```
short my_pixrect_data[] = {
#include "file_from_iconedit"
};
mpr_static(my_pixrect, 16, 16, 1, my_pixrect_data);

Canvas canvas;

init_my_canvas()
{
    canvas = window_create(frame, CANVAS,
         WIN_CURSOR, cursor_create(CURSOR_IMAGE, &my_pixrect,
                                  0),
         0);
}
```

This example creates a cursor "on the fly" and passes it into the `window_create()` routine for use with the canvas. The attribute `CURSOR_IMAGE` is set to the a pointer to the pixrect we want to use (a diamond or bullseye, for example). All of the other cursor attributes default to the value shown in the attribute table.

Example 2: Changing the Cursor of an Existing Window

Suppose you have already created a window and you want to change its cursor. Let's say you want to change the drawing op to `PIX_SRC`:

```
Cursor  cursor;

cursor = window_get(my_window, WIN_CURSOR);
cursor_set(cursor, CURSOR_OP, PIX_SRC, 0);
window_set(my_window, WIN_CURSOR, cursor, 0);
```

CAUTION

The cursor returned by `window_get()` is a pointer to a static cursor that is shared by all the windows in your application. So, for example, saving the cursor returned by `window_get()` and then making other window system calls might result in the saved cursor being overwritten.[86]

It is safe to get the cursor, modify it with `cursor_set()` and then put the cursor back. If there is any chance that the static cursor will be overwritten, you should use `cursor_copy()` to make a copy of the cursor, then use `cursor_destroy()` when you are done.

13.3. Crosshairs

Crosshairs are horizontal and vertical lines whose intersection tracks the location of the mouse. You can control the appearance of both the horizontal and vertical crosshairs along with the cursor image. For example, you can create a cursor that only shows the cursor image, or only the horizontal crosshair, or both the horizontal and vertical crosshairs and the cursor image. By default both the crosshairs are turned off and only the cursor image is displayed.

[86] Note that this would happen if one of the routines you call happens to call `window_get()` of `WIN_CURSOR`.

Example 3: Turning on the Crosshairs

Suppose you have a canvas window in which you want to turn on both the horizontal and vertical crosshairs. This can be done by getting the cursor from the window and setting the CURSOR_SHOW_CROSSHAIRS attribute:

```
Cursor  cursor;

cursor = window_get(my_canvas, WIN_CURSOR);
cursor_set(cursor, CURSOR_SHOW_CROSSHAIRS, TRUE, 0);
window_set(my_canvas, WIN_CURSOR, cursor, 0);
```

When the crosshairs are turned on, they are displayed according to the current value of their other attributes (e.g. thickness and drawing op).

13.4. Some Cursor Attributes

This section describes some of the cursor attributes in more detail. Note that for the crosshair attributes, you can control the individual crosshairs as well as both crosshairs by using the appropriate attribute. For example, you can set the length for both crosshairs with CURSOR_CROSSHAIR_LENGTH or the length of only the horizontal crosshair with CURSOR_HORIZ_HAIR_LENGTH.

CURSOR_IMAGE

The cursor image is the memory pixrect that is drawn on the screen as the mouse moves. Use the mpr_static() macro, as shown in Example 1, to create the memory pixrect. The image is represented as an array of 16 shorts, each of which represents a 16-pixel wide scan line. The scan lines are usually arranged in a single column, yielding a 16 x 16 pixel image. Other arrangements, such as 32 pixels wide x 8 pixels deep, are also possible. The maximum size of a cursor in SunView 1 is 32 bytes; the minimum width is 16, the width of one scan line.

CURSOR_XHOT and CURSOR_YHOT

The "hot spot" defined by (CURSOR_XHOT, CURSOR_YHOT) associates the cursor image, which has height and width, with the mouse position, which is a single point on the screen. The hot spot gives the mouse position an offset from the upper-left corner of the cursor image. For example, if the upper left corner of the cursor image is at location (50, 40) and the cursor hot spot has been set to (8, 8), the reported mouse position will be at (58, 48).

Most cursors have a hot spot whose position is obvious from the image shape: the tip of an arrow, the center of a bullseye, the center of a cross-hair. Cursors can also be used to give status feedback — an hourglass to indicate that the program is not responding to user input is a typical example. This type of cursor should have the hot spot located in the middle of its image so the user has a definite spot for pointing and does not have to guess where the hot spot is.

CURSOR_OP

The value given for this attribute is the rasterop which will be used to paint the cursor.[87] PIX_SRC | PIX_DST is generally effective on light backgrounds — in text, for example — but invisible over solid black. PIX_SRC ^ PIX_DST is a reasonable compromise over many different backgrounds, although it does poorly over a gray pattern.

[87] Rasterops are described fully in the *Pixrect Reference Manual*.

CURSOR_FULLSCREEN

The cursor crosshairs can be clipped to either the cursor's window or the entire screen. If you want the crosshairs to extend past the edge of the window, set CURSOR_FULLSCREEN to TRUE.

CURSOR_CROSSHAIR_LENGTH

If you don't want the crosshairs to cover the entire window (or screen), you can set the length of both crosshairs with CURSOR_CROSSHAIR_LENGTH. The value of this attribute is actually half the total crosshair length. For example, if you want the crosshairs to be 400 pixels wide and high, set the CURSOR_CROSSHAIR_LENGTH to 200. You can restore the extend-to-edge length by giving a value of CURSOR_TO_EDGE for CURSOR_CROSSHAIR_LENGTH.

CURSOR_CROSSHAIR_BORDER_GRAVITY

If the crosshair border gravity is enabled, the crosshairs will "stick" to the edge of the window (or screen). This is only interesting if the CURSOR_CROSSHAIR_LENGTH is not set to CURSOR_TO_EDGE. With border gravity turned on, each half of each crosshair will be attached to the edge of the window. With the cursor image displayed, this feature might be useful to help the user line up the cursor to a grid drawn on the edges of the window.

CURSOR_CROSSHAIR_GAP

If you don't want the halves of each crosshair to touch, you can set the CURSOR_CROSSHAIR_GAP to the half-length of space to leave between each crosshair half. If you set CURSOR_CROSSHAIR_GAP to CURSOR_TO_EDGE, the crosshairs will back off to the edge of the CURSOR_IMAGE rectangle.

14

Icons

14

Icons

An *icon* is a small (usually 64 by 64 pixel) picture representing a base frame in its closed state. The icon is typically a picture indicating the function of the underlying application.

Header Files

The definitions necessary to use icons are found in the file `<suntool/icon.h>`, which is included by default when you include the file `<suntool/sunview.h>`.

Summary Listing and Tables

To give you a feeling for what you can do with icons, the following page lists the available icon attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the menu summary tables in Chapter 19, *SunView Interface Summary*:

- the *Icon Attributes* table begins on page 328;
- the *Icon Functions and Macros* table begins on page 329.

Icon Attributes		
ICON_FONT	ICON_IMAGE_RECT	ICON_WIDTH
ICON_HEIGHT	ICON_LABEL	
ICON_IMAGE	ICON_LABEL_RECT	

Icon Functions and Attributes	
icon_create(attributes)	icon_set(icon, attributes)
icon_destroy(icon)	DEFINE_ICON_FROM_IMAGE(name, image)
icon_get(icon, attribute)	

14.1. Using Images Generated With iconedit

You can create and edit images easily using the program iconedit(1). The output of iconedit is a file containing an array of shorts representing the image. In order to use the image in a program, you must first define a static memory pixrect containing this data. The mpr_static() macro is provided for this purpose.

The first argument to mpr_static() is the name of the pixrect to be defined. Next come the width, height and depth of the image, typically 64, 64 and 1. The last argument is the array of shorts containing the bit pattern of the icon image. For example:

```
static short icon_image[] = {
#include "file_generated_by_iconedit"
};
mpr_static(icon_pixrect, 64, 64, 1, icon_image);
```

The statically defined image is passed in to icon_create() at run time:

```
my_icon = icon_create(ICON_IMAGE, &icon_pixrect, 0);
```

Once you have created an icon, you can retrieve and modify its attributes with icon_get() and icon_set(), and destroy it with icon_destroy().

Instead of creating the icon dynamically with icon_create(), you can use the DEFINE_ICON_FROM_IMAGE() macro to generate a static icon.[88]

```
static short icon_image[] = {
#include "file_generated_by_iconedit"
};
DEFINE_ICON_FROM_IMAGE(icon, icon_image);
```

This macro statically allocates a structure representing an icon. Note that you

[88] The structure generated is actually an extern.

must pass the *address* of this structure — `&icon` in the example above — into `icon_get()`, `icon_set()`, and `icon_destroy()`.

WARNING ***The*** `DEFINE_ICON_FROM_IMAGE()` ***macro may not be supported in future releases. We reccommend that you use*** `icon_create()` ***instead.***

14.2. Modifying the Icon's Image

It is often useful to change the icon's image dynamically, rather than simply using the icon as a static placeholder. When *mailtool* receives new mail, for example, it lets the user know by modifying its icon to show a letter arrived in the mailbox. `clocktool` uses its icon to represent a moving clock face.

The steps to follow in modifying an icon's image are:

- get the frame's icon (attribute `FRAME_ICON`);
- get the icon's pixrect (attribute `ICON_IMAGE`);
- modify the pixrect as desired, or substitute a new pixrect;
- give the pixrect with the new image back to the icon;
- give the new icon back to the frame.

For example:

```
modify_icon(frame);
    Frame frame;

    Icon icon;
    Pixrect *pr;

    icon = (Icon) window_get(frame, FRAME_ICON);
    pr = (Pixrect *) icon_get(icon, ICON_IMAGE);
    ...
    (modify pr)
    ...
    icon_set(icon, ICON_IMAGE, pr, 0);
    window_set(frame, FRAME_ICON, icon, 0);
}
```

14.3. Loading Icon Images At Run Time

Often it is sufficient to define the image for a program's icon at compile time, with `mpr_static()`. However, you may want to allow the user to create his own icon images, and give the names of the files containing the images to your program as command-line arguments. Then you can load the images from the files the user has specified. Routines to load icon images from files at run time are described in Chapter 11 of the *SunView 1 System Programmer's Guide*.

15

Scrollbars

15

Scrollbars

The canvas, text and panel subwindows have been designed to work with scrollbars. The text subwindow automatically creates its own vertical scrollbar. For canvases and panels, it is your responsibility to create the scrollbar and pass it in with the attributes `WIN_VERTICAL_SCROLLBAR` or `WIN_HORIZONTAL_SCROLLBAR`.

Section 15.2, *Scrollbar User Interface*, describes how the user interacts with scrollbars. Basic scrollbar usage is covered in Section 15.3, *Creating, Destroying and Modifying Scrollbars*, and programmatic scrolling is covered in Section 15.4, *Programmatic Scrolling*.

You may want to use scrollbars in an application not based on canvases, text subwindows or panels, in which case you must manage the interaction with the scrollbar directly. For an explanation of how to do this, see the *Scrollbars* chapter in the *SunView 1 System Programmer's Guide*.

Header Files

The definitions necessary to use scrollbars are found in the header file `<suntool/scrollbar.h>`

Summary Listing and Tables

To give you a feeling for what you can do with scrollbars, the following page contains a list of the available scrollbar attributes, functions and macros. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the scrollbar summary tables in Chapter 19, *SunView Interface Summary*:

- the *Scrollbar Attributes* table begins on page 362;
- the *Scrollbar Functions* table begins on page 365.

Scrollbar Attributes	
SCROLL_ABSOLUTE_CURSOR	SCROLL_NOTIFY_CLIENT
SCROLL_ACTIVE_CURSOR	SCROLL_NORMALIZE
SCROLL_ADVANCED_MODE	SCROLL_OBJECT
SCROLL_BACKWARD_CURSOR	SCROLL_OBJECT_LENGTH
SCROLL_BAR_COLOR	SCROLL_PAGE_BUTTONS
SCROLL_BAR_DISPLAY_LEVEL	SCROLL_PAGE_BUTTON_LENGTH
SCROLL_BORDER	SCROLL_PAINT_BUTTONS_PROC
SCROLL_BUBBLE_COLOR	SCROLL_PIXWIN
SCROLL_BUBBLE_DISPLAY_LEVEL	SCROLL_PLACEMENT
SCROLL_BUBBLE_MARGIN	SCROLL_RECT
SCROLL_DIRECTION	SCROLL_REPEAT_TIME
SCROLL_END_POINT_AREA	SCROLL_REQUEST_MOTION
SCROLL_FORWARD_CURSOR	SCROLL_REQUEST_OFFSET
SCROLL_GAP	SCROLL_THICKNESS
SCROLL_HEIGHT	SCROLL_TO_GRID
SCROLL_LAST_VIEW_START	SCROLL_TOP
SCROLL_LEFT	SCROLL_VIEW_LENGTH
SCROLL_LINE_HEIGHT	SCROLL_VIEW_START
SCROLL_MARGIN	SCROLL_WIDTH
SCROLL_MARK	

Scrollbar Functions and Macros	
scrollbar_create(attributes)	scrollbar_paint(scrollbar)
scrollbar_destroy(scrollbar)	scrollbar_paint_clear(scrollbar)
scrollbar_get(scrollbar, attribute)	scrollbar_clear_bubble(scrollbar)
scrollbar_set(scrollbar, attributes)	scrollbar_paint_bubble(scrollbar)
scrollbar_scroll_to(scrollbar, new_view_start)	

15.1. Scrolling Model

Scrollbars allow the user to control which portion of an object is visible when the object is larger than the window it is displayed in. Within the scrollbar is a darker area called the *bubble*. The size and position of the bubble within the bar tell the user where he is in the object and how much of the object is visible. By moving the bubble within the bar, the user brings different portions of the object into view.

The length of the object, the length of the visible portion of the object, and the offset of the visible portion within the object are given by the attributes `SCROLL_OBJECT_LENGTH`, `SCROLL_VIEW_LENGTH`, and `SCROLL_VIEW_START`. The relationship between these three view-space metrics is shown in the figure on the next page.

Figure 15-1 *Scrolling Model*

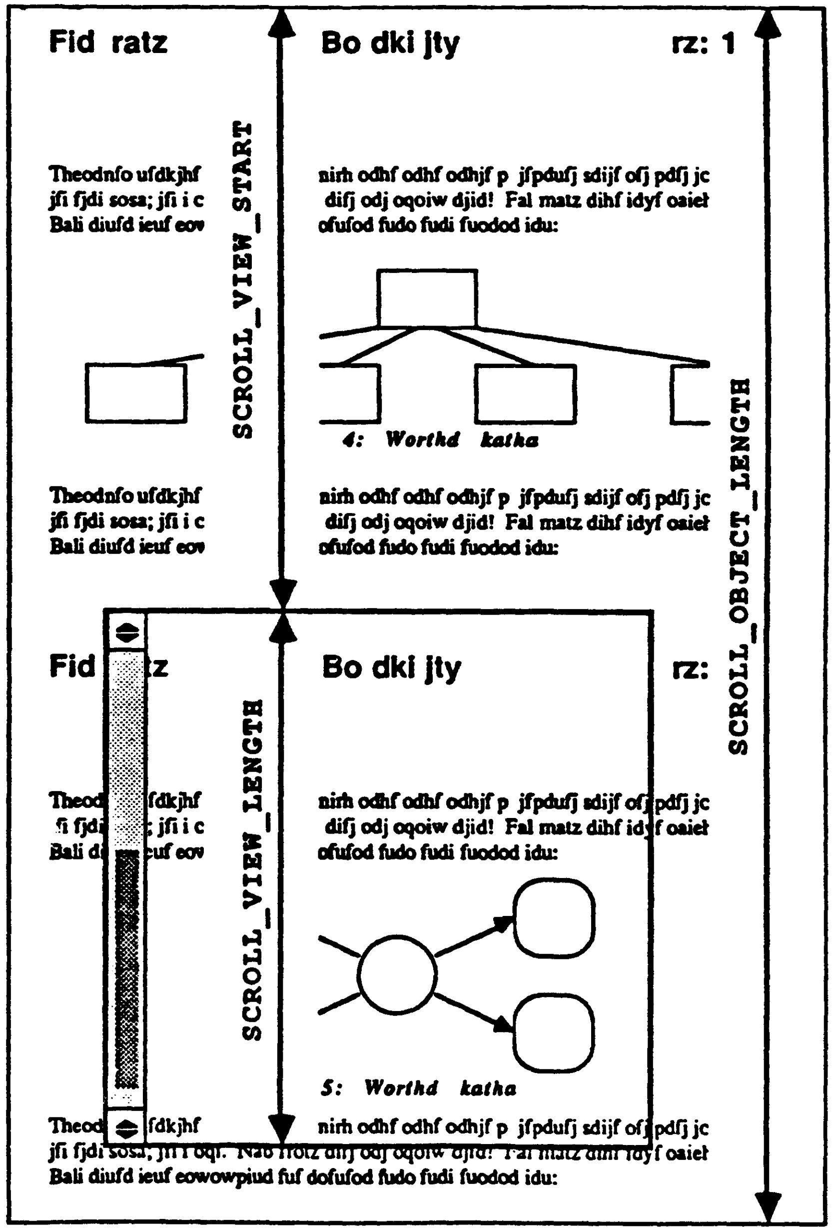


Figure 15-1 shows a two-page document being viewed within a window roughly half the size of the document. The three view-space attributes `SCROLL_OBJECT_LENGTH`, `SCROLL_VIEW_LENGTH`, and `SCROLL_VIEW_START` are shown superimposed on the document. Note the relative size and position of the bubble within the scrollbar — it is roughly half the size of the window and positioned near the bottom.

15.2. Scrollbar User Interface

Types of Scrolling Motion

The default scrollbar is vertical, with *page buttons* at the top and bottom. To scroll, the user moves the cursor into the scrollbar (either the bar itself or one of the page buttons) and clicks one of the mouse buttons. The following table describes the available scrolling actions and how they are generated:

Table 15-1 *Scrolling Motions*

Mouse Button	*Cursor Location*	*Scrolling Action*
LEFT	page button	Line forward
RIGHT	page button	Line backward
MIDDLE	page button	Page forward
MIDDLE (shifted)	page button	Page backward
LEFT	bar	Line opposite cursor goes to top
RIGHT	bar	Top line comes to cursor
LEFT (shifted)	bar	Bottom line comes to cursor
RIGHT (shifted)	bar	Line opposite cursor goes to bottom
MIDDLE	bar	The line whose offset into the scrolling object approximates that of the cursor into the scrollbar is positioned at top ("thumbing").

Holding the button down within the scrollbar causes the cursor to change, previewing the scrolling action for that button. Releasing the button causes the scrolling action to be performed, or, if the user holds down the mouse button, the scrolling motion will start in repeating mode.

Undoing a Scroll

Shift-MIDDLE mouse button positions the viewing window to the most recent position which was left by an absolute motion (thumbing or undoing). The undoing position is initialized to the beginning of the scrollable object.

15.3. Creating, Destroying and Modifying Scrollbars

Scrollbars are created and destroyed with `scrollbar_create()` and `scrollbar_destroy()`. To take the simplest possible example, you get a default scrollbar (vertical, on the left edge of the subwindow, etc.) by calling:

```
Scrollbar bar;

bar = scrollbar_create(0);
```

You would destroy the scrollbar with the call:

```
scrollbar_destroy(bar);
```

The appearance and behavior of a given scrollbar is determined by the values of its attributes. Here's an example of a non-default scrollbar:

```
bar_1 = scrollbar_create(
          SCROLL_PLACEMENT,             SCROLL_EAST,
          SCROLL_BUBBLE_COLOR,          SCROLL_BLACK,
          SCROLL_BAR_DISPLAY_LEVEL,     SCROLL_ACTIVE,
          SCROLL_BUBBLE_DISPLAY_LEVEL,  SCROLL_ACTIVE,
          SCROLL_DIRECTION,             SCROLL_VERTICAL,
          SCROLL_THICKNESS,             20,
          SCROLL_BUBBLE_MARGIN,         4,
          0),
```

In the above call, setting `SCROLL_PLACEMENT` to `SCROLL_EAST` will cause the scrollbar to appear on the right edge of the subwindow. The scrollbar will be 20 pixels wide with a black bubble 4 pixels from each edge of the bar. The bar and bubble will be shown only when the cursor is in the scrollbar.

You can modify and retrieve the attributes of a scrollbar with the two routines:

```
scrollbar_set(scrollbar, attributes)
    Scrollbar  scrollbar;
    <attribute-list> attributes;

caddr_t
scrollbar_get(scrollbar, attribute)
    Scrollbar           scrollbar;
    Scrollbar_attribute attributes;
```

If the `scrollbar` parameter is `NULL`, `scrollbar_get()` returns 0.

`SCROLL_RECT`, `SCROLL_THICKNESS`, `SCROLL_HEIGHT` and `SCROLL_WIDTH` do not have valid values until the scrollbar is passed into the subwindow. As a work-around for this problem, the special symbol `SCROLLBAR` has been provided. You can determine the default thickness of a scrollbar before it has been attached to a subwindow with the call:

```
thickness = (int) scrollbar_get(SCROLLBAR, SCROLL_THICKNESS);
```

This convention is currently only implemented for SCROLL_THICKNESS.

If you set the SCROLL_THICKNESS attribute then you must also set the SCROLL_DIRECTION of the scrollbar, since the dimension of the scrollbar that is altered by SCROLL_THICKNESS depends on the orientation of the scrollbar.

The figures on the next page show some of the attributes controlling the visual appearance of a scrollbar.[89] Figure 15-2 illustrates the attributes that control the scrollbar appearance. Figure 15-3 illustrates the attributes that control the scrollbar placement.

[89] For a complete list of the scrollbar attributes see the *Scrollbar Attributes* table in Chapter 19, *SunView Interface Summary*.

Figure 15-2 *Attributes Controlling Scrollbar Appearance*

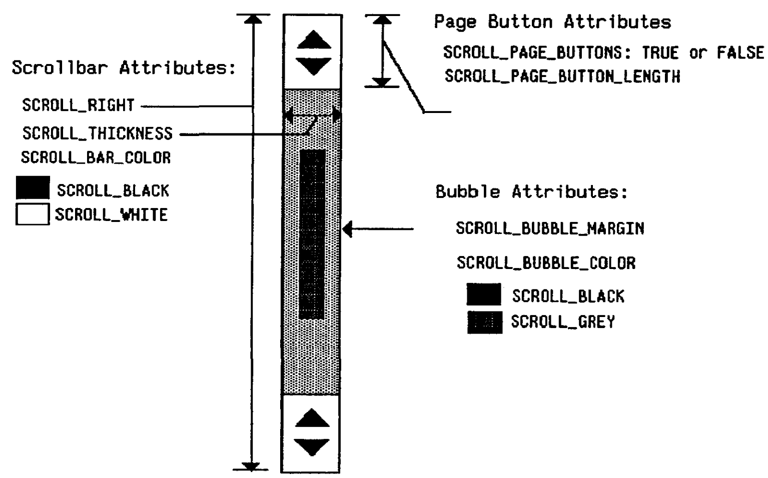
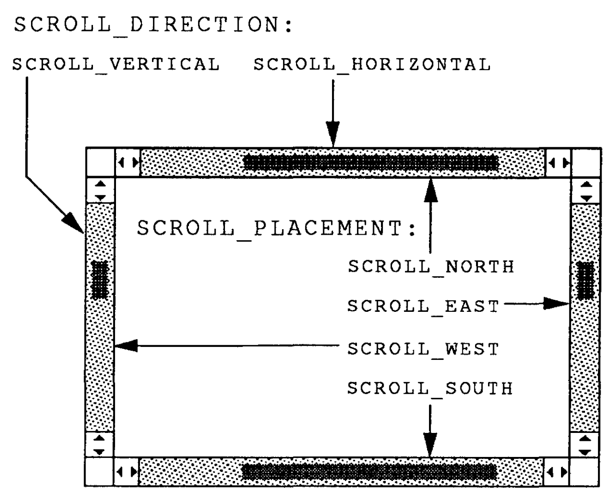


Figure 15-3 *Scrollbar Placement Attributes*



15.4. Programmatic Scrolling

To scroll to a given location from your program, call:

```
scrollbar_scroll_to(scrollbar, new_view_start)
    Scrollbar scrollbar;
    long      new_view_start;
```

This routine saves the current value of SCROLL_VIEW_START as SCROLL_LAST_VIEW_START, sets SCROLL_VIEW_START to the value passed in as new_view_start, and posts a scroll event to the scrollbar's client (i.e. the canvas, panel or text subwindow) using the Notifier. This has the same effect as if the user had requested a scroll to new_view_start.

16

The Selection Service

16

The Selection Service

The Selection Service provides for flexible communication among window applications. You can use the Selection Service to query and manipulate the selections the user has made.

This chapter gives only the simplest example of using the Selection Service. To find out more about the Selection Service and the other functionality it provides, refer to Chapter 9 of the *SunView 1 System Programmer's Guide*.

The definitions necessary to use the Selection Service are found in the include file `<suntool/seln.h>`.

16.1. Getting the Primary Selection

The primary selection is the selection made by the user without holding down any of the function keys, and is indicated with reverse-video highlighting on the screen.

The routine below is taken from the program *filer*, listed in Appendix A. It retrieves the primary selection by first asking the Selection Service which window has the primary selection, then asking that window for the characters that are in the selection, saving them in a static buffer, and returning a pointer to that buffer:

```
#define <suntool/seln.h>

#define MAX_FILENAME_LEN 256

char *
get_selection()
{
    static char   filename[MAX_FILENAME_LEN];
    Seln_holder   holder;
    Seln_request  *buffer;

    holder = seln_inquire(SELN_PRIMARY);
    buffer = seln_ask(&holder, SELN_REQ_CONTENTS_ASCII, 0, 0);

    strncpy(filename,
            buffer->data + sizeof(Seln_attribute),
            MAX_FILENAME_LEN);

    return (filename);
}
```

This example has been kept simple by removing error checking. The code relies on the fact that if there is no primary selection, or the Selection Service process is not running, or the holder of the primary selection failed to returned the selection string, then the buffer returned by `seln_ask()` will have an empty string for the selection characters.

The routine also assumes that the selection will be no more than 256 characters long. `seln_ask()` will handle selections of up to about 2000 characters. To find out how to handle arbitrarily large selections, or selections other than the primary selection, refer to the *SunView 1 System Programmer's Guide.*

16.2. Setting the Primary Selection

For an example of a program which sets, and responds to queries about, the selection, see *seln_demo*, in Chapter 9 of the *SunView 1 System Programmer's Guide.*

17

The Notifier

17

The Notifier

The Notifier is a general-purpose mechanism for distributing events to a collection of clients within a process. It detects events in which its clients have expressed an interest, and dispatches these events to the proper clients, queuing client processing so that clients respond to events in a predictable order.

An overview of the notification-based model is given in Chapter 2, *The SunView Model.*

To encourage the porting of existing applications, the Notifier has provisions to allow programs to run in the Notifier environment without inverting their control structure. See Section 17.6, *Porting Programs to SunView.*

Header Files

The definitions for the Notifier are contained in the file `<sunwindow/notify.h>`, which will be included indirectly when you include `<suntool/sunview.h>`.[90]

Related Documentation

This chapter will suffice for the majority of SunView applications. See the chapters titled *Advanced Notifier Usage* and *The Agent and Tiles* in the *SunView 1 System Programmer's Guide* for more information on the Notifier and SunView's usage of it. When looking up Notifier-related information, look first in the index to this book, then in the index to the *SunView 1 System Programmer's Guide.*

Summary Listing and Table

To give you a feeling for what you can do with the Notifier, the following page contains a list of the available Notifier functions. Many of these are discussed in the rest of this chapter and elsewhere (use the *Index* to check). All are briefly described with their arguments in the *Notifier Functions* table beginning on page 343 in Chapter 19, *SunView Interface Summary.*

[90] For those programmers utilizing the Notifier outside of SunView (a perfectly reasonable thing to do), the code that implements the Notifier is found in `/usr/lib/libsunwindow.a`.

Notifier Functions
`notify_default_wait3(client, pid, status, rusage)`
`notify_dispatch()`
`notify_do_dispatch()`
`notify_interpose_destroy_func(client, destroy_func)`
`notify_interpose_event_func(client, event_func, type)`
`notify_itimer_value(client, which, value)`
`notify_next_destroy_func(client, status)`
`notify_no_dispatch()`
`notify_perror(s)`
`notify_set_destroy_func(client, destroy_func)`
`notify_set_exception_func(client, exception_func, fd)`
`notify_set_input_func(client, input_func, fd)`
`notify_set_itimer_func(client, itimer_func, which, value, ovalue)`
`notify_set_signal_func(client, signal_func, signal, when)`
`notify_start()`
`notify_stop()`
`notify_set_output_func(client, output_func, fd)`
`notify_set_wait3_func(client, wait3_func, pid)`
`notify_veto_destroy(client)`

17.1. When to Use the Notifier

Since the Notifier is used by the SunView libraries, any program that uses SunView implicitly uses the Notifier. You will have to use the Notifier explicitly if you want to do any of the following:

- Catch signals, e.g., `SIGCONT`.
- Notice state changes in processes that your process has spawned, e.g., a child process has died.
- Read and write through file descriptors, e.g., using pipes.
- Receive notification of the expiration of an interval timer, e.g., so that you can provide some blinking user feedback.
- Extend, modify or monitor SunView Notifier clients, e.g., noticing when a frame is opened, closed or about to be destroyed.
- Use a non-notification-based control structure while running under SunView, e.g., porting programs to SunView.

17.2. Restrictions

The Notifier imposes some restrictions on its clients which designers should be aware of when developing software to work in the Notifier environment. These restrictions exist so that the application and the Notifier don't interfere with each other. More precisely, since the Notifier is multiplexing access to user process resources, the application needs to respect this effort so as not to violate the sharing mechanism.

Don't Call...

Assuming an environment with multiple clients with an unknown notifier usage pattern, you should not use any of the following system calls or C library routines:[91]

`signal`(3) The Notifier is catching signals on the behalf of its clients. If you set up your own signal handler over the one that the Notifier has set up then the Notifier will never notice the signal.

`sigvec`(2) The same applies for `sigvec`(2) as does for `signal`(3), above.

`setitimer`(2) The Notifier is managing two of the process's interval timers on the behalf of its many clients. If you access an interval timer directly, the Notifier could miss a timeout. Use `notify_set_itimer_func()` instead of `setitimer`(2).

`alarm`(3) Because `alarm`(3) sets the process's interval timer directly, the same applies for `alarm`(3) as does for `setitimer`(2), above.

`getitimer`(2) When using a notifier-managed interval timer, you should call `notify_itimer_value()` to get its current status. Otherwise, you can get inaccurate results.

`wait3`(2) The Notifier notices child process state changes on behalf of its clients. If you do your own `wait3`(2), then the notifier may never notice the change in a child

[91] A future release may provide modified versions of some of these forbidden routines that will allow their use without restriction. However, the restrictions described in *Don't Catch...*, below, will continue to be germane. *A* `signal()` *Replacement for Notifier Compatibility*, in Section 17.4, provides a code patch for programs that catch signals.

process or you may get a change of state for a child process in which you have no interest. Use `notify_set_wait3_func()` instead of `wait3`(2).

`wait`(2) The same applies for `wait`(2) as does for `wait3`(2), above.

`ioctl`(2) (..., `FIONBIO`, ...) This call sets the blocking status of a file descriptor. The Notifier needs to know the blocking status of a file descriptor in order to determine if there is activity on it. `fcntl`(2) has an analogous request that should be used instead of `ioctl`(2).

`ioctl`(2) (..., `FIOASYNC`, ...) This call controls a file descriptor's asynchronous io mode setting. The Notifier needs to know this mode in order to determine if there is activity on it. `fcntl`(2) has an analogous request that should be used instead of `ioctl`(2).

`system`(3) In the SunOS, this function calls `signal`(3) and `wait`(2). Hence you should avoid using this for the reasons mentioned above. Calls to `system`(3) should be replaced with something like the following.

```
if((pid = vfork()) == 0) {
        (void) execl("/bin/sh", "sh", "-c", str, (char *)0);
        _exit(127);
}
notify_set_wait3_func(me, my_handler, pid);
```

Don't Catch...

Clients should not have to catch any of the following signals. If you are, then you are probably also making one of the forbidden calls described above. You might also be utilizing the Notifier inappropriately if you think that you have to catch any of these signals. The Notifier catches these signals itself under a variety of circumstances:

`SIGALRM` Caught by the Notifier's interval timer manager. Use `notify_set_itimer_func()` instead.

`SIGVTALRM` The same applies for `SIGVTALRM` as does for `SIGALRM` above.

`SIGTERM` Caught by the Notifier so that it can tell its clients that the process is going away. Use `notify_set_destroy_func()` if that is why you are catching `SIGTERM`.

`SIGCHLD` Caught by the Notifier so that it can do child process management. Use `notify_set_wait3_func()` instead.

`SIGIO` Caught by the Notifier so that it can manage its file descriptors that are running in asynchronous io mode. Use `notify_set_input_func()`[92] or `notify_set_output_func()` if you want to know when there is activity on your file descriptor.

`SIGURG` Caught by the Notifier so that it can dispatch exception activity on a file descriptor to its clients. Use `notify_set_exception_func()` if you are looking for out-of-band communications when using a socket.

[92] Do not use a `NULL` client handle when you use `notify_set_input_func()` or the Notifier will go into an infinite loop.

If you think you have to catch one of these signals, then be sure to use `notify_set_signal_func()`.

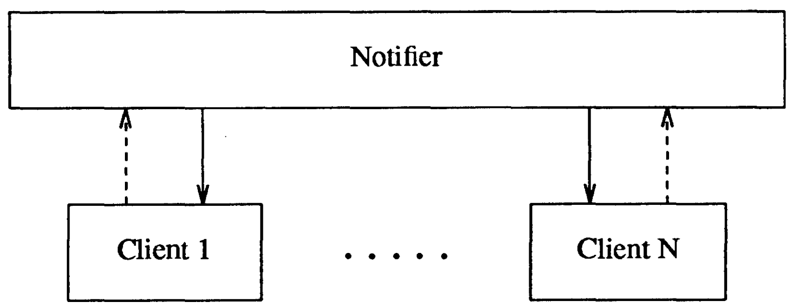
17.3. Overview

How the Notifier Works

Before it can receive events, a client must advise the Notifier of the types of events in which it is interested. It does this by registering an *event handler* function (which it must supply) for each type of event in which it is interested. When an event occurs, the Notifier calls the event handler appropriate to the type of event.

Figure 17-1 shows an overview of how the notification mechanism works.

Figure 17-1 *Overview of Notification*



---> *Client registers event proc at initialization time*
——> *Notifier calls back to client when event received*

Client Handles

The Notifier uses a *client handle* as the unique identifier for a given client. The Notifier, without interpreting the client handle in any way, uses it to associate each event with the event handler for a given client.

The only requirement for a client handle is that it must be unique (within a process). Since a program text address or the address of an allocated data block are guaranteed to be unique, they can be used. Since stack addresses are not in general guaranteed to be unique they should not be used. Internally, SunView uses the object handles returned from `window_create()` as notifier client handles.

Types of Interaction

Client interaction with the Notifier falls into the following functional areas:

- Event handling — A client may receive events and respond to them via *event handlers*. Event handlers do the bulk of the work in the Notifier environment. The various types of events are in Section 17.4, *Event Handling*.
- Interposition — A client may request that the Notifier install a special type of event handler (supplied by the client) to be inserted (or *interposed*) ahead of the current event handler for a given type of event and client. This allows clients to screen incoming events and redirect them, and to monitor and change the status of other clients. Examples of interposition may be found below under *Monitoring a Frame's State*.

- Notifier control — A client may exercise control over when dispatching of events occurs. See Section 17.6, *Porting Programs to SunView*.

17.4. Event Handling

This section describes how to be notified of UNIX-related events and notifier supported destroy events (see Chapter 6, *Handling Input*, for a description of SunView-defined events). UNIX events are low-level occurrences that are meaningful at the level of the operating system. These include signals (software interrupts), input pending on a file descriptor, output completed on a file descriptor, tasks associated with managing child processes, and tasks associated with managing interval timers.

A client establishes an interest in a certain type of event by registering an event handler procedure to respond to it. The event handler for a given type of event has a mandatory calling sequence, as described below. All event handlers return a value of either `NOTIFY_DONE` or `NOTIFY_IGNORED` depending on whether the event was acted on in some way or failed to provoke any action, respectively.

When registering an event handler, the registration procedure returns a pointer to the function that was in place previous to the current call. On initialization, the Notifier sets up its internal tables by registering "dummy" functions as placeholders. These dummy functions are no-op functions with no harmful side-effects. The first time a client registers a given type of event handler, it will receive a pointer to a "dummy" function.

The following sections describe common usages of various types of events.

Child Process Control Events

Let's say that you want to fork a process to perform some processing on your behalf. UNIX requires that you perform some housekeeping of that process. The minimum housekeeping required is to notice when that process dies and "reap" it. You can register a *wait3 event* handler,[93] which the Notifier will call whenever a child process changes state (e.g. dies), by calling:

```
Notify_func
notify_set_wait3_func(client, wait3_func, pid)
    static Notify_client client;
    Notify_func          wait3_func;
    int                  pid;
```

"Reaping" Dead Processes

Clients using child process control which simply need to perform the required reaping after a child process dies can use the predefined `notify_default_wait3()` as their wait3 event handler. For example:

[93] The name *wait3 event* originates from the `wait3`(2) system call.

```
#include <sunwindow/notify.h>

static   int            my_client_object;
static   Notify_client *me = &my_client_object;

int pid;

if ((pid = my_fork()))
    (void) notify_set_wait3_func(me, notify_default_wait3,
                                 pid);
/* Start dispatching events */
(void) notify_start();
```

This is sufficient to have your child process reaped on its death. The Notifier automatically removes a dead process's wait3 event handler from its internal data structures.

NOTE *The use of* me *as a client handle is arbitrary, but illustrates one method of generating a unique client handle.*

Results from a Process

A more interesting application might actually receive some results from the process it forked. In this case, the application would supply its own wait3 event handler[94]. For example:

```
#include <sunwindow/notify.h>
#include <sys/wait.h>
#include <sys/time.h>
#include <sys/resource.h>
static Notify_value my_wait3_handler();

/* Register a wait3 event handler */
(void) notify_set_wait3_func(me, my_wait3_handler, pid);
/* Start dispatching events */
(void) notify_start();

static Notify_value
my_wait3_handler(me, pid, status, rusage)
    Notify_client  me;
    int            pid;
    union wait    *status;
    struct rusage *rusage;

    if (WIFEXITED(*status)) {
        /* Child process exited with return code */
        my_return_code_handler(me, status->w_retcode);
        /* Tell the notifier that you handled this event */
        return (NOTIFY_DONE);
    }
    /* Tell the notifier that you ignored this event */
    return (NOTIFY_IGNORED);
```

[94] See the wait(2) manual page for details of union wait and struct rusage.

Input-Pending Events (pipes)

A program may need to know when there is input pending on a file descriptor — for instance, on one end of a pipe. Let's extend our previous example a bit to include reading data from a pipe connected to a process that we have forked. You can register an input-pending event handler which the Notifier will call whenever whenever there is input pending on a file descriptor[95] by calling:

```
Notify_func
notify_set_input_func(client, input_func, fd)
    Notify_client client;
    Notify_func   input_func;
    int           fd;
```

The calling sequence for the `input_func()` you supply is as follows:

```
Notify_value
input_func(client, fd)
    Notify_client client;
    int           fd;
```

Example: Reading a Pipe

```
#include <sunwindow/notify.h>

static Notify_value my_pipe_reader();

    int fildes[2];
    /* Create a pipe */
    if (pipe(fildes) == -1) {
        perror("pipe");
        exit(1);
    }
    /* Register an input-pending event handler */
    (void) notify_set_input_func(me, my_pipe_reader, fildes[0]);
    ... do fork and dispatching from wait3 event example ...
    ... do fork and dispatching from wait3 event example ...

static Notify_value
my_pipe_reader(me, fd)
    Notify_client me;
    int           fd;
    /* Read the pipe (fd) */
    ...
    /* Tell the notifier that the input event is handled */
    return (NOTIFY_DONE);
```

In the above example, the application uses the Notifier to read from the pipe because it doesn't want to block on input pending on the pipe. In the case of a SunView program, the program wants to return back to the Notifier's central dispatching loop so that the user can interact with the window while waiting for input to become available on the pipe.

[95] The file descriptor can be in blocking or non-blocking mode, or in asynchronous mode; the Notifier handles both as long as you have used `fcntl`(2) to set the modes.

Closing the Pipe

When you close any file descriptor that has been registered with the Notifier you should *unregister* it. To do this, call `notify_set_input_func()` with a `notify_func` of `NOTIFY_FUNC_NULL`.[96]

Signal Events

Signals are UNIX software interrupts. The Notifier multiplexes access to the UNIX signal mechanism. A client may ask to be notified that a UNIX signal occurred either when it is received (asynchronously) and/or later during normal processing (synchronously).

Clients may define and register a signal event handler to respond to any UNIX signal desired. However, many of the signals that you might catch in a traditional UNIX program may be being caught for you by the Notifier (see *Don't catch* above).

CAUTION **Clients of the Notifier must not directly catch any UNIX signals using `signal`(3) or `sigvec`(2). Regardless of whether clients choose synchronous or asynchronous signal notification, they must use the signal event mechanism described in this section. See Section 17.2, *Restrictions*.**

You can register a signal event handler which the Notifier will call whenever a signal has been caught by calling:

```
Notify_func
notify_set_signal_func(client, signal_func, signal, when)
    Notify_client      client;
    Notify_func        signal_func;
    int                signal;
    Notify_signal_mode when;
```

`when` can be either `NOTIFY_SYNC` or `NOTIFY_ASYNC`. `NOTIFY_SYNC` causes notification during normal processing, that is, the delivering of the signal is delayed, so that your program doesn't receive it at an arbitrary time. `NOTIFY_ASYNC` causes notification immediately as the signal is received, — this mode mimics the UNIX `signal`(3) semantics.

A `signal()` Replacement for Notifier Compatibility

You should rewrite applications to use `notify_set_signal_func()`. However, the Notifier routine `notify_set_signal_func()` does not fully emulate the `signal`(3) function. It does not handle errors the same way `signal`(3) does. Errors from `signal`(3) are indicated by a `-1` return value, and the value of `errno` is set to `EINVAL`.

The errors for `notify_set_signal_func()` are not communicated back to the caller, but error messages are printed. For example, if the signal number is not valid, the Notifier prints

```
Bad signal number
```

but its return value indicates success; the `signal`(3) system call does not print a message, but returns `-1` and sets `errno` to `EINVAL`. As another example, if

[96] This method of passing in a `NOTIFY_FUNC_NULL` to unregister an event handler from the Notifier works for any type of event.

SIGKILL or SIGSTOP are ignored or a handler supplied, the Notifier prints

```
Notifer assertion botched: Unexpected error: sigvec
```

but its return value indicates success, while signal(3) does not print a message, returns value of -1, and sets errno to EINVAL.

The work-around is to use the following replacement function for the C library version of signal(3). This code converts signal() calls into notify_set_signal_func() calls. Explicitly loading this code will override the loading of the C library's version of signal(). This approach works only if all the signal handlers registered by signal() only look at the first argument passed to them when a signal is received. Also, no Notifier client handle may be a small integer.

```
#include <sunwindow/notify.h>
#include <errno.h>

int (*
signal(sig, func))()
int sig,(*func)();

    if ( (sig < 1 || sig > NSIG) ||
         (sig == SIGKILL || sig == SIGSTOP) ) {
        errno = EINVAL;
        return(BADSIG);
    }
    if (sig == SIGCONT && func == SIG_IGN) {
        errno = EINVAL;
        return(BADSIG);
    }
    return ((int(*)())notify_set_signal_func(sig, func,
                                              sig, NOTIFY_ASYNC));
```

Example: Writing to a Pipe

Let's extend our on-going example by writing on the pipe. Writing to a pipe that has no process at the other end to receive the message causes a SIGPIPE to be generated by UNIX. By default, an uncaught SIGPIPE causes a premature process termination. So, we are going to catch SIGPIPE so that our process doesn't get killed if we start a process that dies.[97]

[97] We are glossing over the part about actually writing to the pipe. If we wanted to write something to the pipe and then get some notification about when the write had actually completed (i.e., the other process had read it) we would use the notify_set_output_func() call. The calling sequences for this routine and its event handler are exactly the same as those for notify_set_input_func() (previously described).

```
#include <sunwindow/notify.h>
#include <signal.h>

static Notify_value my_sigpipe_handler();

    ... do pipe from input-pending example ...
    ... do notify_set_input_func from input-pending example ...
    ... do fork from wait3 event example ...

    /* Register a signal event handler */
    (void) notify_set_signal_func(me, my_sigpipe_handler,
                              SIGPIPE, NOTIFY_ASYNC);

    /* Write a message on the pipe */

...

    /* Start dispatching events */
    (void) notify_start();

static Notify_value
my_sigpipe_handler(me, signal, when)
    Notify_client      me;
    int                signal;
    Notify_signal_mode when;

    /*
     * This is a no-op function meant only to prevent us from
     * being killed because we didn't have a SIGPIPE handler.
     */
    return (NOTIFY_IGNORED);
```

This example wouldn't actually show `my_sigpipe_handler()` being called unless you set up the child process to die right away.

Asynchronous Event Handling

An asynchronous signal notification can come at any time (unless blocked using `sigblock(2)`). This means that the client can be executing code at any arbitrary place. Great care must be exercised during asynchronous processing.

It is rarely safe to do much of anything in response to an asynchronous signal. Unless your program has taken steps to protect its data from asynchronous access, the only safe thing to do is to set a flag indicating that the signal has been received.

When in an asynchronous signal event handler, the signal context and signal code is available from the follow routines:

```
int
notify_get_signal_code()

struct  sigcontext *
notify_get_signal_context()
```

The return values of these routines are undefined if called from a synchronous signal event handler.

Timeout Events

A client may require notification of an expired timer based on real time (approximate elapsed wall clock time; ITIMER_REAL) or on process virtual time (CPU time used by this process; ITIMER_VIRTUAL). To receive this type of notification, the client must define and register a timeout event handler.

```
Notify_func
notify_set_itimer_func(client, itimer_func, which, value,
                       ovalue)
    Notify_client     client;
    Notify_func       itimer_func;
    int               which;
    struct itimerval *value, *ovalue;
```

The semantics of which, value and ovalue parallel the arguments to setitimer(2) (see the getitimer(2) manual page). which is either ITIMER_REAL or ITIMER_VIRTUAL.

Example: Periodic Feedback

As an example, we want to provide some form of blinking feedback. We do this by setting up an interval timer when we want to blink. We turn the internal timer off when we no longer need the blinking.[98]

[98] This code segment should be wrapped in, say, a panel notify procedure, in order to be actually run.

```
#include <sunwindow/notify.h>
#include <sys/time.h>

static  int blinking_required;  /* blinking desired */
static  int blinking;           /* blinking enabled */
#define ITIMER_NULL  ((struct itimerval *)0)
static  Notify_value my_blinker();

    if (blinking_required && !blinking) {

        struct itimerval blink_timer;

        /* Set up interval with which to RELOAD the timer */
        blink_timer.it_interval.tv_usec = 0;
        blink_timer.it_interval.tv_sec = 1;

        /* Set up INITIAL value with which to SET the timer */
        blink_timer.it_value.tv_usec = 0;
        blink_timer.it_value.tv_sec = 1;

        /* Turn on interval timer for client */
        (void) notify_set_itimer_func(me, my_blinker,
            ITIMER_REAL, &blink_timer, ITIMER_NULL);
        blinking = 1;

    } else if (!blinking_required && blinking) {

        /* Turn off interval timer for client */
        (void) notify_set_itimer_func(me, my_blinker,
        ITIMER_REAL, ITIMER_NULL, ITIMER_NULL);
        blinking = 0;
    }
static Notify_value
my_blinker(me, which)
    Notify_client me;
    int which;
    /* Do the blink */
    ...
    return (NOTIFY_DONE);
```

Polling

Interval timers can be used to set up a polling situation. There is a special `value` argument to `notify_set_itimer_func()` that tells the Notifier to call you as often and as quickly as possible. This `value` is the address of the following constant:

```
struct itimerval NOTIFY_POLLING_ITIMER; /*{{0,1},{0,1}}*/
```

This high speed polling can consume all of your machine's available CPU time, but may be appropriate for high speed animation. It is used in the program *spheres*, which shows one way to convert and old SunWindows gfx subwindow-based program to SunView. *spheres* is explained in Appendix C, *Converting SunWindows Programs to SunView*, and is listed in full in in Appendix A, *Example Programs*.

Checking the Interval Timer

The following function checks on the state of an interval timer by returning its current state in the structure pointed to by value.

```
Notify_error
notify_itimer_value(client, which, value)
    Notify_client     client;
    int               which;
    struct itimerval *value;
```

Turning the Interval Timer Off

If you specify an interval timer with its it_interval structure set to {0, 0}, the Notifier flushes any knowledge of the interval timer after it delivers the timeout notification. Otherwise, supplying a NULL interval timer pointer to notify_set_itimer_func() will turn the timer off.

17.5. Interposition

SunView window objects utilize the Notifier for much of their communication and cooperation. The Notifier provides a mechanism called *interposition*, with which you can intercept control of the internal communications within SunView. Interposition is a powerful way to both monitor and modify window behavior in ways that extend the functionality of a window object.

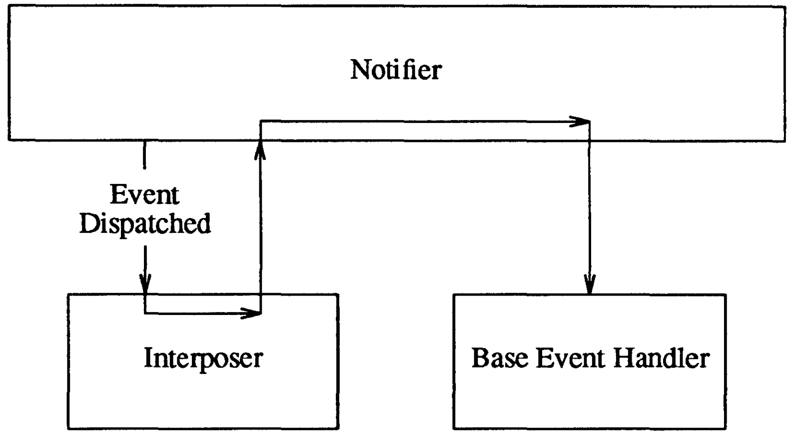
Interposition allows a client to intercept an event before it reaches the *base event handler*. The base event handler is the one set originally by a client. The client can call the base event handler before or after its own handling of the event, or not at all. Clients may use interposition to monitor and filter events coming in to an event handler and/or to modify a series of actions based on the results of some calculation.

How Interposition Works

A client requests that the Notifier install an interposer function, supplied by the client, for a specified client and type of event. When an event arrives, the Notifier calls the function at the top of the wait list for that client and that type of event. An interposed routine may (indirectly) call the next function in the interposition sequence and receive its results.

Figure 17-2 illustrates the flow of control with interposition. Note that the interposer could have stopped the flow of control to the base event handler.

Figure 17-2 *Flow of Control in Interposition*



Monitoring a Frame's State

You can notice when a frame opens or closes by interposing in front of the frame's *client event* handler. The client event handler is a SunView specific event handler which is built on top of the Notifier's general client event mechanism.[99] To install an interposer call the following routine:

```
Notify_error
notify_interpose_event_func(client, event_func, type)
    Notify_client     client;
    Notify_func       event_func;
    Notify_event_type type;
```

`client` must be the handle of the Notifier client in front of which you are interposing. In SunView, this is the handle returned from `window_create()`.[100] `type` is always `NOTIFY_SAFE` for SunView clients.

Example: Interposing on Open/Close

Let's say that the application is displaying some animation, and wants to do the necessary computation only when the frame is open. It can use interposition to notice when the frame opens or closes.

The program *spheres* (which shows one way to convert an old SunWindows gfx subwindow-based program to SunView) uses this technique to stop shading an image when its frame is closed. It is explained in Appendix C, *Converting SunWindows Programs to SunView*, and is listed in full in in Appendix A, *Example Programs*.

Another example appears on the following page. Note the the call to `notify_next_event_func()`, which transfers control to the frame's client event handler through the Notifier. `notify_next_event_func()` takes the same arguments as the interposer.

[99] The stream of events sent to a client event handler is described in in Chapter 6, *Handling Input*.

[100] It could also be the handle returned from the call to `scrollbar_create()`.

```
#include <suntool/sunview.h>

static Notify_value my_frame_interposer();


...
    Frame frame;

    /* Create the frame */
    frame = window_create(0, FRAME,
...,
0);

...
    /* Interpose in front of the frame's event handler */
    (void) notify_interpose_event_func(frame,
                              my_frame_interposer, NOTIFY_SAFE);
    /* Show frame and start dispatching events */
    window_main_loop(frame);

static Notify_value
my_frame_interposer(frame, event, arg, type)
    Frame              frame;
    Event              *event;
    Notify_arg          arg;
    Notify_event_type  type;

    int closed_initial, closed_current;
    Notify_value value;
{
    /* Determine initial state of frame */
    closed_initial = (int) window_get(frame, FRAME_CLOSED);

    /* Let frame operate on the event */
    value = notify_next_event_func(frame, event, arg, type);

    /* Determine current state of frame */
    closed_current = (int) window_get(frame, FRAME_CLOSED);

    /* Change animation if states differ */
    if (closed_initial != closed_current) {
        if (closed_current) {
            /* Turn off animation because closed */
            (void) notify_set_itimer_func(me, my_animation,
                ITIMER_REAL, ITIMER_NULL, ITIMER_NULL);
        } else {
            /* Turn on animation because opened */
            (void) notify_set_itimer_func(me, my_animation,
                ITIMER_REAL, &NOTIFY_POLLING_ITIMER,
                ITIMER_NULL);
        }
    }
    return (value);
}
```

Discarding the Default Action

In the example on the preceding page, you wanted the base event handler to handle the event (so that the frame gets closed/opened). If the interposed function replaces the base event handler, and you don't want the base event handler to be called at all, your interposed procedure should not call `notify_next_event()`. For example, your interposed function might handle scroll events itself, so you would not want the base event handler to perform an additional scroll.

Interposing on Resize Events

Another common use of interposition is to give your application more control over the layout of its subwindows. The code is very similar. You call `notify_interpose_event_func()` to interpose your event handler. In the event handler, the following fragment could be used:

```
value = notify_next_event_func(frame, event, arg, type);
if (event_action(event) == WIN_RESIZE)
    resize(frame);
return(value);
```

Let the default event handler handle the event, then check if the event is a resize event. If so, call your own `resize()` procedure to lay out the subwindows.

NOTE *A* `WIN_RESIZE` *event is* **not** *generated until the frame is resized. If you want* your resize procedure to be called when the window first appears you must do so yourself. This is different from a canvas with the `CANVAS_RESIZE` attribute set, whose resize procedure is called the first time the canvas is displayed.

If the user manually adjusts subwindow sizes using [Control]-middle mouse button, no `WIN_RESIZE` event is generated. You can disallow subwindow resizing by setting the `FRAME_SUBWINDOWS_ADJUSTABLE` attribute to `FALSE`.

Example: *resize_demo*

The program *resize_demo* shows how to achieve more complex window layouts than possible using window layout attributes. It is listed in Appendix A, *Example Programs*.

Modifying a Frame's Destruction

Suppose an application must detect when the user selects the 'Quit' menu item in the frame menu, in order to perform some application-specific confirmation. We have to interpose in front of the frame's *client destroy event* handler using the following routine.

```
Notify_error
notify_interpose_destroy_func(client, destroy_func)
    Notify_client client;
    Notify_func   destroy_func;
```

First, however, you need to understand client destroy events.

Destroy Events

The Notifier can tell each client to destroy itself. It is possible for a destroy event handler to receive two calls concerning client destruction: one call may be a status inquiry and the other a demand for termination. Destroy event handlers use a status code to determine whether the caller demands actual termination (DESTROY_CLEANUP or DESTROY_PROCESS_DEATH), or simply requires an indication if it is feasible for the client to terminate at present DESTROY_CHECKING).

Checking

If the status argument indicates an inquiry and the client cannot terminate at present, the destroy event handler should call notify_veto_destroy(), indicating that termination would not be advisable at this time, and return normally. If the status argument indicates an inquiry and the client can terminate at present, then the destroy handler should do nothing; a subsequent call will tell the client to actually destroy itself.

This veto option is used, for example, to give a text subwindow the chance to ask the user to confirm the saving of any editing changes when quitting a tool.

Destruction

If the status argument is not DESTROY_CHECKING then the client is being told to destroy itself. If status is DESTROY_PROCESS_DEATH then the client can count on the entire process dying and so should do whatever it needs to do to cleanup its outside entanglements, e.g., update a file used by other processes. Since the entire process is dying, one might choose to not release all the resources used within the process, e.g., dynamically allocated memory. However, if status is DESTROY_CLEANUP then the client is being asked to destroy itself and be very tidy about cleaning up all the process internal resources that it is using, as well as its outside entanglements.

A Typical Destroy Handler

A typical destroy handler looks like the following:

```
Notify_value
common_destroy_func(client, status)
    Notify_client client;
    Destroy_status status;
    if (status == DESTROY_CHECKING) {
        if (/* Don't want to go away now */)
            notify_veto_destroy(client);
    } else {
        /* Always release external commitments */
        if (status == DESTROY_CLEANUP)
        /* Conditionally release internal resources */
    }
    return (NOTIFY_DONE);
```

Example: Interposing a Client Destroy Handler

Now we can present the example of interposing in front of the frame's client destroy event handler. In addition to doing our own confirmation, we prevent double confirmation by suppressing the frame's default confirmation.

Note that after having the destroy OK'd by the user, we call `notify_next_destroy_func()` before returning. This allows other subwindows to request confirmation.

The code appears on the following page.

```
#include <suntool/sunview.h>

static Notify_value my_frame_destroyer();

...
    /*
     * Interpose in front of the frame's destroy event handler
     */
    (void) notify_interpose_destroy_func(frame,
                                         my_frame_destroyer);
    /* Show frame and start dispatching events */
    window_main_loop(frame);

...

static Notify_value
my_frame_destroyer(frame, status)
    Frame          frame;
    Destroy_status status;

    if (status == DESTROY_CHECKING) {
        if (my internal state requires confirmation) {
            /*
             * Request confirmation from the user
             * (see window_loop() in the index).
             */

...
            if (destroy OK'd by user) {
                /* Tell frame not to do confirmation */
                window_set(frame, FRAME_NO_CONFIRM, TRUE, 0);
            } else {
                /*
                 * Tell the Notifier that the destroy has
                 * been vetoed.
                 */
                (void) notify_veto_destroy(frame);
                /*
                 * Return now so that the destroy event
                 * never reaches the frame's destroy handler.
                 */
                return (NOTIFY_DONE);
            }
        } else {
            /* Let frame do normal confirmation */
            window_set(frame, FRAME_NO_CONFIRM, FALSE, 0);
        }
    }
    /* Let frame get destroy event */
    return (notify_next_destroy_func(frame, status));
}
```

17.6. Porting Programs to SunView

Most programs that are ported to SunView are not notification-based. They are traditional programs that maintain strict control over the inner control loop. Much of the state of such programs is preserved on the stack in the form of local variables. The Notifier supports this form of programming so that you can use SunView packages without inverting the control structure of your program to be notification-based.

Explicit Dispatching

The simplest way to convert a program to coexist with the Notifier is called *explicit dispatching*. This approach replaces the call to `window_main_loop()`, which usually doesn't return until the application terminates, with the following bit of code:

```
#include <suntool/sunview.h>

static  int my_done;

extern  Notify_error notify_dispatch();

    /* Make the frame visible on the screen */
    window_set(frame, WIN_SHOW, TRUE, 0);
    while (!my_done) {
        ...
        /* Dispatch events managed by the Notifier */
        (void) notify_dispatch();
        ...
    }
```

`notify_dispatch()` goes once around the Notifier's internal loop, dispatches any pending events, and returns. You should try to have `notify_dispatch()` called at least once every 1/4 second so that good interactive response with SunView windows can be maintained.

The program *bounce* (which shows one way to convert an old SunWindows gfx subwindow–based program to SunView) uses explicit dispatching. It is explained in Appendix C, *Converting SunWindows Programs to SunView*, and is given in full in in Appendix A, *Example Programs*.

Implicit Dispatching

Explicit dispatching is good when you are performing some computationally intensive processing and you want to occasionally give the user a chance to interact with your program. There is another method of interacting with the Notifier that is useful when you simply want the Notifier to take care of its clients and block until there is something of interest to you. This is called *implicit dispatching*.

This time, we replace the call to `window_main_loop()` with the following bit of code:

```
#include <suntool/sunview.h>

static  int my_done;

    window_set(frame, WIN_SHOW, TRUE, 0);
    /* Enable implicit dispatching */
    (void) notify_do_dispatch();
    while (!my_done) {
        char c;
        ...
        /* read allows implicit dispatching by Notifier */
        if ((n = read(0/*stdin*/, &c, 1)) < 0)
        perror("my_program");
        ...
    }
```

`notify_do_dispatch()` allows the Notifier to dispatch events from within the calls to `read`(2) or `select`(2). The Notifier's versions of `read`(2) and `select`(2) won't return until the normal versions would. They can block exactly like the normal versions.

`notify_no_dispatch()` (it takes no arguments) prevents the Notifier from dispatching events from within the call to `read`(2) or `select`(2).

Getting Out

When you use either of these dispatching approaches, you will need to find out when the frame is 'Quit' by the user, in order to know when to terminate your program. To do so, interpose in front of the frame's destroy event handler, as in the previous section, so that you can notice when the frame goes away. At this point you can call `notify_stop()` to break the `read`(2) or `select`(2) out of a blocking state.

```
#include <suntool/sunview.h>

static    int my_done;

static Notify_value my_notice_destroy();

     /*
     * Interpose in front of the frame's destroy event handler
     */
    (void) notify_interpose_destroy_func(frame,
                                          my_notice_destroy);

static Notify_value
my_notice_destroy(frame, status)
    Frame          frame;
    Destroy_status status;

    if (status != DESTROY_CHECKING) {
        /* Set my flag so that I terminate my loop soon */
        my_done = 1;
        /* Stop the notifier if blocked on read or select */
        (void) notify_stop();
    }
    /* Let frame get destroy event */
    return (notify_next_destroy_func(frame, status));
```

17.7. Error Handling

Error Codes

Every call to a notifier routine returns a value that indicates success or failure. Routines that return an enumerated type called `Notify_error` deliver `NOTIFY_OK` (zero) to indicate a successful operation, while any other value indicates failure. Routines that return function pointers deliver a non-null value to indicate success, while a value of `NOTIFY_FUNC_NULL` indicates an error condition.

When an error occurs, the global variable `notify_errno` describes the failure. The Notifier sets `notify_errno` much like UNIX system calls set the global `errno`; that is, the Notifier only sets `notify_errno` when it detects an error and does not reset it to `NOTIFY_OK` on a successful operation. A table in the *SunView 1 System Programmer's Guide* lists each possible value of `notify_errno` and its meaning.

Handling Errors

Most of the errors returned from the Notifier indicate a programmer error, e.g., the arguments are not valid. Often the best approach for the client is to print a message if the return value is non-zero and exit. The procedure `notify_perror()` takes a string which is printed to `stderr`, followed by a colon, followed by a terse description of `notify_errno`. This is done in a manner analogous to the UNIX `perror(3)` call.

Debugging

Here are some debugging hints that may prove useful when programming:

NOTIFY_ERROR_ABORT

Setting the environment variable NOTIFY_ERROR_ABORT to YES will cause the Notifier to abort with a core dump when the Notifier detects an error. This is useful if there is some race condition that produces notifier error messages that you are having a hard time tracking down.

Stop in notify_perror() or fprintf(3S)

If you are getting notifier error messages, but don't know from where, try putting a break point on the entry to either notify_perror() or fprintf(3S). Trace the stack to see what provoked the message.

notify_dump

The following call can be made from the debugger or your program to dump a printout of the state of the Notifier:

```
void
notify_dump(client, type, file)
    Notify_client client;
    int            type;
    FILE          *file;
```

The state of client is dumped to file based on the value of type. If client is 0 then all clients are dumped. If type is 1 then all the registered event handlers are dumped. If type is 2 then all the events pending for delivery are dumped. If type is 3 then both the registered event handlers and the events pending for delivery are dumped. If file is 1 then *stdout* is assumed. If file is 2 then *stderr* is assumed. To be able to call notify_dump() you need to reference it from some place in your program so that it gets loaded into your binary.

18

Attribute Utilities

18

Attribute Utilities

This chapter describes macros and functions that are provided as utilities to be used with attributes.

18.1. Character Unit Macros

By default in SunView, coordinate specification attributes interpret their values in pixel units. For applications that don't make heavy use of images, it is usually more convenient to specify positions in character units — columns and rows rather than xs and ys. To this end two macros `ATTR_ROW()` and `ATTR_COL()` are provided, which interpret their arguments as rows or columns, respectively, and convert the value to the corresponding number of pixels, based on the subwindow's font, as specified by `WIN_FONT`. `ATTR_ROW()` and `ATTR_COL()` take as arguments any expression yielding an integer. The use of these macros as an operand in an expression is restricted to adding a pixel offset (e.g., `ATTR_ROW(5) + 2`). Examples of legal and illegal usage are given in the table below.

Table 18-1 *Example uses of the* `ATTR_ROW()` *and* `ATTR_COL()` *macros*

Attribute/Value	*Interpretation*
`PANEL_ITEM_X, 5`	5 pixels from left
`PANEL_ITEM_Y, 10`	10 pixels from top
`PANEL_ITEM_X, ATTR_COL(5)`	column 5
`PANEL_ITEM_X, ATTR_COL(-5)`	column -5
`PANEL_ITEM_X, ATTR_COL(5+2)`	column 7
`PANEL_ITEM_X, ATTR_COL(5)+2`	2 pixels to right of col 5
`PANEL_ITEM_X, ATTR_COL(5)-1`	1 pixel to left of col 5
`PANEL_ITEM_Y, ATTR_ROW(10)`	row 10
`PANEL_ITEM_Y, ATTR_ROW(-10)`	row -10
`PANEL_ITEM_Y, ATTR_ROW(10+2)`	row 12
`PANEL_ITEM_Y, ATTR_ROW(10)+2`	2 pixels down from row 10
`PANEL_ITEM_Y, ATTR_ROW(10)-1`	1 pixel up from row 10
`PANEL_ITEM_X, ATTR_COL(10)+ATTR_COL(2)`	*illegal*
`PANEL_ITEM_X, 2*ATTR_COL(10)`	*illegal*

NOTE `ATTR_ROW()` *and* `ATTR_COL()` *treat their arguments as character* positions *rather than* lengths. In other words, when you use `ATTR_ROW(5)`, the pixel value that is computed includes the top margin. Similarly, the pixel value computed using `ATTR_COL(5)` includes the left margin.

These macros can be used with the panel attributes or the window attributes such as WIN_X, WIN_HEIGHT, etc.

Both the attributes and the ATTR_ROW() and ATTR_COL() macros are zero-based — that is, the first row is row zero.

If you want to use lengths rather than positions, you can use the alternate macros ATTR_ROWS() and ATTR_COLS(). Examples of the differences between the character position and length macros are given in the table below.

Table 18-2 *Example uses of the* ATTR_ROWS() *and* ATTR_COLS() *macros*

Attribute/Value	*Interpretation*
WIN_WIDTH, ATTR_COL(80)	80 characters wide + left margin
WIN_WIDTH, ATTR_COLS(80)	exactly 80 characters wide
WIN_HEIGHT, ATTR_ROW(24)	24 lines high + top margin
WIN_HEIGHT, ATTR_ROWS(24)	exactly 24 lines high
PANEL_ITEM_X, ATTR_COL(5)	col 5 (left margin + 5 character widths)
PANEL_ITEM_X, ATTR_COLS(5)	5 character widths from the left edge
PANEL_ITEM_Y, ATTR_ROW(5)	row 5 (top margin + 5 row heights)
PANEL_ITEM_Y, ATTR_ROWS(5)	5 row heights from the top edge

18.2. Creating Reusable Attribute Lists

You may want to create an attribute list that can be passed to different routines. You can do this either by creating the list explicitly, or by using the routine attr_create_list().

To create an attribute list explicitly, define a static array of char *, which is initialized (or later filled in with) the desired attribute/value pairs. Note that non-string values must be coerced to type char *:

```
static char *attributes[] = {
      (char*)PANEL_LABEL_STRING,  "Name: ",
      (char*)PANEL_VALUE,         "Goofy ",
      (char*)PANEL_NOTIFY_PROC,   (char *)name_item_proc,
       0 }
```

To make an attribute list dynamically, use:

```
Attr_avlist
attr_create_list(attributes)
    <attribute-list> attributes;
```

attr_create_list() allocates storage for the list it returns. It is up to you to free this storage when no longer needed, as in:

```
Attr_avlist list;

list = attr_create_list(PANEL_LABEL_BOLD, TRUE, 0);
...
...
free(list);
```

The `free()` procedure is the standard UNIX `free(3)` routine.

Default Attributes

The code below shows how to use `attr_create_list()` in conjunction with the attribute `ATTR_LIST` to support default attributes in a panel.

```
int          text_proc(), name_proc();
Panel_item   name_item, address_item;
Pixfont     *big_font, *small_font;
Attr_avlist  defaults;

defaults =     attr_create_list(
                          PANEL_SHOW_ITEM,     FALSE,
                          PANEL_LABEL_FONT,    big_font,
                          PANEL_VALUE_FONT,    small_font,
                          PANEL_NOTIFY_PROC,   text_proc,
                          0);

name_item =     panel_create_item(PANEL_TEXT,
                          ATTR_LIST,           defaults,
                          PANEL_NOTIFY_PROC,   name_proc,
                          0);

address_item = panel_create_item(PANEL_TEXT,
                          ATTR_LIST,           defaults,
                          PANEL_SHOW_ITEM,     TRUE,
                          PANEL_VALUE_FONT,    big_font,
                          0);
```

The special attribute `ATTR_LIST` takes as its value an attribute list. In the above example, first an attribute list called `defaults` is created. Then, by mentioning `defaults` first in the attribute lists for subsequent item creation calls, each item takes on those default attributes. Subsequent references to an attribute override the setting in `defaults` since the last value mentioned for an attribute is the one which takes effect.

18.3. Maximum Attribute List Size

The maximum length of attribute-value lists supported by the SunView packages (see `ATTR_STANDARD_SIZE` in `<sunwindow/attr.h>`) is 250. If the number of attributes in a list you pass to SunView exceeds this size, the attribute package prints

```
Number of attributes (nnn) in the attr list exceeds
the maximum number (nnn) specified.  Exit!
```

on standard output and exits with exit status `1`.

19

SunView Interface Summary

19

SunView Interface Summary

This chapter contains tables summarizing the data types, functions and attributes which comprise the SunView programmatic interface.[101]

The tables correspond to the chapters in this book, but are in *alphabetical* order: Alerts, Canvases, Cursors, Data Types, Icons, Input (including events and input-related window atttributes), Menus, the Notifier, Panels, Pixwins, Scrollbars, Text Subwindows, TTY Subwindows and Windows (including frames and frame command line arguments).

Note that the order of the chapters is different than the order of the tables. The chapter on windows (including frames) comes first, followed by canvases, input, pixwins, text subwindows, panels, alerts, tty subwindows, menus, cursors, icons, scrollbars, the Selection Service, and the Notifier.

Within each topic, the attribute tables come first, then the functions and macros, then miscellaneous tables.

To help distinguish where one table ends and another begins, the start of each table is marked with a horizontal grey bar.

---

[101] This chapter does not include a table for the Selection Service functions; see the *SunView System Programmer's Guide* for a complete discussion of the Selection Service interface.

Table 19-1 *Alert Attributes*

Attribute	*Type*	*Description*
ALERT_BUTTON	char *, int	A string to be displayed in a button and a value to associate with it. The value specified with the string will be returned when the button is selected. The value may be any integer, but should not be a value predefined by the alerts package; that is, not ALERT_YES, ALERT_NO, ALERT_FAILED, or ALERT_DEFAULT_TRIGGERED). See the values given in the *Alert Functions* table.
ALERT_BUTTON_FONT	Pixfont *	Font used for buttons. Default is the font specified for menus, which is *Menu/Font* in defaultsedit or screen.b.14 if no default is specified.
ALERT_BUTTON_NO	char *	A string that is associated with the accelerated NO (cancel, don't do it) button which is triggered via a keyboard accelerator. The value returned if this button is selected (or the accelerator is triggered) will be ALERT_NO. Only one instance of this attribute is allowed.
ALERT_BUTTON_YES	char *	A string to associate with the accelerated YES (ie. confirm, continue, do it) button which is also triggered via a keyboard accelerator. The value returned when this button is selected (or the accelerator is triggered) will be ALERT_YES. Only one instance of this attribute is allowed.
ALERT_MESSAGE_FONT	Pixfont *	Font used for message strings. The default is the same as Client Frame (if specified) otherwise it is the same as *SunView/Font*.
ALERT_MESSAGE_STRINGS	list char*	Strings to be displayed in the message area of the alert panel. The default is to be determined.
ALERT_MESSAGE_STRINGS_ARRAY_PTR	array char*	Same as ALERT_MESSAGE_STRINGS except the client need not know the actual strings being passed, just that the value is pointer to first of null terminated array of strings. The alerts package will cast the value into a type char **.
ALERT_NO_BEEPING	int	Allows the client to specify that no beeping should take place reguardless of defaults database setting. The default for this option is FALSE; that is, beep however many times database specifies.

Table 19-1 *Alert Attributes— Continued*

Attribute	*Type*	*Description*
ALERT_OPTIONAL	boolean	Specifies whether an optional alert will be enabled or disabled. You make an alert a courtesy alert by specifing the ALERT_OPTIONAL attribute in the attribute list passed to alert_prompt().
ALERT_POSITION	int	Specifies the position of the alert. Default is ALERT_CLIENT_CENTERED unless client_frame = NULL NULL causes the alert to default to ALERT_SCREEN_CENTERED regardless of this setting. Possible values that may be passed are: ALERT_SCREEN_CENTERED, ALERT_CLIENT_CENTERED, and ALERT_CLIENT_OFFSET. Use WIN_X and WIN_Y for the offset attributes. This position describes where the "center" of an alert should be.
ALERT_TRIGGER	int	This special attribute allows the client to specify a SunView event which should cause the alert to return. The default is not to return unless an actual button has been selected or the other YES/NO accelerators are seen. When this event is triggered, the value returned will be ALERT_TRIGGERED.

Table 19-2 *Alert Functions*

Definition	*Description*
`int` `alert_prompt(client_frame, event, attributes)` `    Frame      client_frame;` `    Event     *event;` `    `*<attribute-list>* `attributes;`	Displays alert and doesn't return until the user pushes a button, or its trigger or the default has been seen. A value of ALERT_FAILED is returned if alert_prompt() failed for any reason, otherwise equivalent to ordinal value of button which caused return (ie. button actually selected, or default button if default action triggered return). The client_frame may be NULL (see ALERT_POSITION for consequences). The event will be completely filled in at the time the alert_prompt() returns. The possible status values that may be returned from this function are: the (int) value passed with every ALERT_BUTTON attribute; ALERT_YES, if a confirm button or trigger was pushed; ALERT_NO, if a cancel button or trigger was pushed; ALERT_FAILED, if the alert failed to pop up; and ALERT_TRIGGERED, if a keyboard accelerator was used.

Table 19-3 *Canvas Attributes*

Attribute	*Type*	*Description*
CANVAS_AUTO_CLEAR	boolean	If TRUE, repaint area of canvas pixwin is cleared before. repaint proc is called. Default: TRUE unless the canvas is retained.
CANVAS_AUTO_EXPAND	boolean	If TRUE, canvas width and height are never allowed to be less than the edges of the canvas pixwin. Default: TRUE.
CANVAS_AUTO_SHRINK	boolean	If TRUE, canvas width and height are never allowed to be greater than the edges of the canvas pixwin. Default: TRUE.
CANVAS_FAST_MONO	boolean	If TRUE, tells canvases and graphics subwindows to use the monochrome overlay plane of the Sun–3/110 display. Default: FALSE.
CANVAS_FIXED_IMAGE	boolean	If TRUE, canvas package assumes that client is drawing a fixed-size image whose rendering does not depend on the size of the canvas. Default: TRUE.
CANVAS_HEIGHT	int	Height of object being drawn. Default: height of usable window, which is WIN_HEIGHT – (SCROLL_THICKNESS of WIN_HORIZONTAL_SCROLLBAR) – CANVAS_MARGIN*2.
CANVAS_MARGIN	int	Margin to leave around the canvas pixwin from inside of window. Default: 0.
CANVAS_PIXWIN	Pixwin *	Pixwin for drawing. Get only.
CANVAS_REPAINT_PROC	(procedure)	Called when repaint needed, even if retained. Default: NULL. Form: `repaint_proc(canvas, pixwin, repaint_area)` `Canvas canvas;` `Pixwin *pixwin;` `Rectlist *repaint_area;`
CANVAS_RESIZE_PROC	(procedure)	Called when canvas width or height changes. Default: NULL. Form: `resize_proc(canvas, width, height)` `Canvas canvas;` `int width;` `int height;`
CANVAS_RETAINED	boolean	If TRUE, image is backed up for repaint. Default: TRUE.
CANVAS_WIDTH	int	Width of object being drawn. Default: width of usable window, which is WIN_WIDTH – (SCROLL_THICKNESS of WIN_VERTICAL_SCROLLBAR) – CANVAS_MARGIN*2.

Table 19-4 *Canvas Functions and Macros*

Definition	*Description*
`Event *` `canvas_event(canvas, event)` `    Canvas canvas;` `    Event *event;`	Translates the coordinates of `event` from the space of the canvas subwindow to the space of the logical canvas (which may be larger and scrollable). That is, the client passes in a pointer to an event, then the function does an `event_set_x(event, translated_x)` and an `event_set_y(event, translated_y)`. It then returns the same pointer that was passed in.
`Pixwin *` `canvas_pixwin(canvas)` `    Canvas canvas;`	Returns the pixwin to use when drawing into the canvas with the `pw_*()` routines.
`Event *` `canvas_window_event(canvas, event)` `    Canvas canvas;` `    Event *event;`	Translates the coordinates of `event` to the space of the canvas subwindow from the space of the logical canvas.

Table 19-5 *Cursor Attributes*

Attribute	Value Type	Description
CURSOR_CROSSHAIR_BORDER_GRAVITY	boolean	Crosshairs stick to borders. Default: FALSE.
CURSOR_CROSSHAIR_COLOR	int	Color for crosshairs. Default: 1. (Note: the color displayed depends on the settings in your colormap segment).
CURSOR_CROSSHAIR_GAP	int	Half-length of space to leave untouched from intersection of crosshairs. Value of CURSOR_TO_EDGE extends crosshairs to edge of cursor rect. Default: 0.
CURSOR_CROSSHAIR_LENGTH	int	Half-length of crosshairs. Default: CURSOR_TO_EDGE.
CURSOR_CROSSHAIR_OP	int	Raster op for drawing crosshairs. Default: PIX_SRC.
CURSOR_CROSSHAIR_THICKNESS	int	Thickness of crosshairs. Maximum value is CURSOR_MAX_HAIR_THICKNESS (5). Default: 1.
CURSOR_FULLSCREEN	boolean	Clip crosshairs to edge of screen not window. Default: FALSE.
CURSOR_HORIZ_HAIR_BORDER_GRAVITY	boolean	Horizontal crosshair sticks to borders. Default: FALSE.
CURSOR_HORIZ_HAIR_COLOR	int	See CURSOR_HORIZ_HAIR_COLOR
CURSOR_HORIZ_HAIR_GAP	int	See CURSOR_CROSSHAIR_GAP.
CURSOR_HORIZ_HAIR_LENGTH	int	See CURSOR_CROSSHAIR_LENGTH.
CURSOR_HORIZ_HAIR_OP	int	Raster op for drawing horizontal crosshair. Default: PIX_SRC.
CURSOR_HORIZ_HAIR_THICKNESS	int	See CURSOR_CROSSHAIR_THICKNESS.
CURSOR_IMAGE	Pixrect *	Cursor's image. Default: 16 x 16 x 1 blank pixrect.
CURSOR_OP	int	Raster op for drawing cursor image. Default: PIX_SRC | PIX_DST.
CURSOR_SHOW_CROSSHAIRS	boolean	Show or don't show crosshairs. Default: FALSE.
CURSOR_SHOW_CURSOR	boolean	Show or don't show cursor image. Default: TRUE.
CURSOR_SHOW_HORIZ_HAIR	boolean	Show or don't show horizontal crosshair. Default: FALSE.
CURSOR_SHOW_VERT_HAIR	boolean	Show or don't show vertical crosshair. Default: FALSE.

Table 19-5 *Cursor Attributes— Continued*

Attribute	*Value Type*	*Description*
CURSOR_VERT_HAIR_BORDER_GRAVITY	boolean	Vertical crosshair sticks to borders. Default: FALSE.
CURSOR_VERT_HAIR_COLOR	int	See CURSOR_CROSSHAIR_COLOR
CURSOR_VERT_HAIR_GAP	int	See CURSOR_CROSSHAIR_GAP.
CURSOR_VERT_HAIR_LENGTH	int	See CURSOR_CROSSHAIR_LENGTH.
CURSOR_VERT_HAIR_OP	int	Raster op for drawing vertical crosshair. Default: PIX_SRC.
CURSOR_VERT_HAIR_THICKNESS	int	See CURSOR_CROSSHAIR_THICKNESS.
CURSOR_XHOT	int	Hot spot x coordinate. Default: 0.
CURSOR_YHOT	int	Hot spot y coordinate. Default: 0.

Table 19-6 *Cursor Functions*

Definition	***Description***
`Cursor` `cursor_copy(src_cursor)` `    Cursor src_cursor;`	Creates and returns a copy of `src_cursor`.
`Cursor` `cursor_create(attributes)` `    `*<attribute-list>* `attributes;`	Creates and returns the opaque handle to a cursor.
`void` `cursor_destroy(cursor)` `    Cursor cursor;`	Destroys `cursor`.
`caddr_t` `cursor_get(cursor, attribute)` `    Cursor cursor;` `    Cursor_attribute attribute;`	Retrieves the value for an attribute of `cursor`.
`void` `cursor_set(cursor, attributes)` `    Cursor cursor;` `    `*<attribute-list>* `attributes;`	Sets the value for one or more attributes of `cursor`. `attributes` is a null-terminated attribute list.

Table 19-7 *Data Types*

Data Type	*Description*
Canvas	Pointer to an opaque structure which describes a canvas.
Cursor	Pointer to an opaque structure which describes a cursor.
Destroy_status	Enumeration: DESTROY_PROCESS_DEATH, DESTROY_CHECKING, or DESTROY_CLEANUP.
Event	The structure which describes an input event: `typedef struct inputevent {` `short ie_code;` `short ie_flags;` `short ie_shiftmask;` `short ie_locx;` `short ie_locy;` `struct timeval ie_time;` `} Event;`
Frame	Pointer to an opaque structure which describes a frame.
Icon	Pointer to an opaque structure which describes a icon.
Inputmask	Mask specifying which input events a window will receive.
Menu	Pointer to an opaque structure which describes a menu.
Menu_attribute	One of the menu attributes (MENU_*).
Menu_generate	Enumerated type of the operation parameter passed to generate procs: MENU_CREATE, MENU_DESTROY, MENU_NOTIFY_CREATE or MENU_NOTIFY_DESTROY.
Menu_item	Pointer to an opaque structure which describes a menu item.
Notify_arg	Opaque client optional argument.
Notify_destroy	Enumeration: NOTIFY_SAFE, NOTIFY_IMMEDIATE. (See also Notify_event_type).
Notify_event	Opaque client event.

Table 19-7 *Data Types— Continued*

Data Type	*Description*
Notify_error	Enumeration of errors for notifier functions: NOTIFY_OK, NOTIFY_UNKNOWN_CLIENT, NOTIFY_NO_CONDITION, NOTIFY_BAD_ITIMER, NOTIFY_BAD_SIGNAL, NOTIFY_NOT_STARTED, NOTIFY_DESTROY_VETOED, NOTIFY_INTERNAL_ERROR, NOTIFY_SRCH, NOTIFY_BADF, NOTIFY_NOMEM, NOTIFY_INVAL, or NOTIFY_FUNC_LIMIT.
Notify_event_type	Enumeration: NOTIFY_SAFE, NOTIFY_IMMEDIATE.
Notify_func	Notifier function.
Notify_signal_mode	Enumeration: NOTIFY_SYNC, NOTIFY_ASYNC.
Notify_value	Enumeration of possible return values for client notify procs: NOTIFY_DONE, NOTIFY_IGNORED, or NOTIFY_UNEXPECTED.
Panel	Pointer to an opaque structure which describes a panel.
Panel_attribute	One of the panel attributes (PANEL_*).
Panel_item	Pointer to an opaque structure which describes a panel item.
Panel_setting	Enumerated type returned by panel_text_notify(); also type of repaint argument to panel_paint(). See the *Panels* chapter and <suntool/panel.h>.
Pixfont	The structure representing a font (for definition see the Pixrect Reference Manual).
Pixrect	The basic object of pixel manipulation in the SunView window system. Pixrects include both a rectangular array of pixels and the means of accessing operations for manipulating those pixels (for definition see the Pixrect Reference Manual).
Pixwin	The basic imaging element of the SunView window system. While, for historical reasons, its fields are public, clients should treat it as an opaque handle.
Rect	The structure describing a rectangle: typedef struct rect { short r_left; short r_top; short r_width; short r_height; } Rect;

Table 19-7 *Data Types— Continued*

Data Type	Description
`Rectlist`	A list of rectangles: `typedef struct rectlist {` `  short rl_x, rl_y;` `  Rectnode *rl_head;` `  Rectnode *rl_tail;` `  Rect rl_bound;` `} Rectlist;` `typedef struct rectnode {` `  Rectnode *rn_next;` `  Rect rn_rect;` `} Rectnode;`
`Scroll_motion`	Enumerated type representing possible scrolling motions: SCROLL_ABSOLUTE, SCROLL_FORWARD, SCROLL_MAX_TO_POINT, SCROLL_PAGE_FORWARD, SCROLL_LINE_FORWARD, SCROLL_BACKWARD, SCROLL_POINT_TO_MAX, SCROLL_PAGE_BACKWARD, or SCROLL_LINE_BACKWARD.
`Scrollbar`	The opaque handle for a scrollbar.
`Scrollbar_attribute`	One of the scrollbar attributes (SCROLL_*).
`Scrollbar_setting`	The value of an enumerated type scrollbar attribute.
`Textsw`	Pointer to an opaque structure which describes a text subwindow.
`Textsw_index`	An index for a character within a text subwindow.
`Textsw_enum`	Enumerated type for various text subwindow attribute values: TEXTSW_ALWAYS, TEXTSW_NEVER, TEXTSW_ONLY, TEXTSW_IF_AUTO_SCROLL, TEXTSW_CLIP, TEXTSW_WRAP_AT_CHAR, TEXTSW_WRAP_AT_WORD.
`Textsw_status`	Enumeration describing the status of text subwindow operations: TEXTSW_STATUS_OKAY, TEXTSW_STATUS_BAD_ATTR, TEXTSW_STATUS_BAD_ATTR_VALUE, TEXTSW_STATUS_CANNOT_ALLOCATE, TEXTSW_STATUS_CANNOT_OPEN_INPUT, or TEXTSW_STATUS_OTHER_ERROR,
`Tty`	Pointer to an opaque structure which describes a tty subwindow.
`Window`	Pointer to an opaque structure which describes a window.

Table 19-7 *Data Types— Continued*

Data Type	*Description*
`Window_attribute`	One of the window attributes (`WIN_*`).
`Window_type`	Type of window, retrieved via the `WIN_TYPE` attribute. One of: `FRAME_TYPE`, `PANEL_TYPE`, `CANVAS_TYPE`, `TEXTSW_TYPE`, or `TTY_TYPE`.

Table 19-8 *Icon Attributes*

Attribute	*Type*	*Description*
ICON_FONT	Pixfont *	Font for icon's label.
ICON_HEIGHT	int	Icon's height in pixels. Default: 64.
ICON_IMAGE	Pixrect *	Memory pixrect for icon's image.
ICON_IMAGE_RECT	Rect *	Rect for icon's image. Default: origin (0, 0), width 64, height 64.
ICON_LABEL	char *	Icon's label.
ICON_LABEL_RECT	Rect *	Rect for icon's label. Default: origin (0, 0), width 0, height 0.
ICON_WIDTH	int	Icon's width in pixels. Default: 64.

Table 19-9 *Icon Functions and Macros*

Definition	***Description***
`Icon` `icon_create(attributes)` *<attribute-list>* `attributes;`	Creates and returns the opaque handle to an icon.
`int` `icon_destroy(icon)` `Icon icon;`	Destroys `icon`.
`caddr_t` `icon_get(icon, attribute)` `Icon icon;` `Icon_attribute attribute;`	Retrieves the value for an attribute of `icon`.
`int` `icon_set(icon, attributes)` `Icon icon;` *<attribute-list>* `attributes;`	Sets the value for one or more attributes of `icon`. `attributes` is a null-terminated attribute list.
`extern static struct mpr_data` `DEFINE_ICON_FROM_IMAGE(name, image)` `static short   icon_image[];`	Macro that creates a static memory pixrect `icon` from `image`; the latter typically is generated by including a file created by `iconedit`. **Note:** you must pass the *address* of `icon` to the icon routines, since the `Icon` object is a pointer.

Table 19-10 *Event Codes*

Event Code	Description	Value (for debugging)
ASCII_FIRST	Marks beginning of ASCII range	0
ASCII_LAST	Marks end of ASCII range	127
META_FIRST	Marks beginning of META range	128
META_LAST	Marks end of META range	255
ACTION_ERASE_CHAR_BACKWARD	Erase char to the left of caret	31744
ACTION_ERASE_CHAR_FORWARD	Erase char to the right of caret	31745
ACTION_ERASE_WORD_BACKWARD	Erase word to the left of caret	31746
ACTION_ERASE_WORD_FORWARD	Erase word to the right of caret	31747
ACTION_ERASE_LINE_BACKWARD	Erase to the beginning of the line	31748
ACTION_ERASE_LINE_END	Erase to the end of the line	31749
ACTION_GO_CHAR_BACKWARD	Move the caret one character to the left	31752
ACTION_GO_CHAR_FORWARD	Move the caret one character to the right	31753
ACTION_GO_WORD_BACKWARD	Move the caret one word to the left	31754
ACTION_GO_WORD_END	Move the caret to the end of the word	31756
ACTION_GO_WORD_FORWARD	Move the caret one word to the right	31755
ACTION_GO_LINE_BACKWARD	Move the caret to the start of the line	31757
ACTION_GO_LINE_END	Move the caret to the end of the line	31759
ACTION_GO_LINE_FORWARD	Move the caret to the start of the next line	31758
ACTION_GO_COLUMN_BACKWARD	Move the caret up one line, maintaining column position	31761
ACTION_GO_COLUMN_FORWARD	Move the caret down one line, maintaining column position	31762
ACTION_GO_DOCUMENT_START	Move the caret to the beginning of the text	31763
ACTION_GO_DOCUMENT_END	Move the caret to the end of the text	31764
ACTION_STOP	Stop the operation	31767
ACTION_AGAIN	Repeat previous operation	31768
ACTION_PROPS	Show property sheet window	31769
ACTION_UNDO	Undo previous operation	31770
ACTION_FRONT	Bring window to the front of the desktop	31772
ACTION_BACK	Put the window at the back of the desktop	31773
ACTION_OPEN	Open a window from its icon form or close if already open)	31775
ACTION_CLOSE	Close a window to an icon	31776
ACTION_COPY	Copy the selection to the clipboard	31774
ACTION_PASTE	Copy clipboard contents to the insertion point	31777
ACTION_CUT	Delete the selection, put on clipboard	31781
ACTION_COPY_THEN_PASTE	Copies then pastes text	31784
ACTION_FIND_FORWARD	Find the text selection to the right of the caret	31779
ACTION_FIND_BACKWARD	Find the text selection to the left of the caret	31778
ACTION_FIND_AND_REPLACE	Show find and replace window	31780
ACTION_SELECT_FIELD_FORWARD	Select the next delimited field	31783

Table 19-10 *Event Codes— Continued*

Event Code	*Description*	*Value (for debugging)*
ACTION_SELECT_FIELD_BACKWARD	Select the previous delimited field	31782
ACTION_MATCH_DELIMITER	Selects text up to a matching delimiter	31894
ACTION_QUOTE	Causes next event in the input stream to pass untranslated by the keymapping system	31898
ACTION_EMPTY	Causes the subwindow to be emptied	31899
ACTION_STORE	Stores the specified selection as a new file	31785
ACTION_LOAD	Loads the specified selection as a new file	31786
ACTION_GET_FILENAME	Gets the selected filename	31788
ACTION_SET_DIRECTORY	Sets the directory to the selection	31788
ACTION_INCLUDE_FILE	Selects the current line (in pending-delete mode) and attempts to insert the file described by that selection	31891
ACTION_CAPS_LOCK	Toggle caps lock state	31895
PANEL_EVENT_CANCEL	The panel or panel item is no longer "current"	32000
PANEL_EVENT_MOVE_IN	The panel or panel item was entered with no mouse buttons down	32001
PANEL_EVENT_DRAG_IN	The panel or panel item was entered with one or more mouse buttons down	32002
SCROLL_REQUEST	Scrolling has been requested	32256
SCROLL_ENTER	Locator (mouse) has moved into the scrollbar	32257
SCROLL_EXIT	Locator (mouse) has moved out of the scrollbar	32258
LOC_MOVE	Locator (mouse) has moved	32512
LOC_STILL	Locator (mouse) has been still for 1/5 second	32513
LOC_WINENTER	Locator (mouse) has entered window	32514
LOC_WINEXIT	Locator (mouse) has exited window	32515
LOC_DRAG	Locator (mouse) has moved while a button was down	32516
LOC_RGNENTER	Locator (mouse) has entered a region of the window	32519
LOC_RGNEXIT	Locator (mouse) has exited a region of the window	32520
LOC_TRAJECTORY	Inhibits the collapse of mouse motions; clients receive LOC_TRAJECTORY events for every locator motion the window system detects.	32523
WIN_REPAINT	Some portion of window requires repainting	32517
WIN_RESIZE	Window has been resized	32518
WIN_STOP	User has pressed the *stop* key	32522
KBD_REQUEST	Window is about to become the focus of keyboard input	32526
KBD_USE	Window is now the focus of keyboard input	32524
KBD_DONE	Window is no longer the focus of keyboard input	32525
SHIFT_LEFT	Left shift key changed state	32530
SHIFT_RIGHT	Right shift key changed state	32531
SHIFT_CTRL	Control key changed state	32532
SHIFT_META	Meta key changed state	32534
SHIFT_LOCK	Shift lock key changed state	32529

Table 19-10 *Event Codes— Continued*

Event Code	*Description*	*Value (for debugging)*
SHIFT_CAPSLOCK	Caps lock key changed state	32528
BUT(i)	Locator (mouse) buttons 1–10	BUT(1) is 32544
MS_LEFT	Left mouse button	32544
MS_MIDDLE	Middle mouse button	32545
MS_RIGHT	Right mouse button	32546
KEY_LEFT(i)	Left function keys 1–15	KEY_LEFT(1) is 32554
KEY_RIGHT(i)	Right function keys 1–15	KEY_RIGHT(1) is 32570
KEY_TOP(i)	Top function keys 1–15	KEY_TOP(1) is 32586

Table 19-11 *Event Descriptors*

Event Descriptor	*Explanation*
`WIN_NO_EVENTS`	Clears input mask — no events will be accepted. Note: the effect is the same whether used with a *consume* or an *ignore* attribute. A new window has a cleared input mask.
`WIN_ASCII_EVENTS`	All ASCII events. ASCII events that occur while the META key is depressed are reported with codes in the META range. In addition, cursor control keys and function keys are reported as ANSI escape sequences: a sequence of events whose codes are ASCII characters, beginning with <ESC>.
`WIN_IN_TRANSIT_EVENTS`	Enables immediate `LOC_MOVE`, `LOC_WINENTER`, and `LOC_WINEXIT` events. Pick mask only. Off by default.
`WIN_LEFT_KEYS`	The left function keys, KEY_LEFT(1) — KEY_LEFT(15).
`WIN_MOUSE_BUTTONS`	Shorthand for `MS_RIGHT`, `MS_MIDDLE` and `MS_LEFT`. Also sets or resets `WIN_UP_EVENTS`.
`WIN_RIGHT_KEYS`	The right function keys, KEY_RIGHT(1) — KEY_RIGHT(15).
`WIN_TOP_KEYS`	The top function keys, KEY_TOP(1) — KEY_TOP(15).
`WIN_UP_ASCII_EVENTS`	Causes the matching up transitions to normal ASCII events to be reported — if you see an 'a' go down, you'll eventually see the matching 'a' up.
`WIN_UP_EVENTS`	Causes up transitions to be reported for button and function key events being consumed.

Table 19-12 *Input-Related Window Attributes*

Attribute	*Value Type*	*Description*
WIN_INPUT_DESIGNEE	int	Window which gets events this window doesn't consume. (Note that the value must be the designee's WIN_DEVICE_NUMBER).
WIN_GRAB_ALL_INPUT	boolean	Window will get all events regardless of location.
WIN_KBD_FOCUS	boolean	Whether or not the window has the keyboard focus.
WIN_KBD_INPUT_MASK	Inputmask *	Window's keyboard inputmask.
WIN_PICK_INPUT_MASK	Inputmask *	Window's pick inputmask.
WIN_CONSUME_KBD_EVENT	short	Window will receive this event.
WIN_IGNORE_KBD_EVENT	short	Window will not receive this event.
WIN_CONSUME_KBD_EVENTS	short list	Null terminated list of events window will receive.
WIN_IGNORE_KBD_EVENTS	short list	Null terminated list of events window will not receive.
WIN_CONSUME_PICK_EVENT	short	Window will receive this pick event.
WIN_IGNORE_PICK_EVENT	short	Window will not receive this pick event.
WIN_CONSUME_PICK_EVENTS	short list	Null terminated list of pick events window will receive.
WIN_IGNORE_PICK_EVENTS	short list	Null terminated list of pick events window will not receive.

Table 19-13 *Menu Attributes*

Attribute	*Value Type*	*Description*
MENU_ACTION_IMAGE	Pixrect *, action proc	Create image menu item with action proc. Set only.
MENU_ACTION_ITEM	char *, action proc	Create string menu item with action proc. Set only.
MENU_APPEND_ITEM	Menu_item	Append item to end of menu. Set only.
MENU_BOXED	boolean	If TRUE, a single-pixel box will be drawn around every menu item.
MENU_CENTER	boolean	If TRUE, all string items in the menu will be centered. Default: FALSE
MENU_CLIENT_DATA	caddr_t	For client's use.
MENU_COLUMN_MAJOR	boolean	If TRUE, string items in the menu will be sorted in column-major order (like ls(1)) instead of row-major order. Default: FALSE
MENU_CLIENT_DATA	caddr_t	For client's use.
MENU_DESCEND_FIRST	(no value)	For menu_find(). If given, search will be depth first, else search will be "deferred".
MENU_DEFAULT	int	Default menu item as a position.
MENU_DEFAULT_ITEM	Menu_item	Default menu item as opaque handle.
MENU_DEFAULT_SELECTION	enum	Either MENU_SELECTED or MENU_DEFAULT.
MENU_FIRST_EVENT	Event *	The event which was initially passed into menu_show(). Get only. (Note that the event's contents can be modified.)
MENU_FONT	Pixfont *	Menu's font.
MENU_GEN_PROC	(procedure)	Client's function called to generate the menu. `Menu gen_proc(m, op)` `Menu m;` `Menu_generate op;`
MENU_GEN_PULLRIGHT_IMAGE	Pixrect *, gen proc	Create image menu item with generate proc for pullright. Set only.
MENU_GEN_PULLRIGHT_ITEM	char *, gen proc	Create string menu item with generate proc for pullright. Set only.
MENU_IMAGE_ITEM	Pixrect *, value	Create image menu item with value. Set only.

Table 19-13 *Menu Attributes— Continued*

Attribute	*Value Type*	*Description*
MENU_IMAGES	list of Pixrect *	Create multiple image menu items. Set only.
MENU_INITIAL_SELECTION	enum	Either MENU_SELECTED or MENU_DEFAULT.
MENU_INITIAL_SELECTION_EXPANDED	boolean	If TRUE, when the menu pops up, it automatically expands to select the initial selection.
MENU_INITIAL_SELECTION_SELECTED	boolean	If TRUE, menu comes up with its initial selection highlighted. If FALSE, menu comes up with the cursor "standing off" to the left.
MENU_INSERT	int, Menu_item	Insert new item after nth item. Set only.
MENU_INSERT_ITEM	Menu_item, Menu_item	The item given as the second value is inserted after the one given as the first value. Set only.
MENU_ITEM	avlist	Create a menu item inline — avlist same as for `menu_create_item()`. Set only.
MENU_JUMP_AFTER_NO_SELECTION	boolean	If TRUE, cursor jumps back to its original position after no selection made.
MENU_JUMP_AFTER_SELECTION	boolean	If TRUE, cursor jumps back to its original position after selection made.
MENU_LAST_EVENT	Event *	The last event read by the menu. Get only. Note that the event's contents can be modified.
MENU_LEFT_MARGIN	int	For each string item, margin in addition to MENU_MARGIN on left between menu's border and text. Default: 16.
MENU_MARGIN	int	Margin in pixels around menu items. Default: 1.
MENU_NCOLS	int	Number of columns in menu.
MENU_NITEMS	int	Get only; returns the # of items in the menu.
MENU_NROWS	int	Number of rows in menu.
MENU_NOTIFY_PROC	(procedure)	Client's function called when the user selects a menu item. `caddr_t notify_proc(m, mi)` `  Menu m;` `  Menu_item mi;`

Table 19-13 *Menu Attributes— Continued*

Attribute	Value Type	Description
MENU_NTH_ITEM	int starting from 1.	Get only; returns nth menu item. n is counted
MENU_PARENT	Menu_item	The menu item for which the menu is a pullright. Get only.
MENU_PULLRIGHT_DELTA	int	Number of pixels the user must move the cursor to the right to cause a pullright menu to pop up. Default: 9999.
MENU_PULLRIGHT_IMAGE	Pixrect *, Menu	Create image menu item with pullright. Set only.
MENU_PULLRIGHT_ITEM	char *, Menu	Create string menu item with pullright. Set only.
MENU_REMOVE	int	Remove the nth item. Set only.
MENU_REMOVE_ITEM	Menu_item	Remove the specified item. Set only.
MENU_REPLACE	int, Menu_item	Replace nth item with specified item. Set only.
MENU_REPLACE_ITEM	Menu_item, Menu_item	The item given as first value is replaced with the one given as the second value in the menu (the old item is not replaced in any other menus it may appear in). Set only.
MENU_RIGHT_MARGIN	int	For each string item, margin in addition to MENU_MARGIN on right between menu's border and text.
MENU_SELECTED	int	Last selected item, as a position in menu.
MENU_SELECTED_ITEM	Menu_item	Last selected item, as the item's handle.
MENU_SHADOW	Pixrect *	Pattern for the shadow to be painted behind the menu. If 0, no shadow is painted. Predefined shadow pixrects you can use: menu_gray25_pr, menu_gray50_pr, and menu_gray75_pr.
MENU_STAY_UP	boolean	If TRUE the first *click* of the Menu button puts up the menu, the second takes it down; in between, the menu stays up. Default: FALSE
MENU_STRINGS	list of char *	Create multiple string menu items. Set only.
MENU_STRING_ITEM	char *, value	Create string menu item with value. Set only.

Table 19-13 *Menu Attributes— Continued*

Attribute	*Value Type*	*Description*
MENU_TITLE_IMAGE	Pixrect *	Create image title item. Set only.
MENU_TITLE_ITEM	char *	Create string title item. Set only.
MENU_TYPE	enum	Get only; returns MENU_MENU.
MENU_VALID_RESULT	boolean	Tells whether a zero return value represents a legitimate value.

Table 19-14 *Menu Item Attributes*

Attribute	Value Type	Description
MENU_ACTION_IMAGE†	Pixrect *, action proc	Modifies appropriate fields in item. Set only.
MENU_ACTION_ITEM†	char *, action proc	Modifies appropriate fields in item. Set only.
MENU_ACTION_PROC	(procedure)	Client's function called after item has been selected: `caddr_t action_proc(menu, menu_item)` `Menu menu` `Menu_item menu_item`
MENU_APPEND_ITEM†	Menu_item	Append item to end of menu. Set only.
MENU_BOXED†	boolean	If TRUE, a single-pixel box will be drawn around the item.
MENU_CENTER†	boolean	If TRUE, the menu item will be centered on its row in the menu. Only meaningful for menu strings.
MENU_CLIENT_DATA†	caddr_t	For use by the client.
MENU_FEEDBACK	boolean	If FALSE, item is never inverted and is not selectable.
MENU_FONT†	Pixfont *	Item's font.
MENU_GEN_PROC†	(procedure)	Client's procedure called to generate the item.
MENU_GEN_PROC_IMAGE	Pixrect *, (procedure)	Modifies appropriate fields in item. Set only.
MENU_GEN_PROC_ITEM	char *, (procedure)	Modifies appropriate fields in item. Set only.
MENU_GEN_PULLRIGHT	generate proc	Generate proc for the item's pullright.
MENU_GEN_PULLRIGHT_IMAGE†	Pixrect *, (procedure)	Modifies appropriate fields in item. Set only.
MENU_GEN_PULLRIGHT_ITEM†	char *, gen proc	Modifies appropriate fields in item. Set only.
MENU_IMAGE	Pixrect *	Item's image.
MENU_IMAGE_ITEM†	char *, action proc	Modifies appropriate fields in item. Set only.
MENU_INACTIVE	boolean	If TRUE, item is grayed out and not selectable.

† Many of the attributes in this table appeared in the previous table. Menus and menu *items* have many attributes in common. Attributes marked with "†" are also valid for menus, although the effect of the attribute may differ.

Table 19-14 *Menu Item Attributes— Continued*

Attribute	*Value Type*	*Description*
MENU_INVERT	boolean	If TRUE, item's display is inverted.
MENU_LEFT_MARGIN†	int	Margin in addition of MENU_MARGIN on left between menu's border and text.
MENU_MARGIN†	int	Margin in pixels around the item.
MENU_PARENT†	Menu	The menu containing the item.
MENU_PULLRIGHT	Menu	Item's pullright menu.
MENU_PULLRIGHT_IMAGE†	Pixrect *, Menu	Modifies appropriate fields in item. Set only.
MENU_PULLRIGHT_ITEM†	char *, Menu	Modifies appropriate fields in item. Set only.
MENU_RELEASE	(no value)	The item will be automatically destroyed when its parent menu is destroyed (default for items created inline).
MENU_RELEASE_IMAGE	(no value)	The string or pixrect associated with the item will be freed when the item is destroyed.
MENU_RIGHT_MARGIN†	int	Margin in addition of MENU_MARGIN on right between menu's border and text.
MENU_SELECTED†	boolean	If TRUE, the item is currently selected.
MENU_STRING†	char *	Item's string.
MENU_STRING_ITEM†	char *, value	Modifies appropriate fields in item. Set only.
MENU_TYPE†	enum	Get only, returns MENU_ITEM.
MENU_VALUE	caddr_t	Item's value.

Table 19-15 *Menu Functions*

Definition	***Description***
`Menu` `menu_create(attributes)` *<attribute-list>* `attributes;`	Creates and returns the opaque handle for a walking menu.
`Menu_item` `menu_create_item(attributes)` *<attribute-list>* `attributes;`	Creates and returns the opaque handle for a single item within a walking menu.
`void` `menu_destroy(menu_object)` *<Menu or Menu_item>* `menu_object;`	Destroys a menu or menu item.
`void` `menu_destroy_with_proc(menu_object, destroy_proc)` *<Menu or Menu_item>* `menu_object;` `void (*destroy_proc)();`	The function supplied as `destroy_proc` is called before the menu or menu item is destroyed. Arguments: `destroy_proc(menu_object, type)` *<Menu or Menu_item>* `menu_object;` `Menu_attribute type;` `type` is `MENU_MENU` for menus, `MENU_ITEM` for items.
`Menu_item` `menu_find(menu, attributes)` `Menu menu;` *<attribute-list>* `attributes;`	Returns the first menu item in `menu` meeting the criteria specified in `attributes`.
`caddr_t` `menu_get(menu_object, attribute[, optional_arg])` *<Menu or Menu_item>* `menu_object;` `Menu_attribute attributes;` `caddr_t optional_arg;`	Retrieves the value for an attribute of a menu or menu item.
`int` `menu_set(menu_object, attributes)` *<Menu or Menu_item>* `menu_object;` *<attribute-list>* `attributes;`	Sets the value of one or more attributes for a menu or menu item. `attributes` is a null-terminated attribute list.
`caddr_t` `menu_show(menu, window, event, 0)` `Menu menu;` `Window window;` `Event *event;`	Displays the menu, gets a selection from the user, and, by default, returns the value of the item the user has selected. `window` is the handle of the window over which the menu is displayed; `event` is the event which causes the menu to come up. The final argument is currently ignored.

Table 19-15 *Menu Functions— Continued*

Definition	*Description*
`caddr_t menu_show_using_fd(menu, fd, event)` `Menu menu;` `int fd;` `Event *event;`	Provided for compatibility with SunWindows 2.0. Allows you to display a menu within a window using the windowfd.
`caddr_t` `menu_return_item(menu, menu_item)` `Menu menu;` `Menu_item menu_item;`	Predefined notify proc which, if given as the value for `MENU_NOTIFY_PROC`, causes `menu_show()` to return the handle of the selected item, rather than its value.
`caddr_t` `menu_return_value(menu, menu_item)` `Menu menu;` `Menu_item menu_item;`	Default notify proc for menus. Causes `menu_show()` to return the value of the selected item.

Table 19-16 *Notifier Functions*

Definition	***Description***
`Notify_value` `notify_default_wait3(client, pid, status, rusage)` `    Notify_client  client;` `    int            pid;` `    union wait    *status;` `    struct rusage *rusage;`	Predefined function you can register with the Notifier via the `notify_set_wait3_func()` call. Causes the required housekeeping to be performed on the process identified by `pid` when it dies. See the `wait(2)` man page for details of the `wait` and `rusage` structures.
`Notify_error` `notify_dispatch()`	Provided to allow programs which are not notification-based to run in the SunView environment. Called regularly from within the application's main loop to allow the Notifier to go once around its internal loop and dispatch any pending events.
`Notify_error` `notify_do_dispatch()`	Called once, before the application's main loop. Enables "implicit dispatching," in which the Notifier dispatches events from within calls to `read(2)` or `select(2)`.
`Notify_error` `notify_interpose_destroy_func(client, destroy_func)` `    Notify_client client;` `    Notify_func   destroy_func;`	Interposes `destroy_func()` in front of `client`'s destroy event handler.
`Notify_error` `notify_interpose_event_func(client,` `                           event_func, type)` `    Notify_client     client;` `    Notify_func       event_func;` `    Notify_event_type type;`	Interposes `event_func()` in front of `client`'s event handler.
`Notify_error` `notify_itimer_value(client, which, value)` `    Notify_client     client;` `    int               which;` `    struct itimerval *value;`	Returns the current state of an interval timer for `client` in the structure pointed to by `value`. The `which` parameter is either `ITIMER_REAL` or `ITIMER_VIRTUAL`.
`Notify_value` `notify_next_destroy_func(client, status)` `    Notify_client  client;` `    Destroy_status status;`	Calls the next destroy event handler for `client`. `status` returns `DESTROY_PROCESS_DEATH`, `DESTROY_CHECKING`, or `DESTROY_CLEANUP`.

Table 19-16 *Notifier Functions— Continued*

Definition	*Description*
`Notify_value` `notify_next_event_func(client, event, arg, type)` `    Notify_client     client;` `    Event            *event;` `    Notify_arg        arg;` `    Notify_event_type type;`	Calls the next event handler for `client`.
`Notify_error` `notify_no_dispatch()`	Prevents the Notifier from dispatching events from within the call to `read`(2) or `select`(2).
`void` `notify_perror(s)` `   char *s;`	Analogous to the UNIX `perror`(3) system call. `s` is printed to `stderr`, followed by a terse description of `notify_errno()`.
`Notify_func` `notify_set_destroy_func(client, destroy_func)` `    Notify_client client;` `    Notify_func   destroy_func;`	Registers `destroy_func()` with the Notifier. `destroy_func()` will be called when a destroy event is posted to `client` or when the process receives a `SIGTERM` signal.
`Notify_func` `notify_set_exception_func(client, exception_func, fd)` `    Notify_client client;` `    Notify_func   exception_func;` `    int           fd;`	Registers the exception handler `exception_func()` with the Notifier. The only known devices that generate exceptions at this time are stream-based socket connections when an out-of-band byte is available.
`Notify_func` `notify_set_input_func(client, input_func, fd)` `    Notify_client client;` `    Notify_func   input_func;` `    int           fd;`	Registers `input_func()` with the Notifier. `input_func()` will be called whenever there is input pending on `fd`.
`Notify_func` `notify_set_itimer_func(client, itimer_func, which,` `                        value, ovalue)` `    Notify_client     client;` `    Notify_func       itimer_func;` `    int               which;` `    struct itimerval *value, *ovalue;`	Registers the timeout event handler `itimer_func()` with the Notifier. The semantics of `which`, `value` and `ovalue` parallel the arguments to `setitimer` (see the `getitimer` manual page). `which` is either `ITIMER_REAL` or `ITIMER_VIRTUAL`.

Table 19-16 *Notifier Functions— Continued*

Definition	*Description*
`Notify_func` `notify_set_signal_func(client, signal_func,` `                       signal, when)` `   Notify_client      client;` `   Notify_func        signal_func;` `   int                signal;` `   Notify_signal_mode when;`	Registers the signal event handler `signal_func()` with the Notifier. `signal_func()` will be called whenever `signal` is caught by the Notifier. `when` can be either `NOTIFY_SYNC` or `NOTIFY_ASYNC`. Calling `notify_set_signal_func()` with a `NULL` in the place of the `signal_func()` turns off checking for that signal for that client.
`Notify_error` `notify_start()`	Begins dispatching of events by the Notifier.
`Notify_error` `notify_stop()`	Terminates dispatching of events by the Notifier.
`Notify_func` `notify_set_output_func(client, output_func, fd)` `   Notify_client client;` `   Notify_func   output_func;` `   int           fd;`	Registers `output_func()` with the Notifier. `output_func()` will be called whenever output has been completed on `fd`.
`Notify_func` `notify_set_wait3_func(client, wait3_func, pid)` `   Notify_client client;` `   Notify_func   wait3_func;` `   int           pid;`	Registers the function `wait3_func()` with the Notifier. The registered function will be called after the child process identified by `pid` dies. To do the minimum processing, register the predefined function `notify_default_wait3()`.
`Notify_error` `notify_veto_destroy(client)` `   Notify_client client;`	Called from within a destroy event handler when `status` is `DESTROY_CHECKING` and the application does not want to be destroyed.

Table 19-17 *Panel Attributes*

Attribute	*Value Type*	*Description*
PANEL_ACCEPT_KEYSTROKE	boolean	If TRUE, keystroke events are passed to the panel's PANEL_BACKGROUND_PROC. Default: FALSE.
PANEL_BACKGROUND_PROC	(procedure)	Event handling procedure called when an event falls on the background of the panel. Form: `background_proc(panel, event)` `Panel panel` `Event *event`
PANEL_BLINK_CARET	boolean	If TRUE, the caret blinks. Default: setting of *Blink_caret* in the *Text* category of defaultsedit.
PANEL_CARET_ITEM	Panel_item	Text item which currently has the caret. Default: first text item.
PANEL_EVENT_PROC	(procedure)	Event handling procedure for panel items. Sets the default for subsequent items created in panel. Form: `event_proc(item, event)` `Panel_item item` `Event *event`
PANEL_FIRST_ITEM	Panel_item	First item in the panel. Get only.
PANEL_ITEM_X_GAP	int	Number of x-pixels between items. Default: 10.
PANEL_ITEM_Y_GAP	int	Number of y-pixels between items. Default: 5.
PANEL_LABEL_BOLD	boolean	If TRUE, item's label is rendered in bold. Sets the default for subsequent items created in panel. Default: FALSE.
PANEL_LAYOUT	Panel_setting	Layout of item's value relative to the label. PANEL_HORIZONTAL (default) or PANEL_VERTICAL.
PANEL_SHOW_MENU	boolean	If TRUE, the menu for the item is enabled. Sets the default for subsequent items created in panel.

Table 19-18 *Generic Panel Item Attributes*

Attribute	*Value Type*	*Description*
PANEL_ACCEPT_KEYSTROKE	boolean	If TRUE, keystroke events are passed to the item's EVENT_PROC.
PANEL_CLIENT_DATA	caddr_t	For application's use.
PANEL_EVENT_PROC	(procedure)	Event handling procedure for the item.
PANEL_ITEM_RECT	Rect *	Enclosing rectangle for the item. Get only.
PANEL_ITEM_X	int	Left edge of item rectangle. If unspecified and label or value positions are fixed, then set to min of PANEL_LABEL_X and PANEL_VALUE_X. Default: after lowest, rightmost item
PANEL_ITEM_Y	int	top edge of item rectangle. If unspecified and label or value positions are fixed, then set to min of PANEL_LABEL_Y and PANEL_VALUE_Y. Default: previous item's PANEL_ITEM_Y.
PANEL_LABEL_X	int	Left edge of label. If unspecified and value position is fixed, then set to left of PANEL_VALUE_X for horizontal layout, or at PANEL_VALUE_X for vertical layout. Default: PANEL_ITEM_X.
PANEL_LABEL_Y	int	Top edge of label. If unspecified and value position is fixed, then set to PANEL_VALUE_Y for horizontal layout, or above PANEL_VALUE_Y for vertical layout. Default: PANEL_ITEM_Y.
PANEL_LABEL_BOLD	boolean	If TRUE, item's label is rendered in bold. Default: FALSE.
PANEL_LABEL_FONT	Pixfont *	Font for PANEL_LABEL_STRING. Default: WIN_FONT.
PANEL_LABEL_IMAGE	Pixrect *	Image for item's label.
PANEL_LABEL_STRING	char *	String for item's label.
PANEL_LAYOUT	Panel_setting	Layout of item's value relative to the label. PANEL_HORIZONTAL (default) or PANEL_VERTICAL.
PANEL_MENU_CHOICE_FONTS	list of Pixfont *	Font for each menu choice string. Create, set. Default: WIN_FONT.
PANEL_MENU_CHOICE_IMAGES	list of Pixrect *	Image for each menu choice. Create, set. Default: PANEL_CHOICE_IMAGES for choice items, PANEL_LABEL_IMAGE for button items, NULL for other items.
PANEL_MENU_CHOICE_STRINGS	list of char *	String for each menu choice. Create, set. Default: PANEL_CHOICE_STRINGS for choice items, NULL for other items.
PANEL_MENU_CHOICE_VALUES	list of caddr_t	The values returned from the item's menu. Create, set.

Table 19-18 *Generic Panel Item Attributes— Continued*

Attribute	*Value Type*	*Description*
PANEL_MENU_TITLE_FONT	Pixfont *	Font for PANEL_MENU_TITLE_STRING.
PANEL_MENU_TITLE_IMAGE	Pixrect *	Image for the menu title.
PANEL_MENU_TITLE_STRING	char *	String for the menu title.
PANEL_NEXT_ITEM	Panel_item	Next item in the panel. Get only.
PANEL_NOTIFY_PROC	(procedure)	Function to call when item is selected. Form for button and text items: `notify_proc(item, event)` `Panel_item item` `Event *event` Choice and slider items have an additional parameter for the current value: `notify_proc(item, value, event)` `Panel_item item` `int value` `Event *event` For toggle items, the `value` parameter is of type `unsigned int`. The type for a text item `notify_proc` is `Panel_setting`.
PANEL_PAINT	Panel_setting	Item's painting behavior for `panel_set()` calls. One of: PANEL_NONE, PANEL_CLEAR, or PANEL_NO_CLEAR.
PANEL_PARENT_PANEL	Panel	The panel which contains the item.
PANEL_SHOW_ITEM	boolean	Whether or not to show the item. Default: TRUE.
PANEL_SHOW_MENU	boolean	If TRUE, the menu for the item is enabled.
PANEL_VALUE_X	int	Left edge of value. If unspecified and label position is fixed, then set to right of PANEL_LABEL_X for horizontal layout, or at PANEL_LABEL_X for vertical layout. Default: after the label.
PANEL_VALUE_Y	int	Top edge of value. If unspecified and label position is fixed, then set to PANEL_LABEL_Y for horizontal layout, or below PANEL_LABEL_Y for vertical layout. Default: PANEL_LABEL_Y.

Table 19-19 *Choice and Toggle Item Attributes*

Attribute	*Value Type*	*Description*
PANEL_CHOICE_FONTS	list of Pixfont *	Font to use for each choice string. Create, set.
PANEL_CHOICE_IMAGE	int, pixrect *	Image for choice specified by the first argument.
PANEL_CHOICE_IMAGES	list of Pixrect *	Image for each choice. Create, set.
PANEL_CHOICE_STRING	int, char *	String for choice specified by first argument.
PANEL_CHOICE_STRINGS	list of char *	String for each choice. Note that you must specify at least one choice — the least you can specify is a single null string (PANEL_CHOICE_STRINGS, "", 0). Create, set.
PANEL_CHOICE_X	int, int	Second argument is left edge of choice specified by first argument.
PANEL_CHOICE_XS	list of int	Left edge of each choice. Create, set.
PANEL_CHOICE_Y	int, int	Second argument is top edge of choice specified by first argument.
PANEL_CHOICE_YS	list of int	Top edge of each choice. Create, set.
PANEL_CHOICES_BOLD	boolean	If TRUE, choices strings are in bold. Default: FALSE.
PANEL_DISPLAY_LEVEL	Panel_setting	How many choices to display. One of PANEL_NONE, PANEL_CURRENT, or PANEL_ALL. Default: PANEL_ALL.
PANEL_FEEDBACK	Panel_setting	Feedback to give when a choice is selected. One of PANEL_NONE, PANEL_MARKED, PANEL_INVERTED. If PANEL_DISPLAY_LEVEL is PANEL_CURRENT, default is PANEL_NONE, otherwise PANEL_MARKED.
PANEL_LAYOUT	Panel_setting	Layout of the choices: PANEL_HORIZONTAL (default) or PANEL_VERTICAL.
PANEL_MARK_IMAGE	int, Pixrect *	Image to mark choice specified by the first argument when it is selected. Default is push-button image: <images/panel_choice_on.pr>.

Table 19-19 *Choice and Toggle Item Attributes— Continued*

Attribute	*Value Type*	*Description*
PANEL_MARK_IMAGES	list of Pixrect *	Image to mark each choice with when selected. Create, set only. Default is push-button image: <images/panel_choice_on.pr>.
PANEL_MARK_X	int, int	Second argument is left edge of choice mark specified by first argument.
PANEL_MARK_XS	list of int	Left edge of each choice mark. Create, set.
PANEL_MARK_Y	int, int	Second argument is top edge of choice mark specified by first argument.
PANEL_MARK_YS	list of int	Top edge of each choice mark. Create, set.
PANEL_MENU_MARK_IMAGE	Pixrect *	Image to mark each menu choice with when selected.
PANEL_MENU_NOMARK_IMAGE	Pixrect *	Image to mark each menu choice with when not selected.
PANEL_NOMARK_IMAGE	int, Pixrect *	Image to mark choice specified by the first argument when it is not selected. Default is push-button image: <images/panel_choice_off.pr>.
PANEL_NOMARK_IMAGES	list of Pixrect *	Image to mark each choice with when not selected. Create, set. Default is push-button image: <images/panel_choice_off.pr>.
PANEL_SHOW_MENU_MARK	boolean	Show or don't show the menu mark for each selected choice. Default: TRUE.
PANEL_TOGGLE_VALUE	int, int	Value of a particular toggle choice. Second argument is value of choice specified by first argument.
PANEL_VALUE	int or unsigned	If item is a choice, value is ordinal position (from 0) of current choice. If item is a toggle, value is a bitmask indicating currently selected choices (e.g., bit 5 is 1 if 5th choice selected).

Table 19-20 *Slider Item Attributes*

Attribute	*Value Type*	*Description*
PANEL_MIN_VALUE	int	Minimum value of slider. Default: 0.
PANEL_MAX_VALUE	int	Maximum value of the slider. Default: 100.
PANEL_NOTIFY_LEVEL	Panel_setting	When to call the notify function: PANEL_DONE notifies when the select button is released, PANEL_ALL notifies continuously as the select button is dragged. Default: PANEL_DONE.
PANEL_SHOW_RANGE	boolean	Show or don't show the min and max slider values. Default: TRUE.
PANEL_SHOW_VALUE	boolean	Show or don't show integer value of slider. Default: TRUE.
PANEL_SLIDER_WIDTH	int	Width of the slider bar in pixels. Default: 100.
PANEL_VALUE	int	Initial or new value for the item, in the range PANEL_MIN_VALUE to PANEL_MAX_VALUE. Default: PANEL_MIN_VALUE.
PANEL_VALUE_FONT	Pixfont *	Font to use when displaying the value.

Table 19-21 *Text Item Attributes*

Attribute	*Value Type*	*Description*
PANEL_MASK_CHAR	char	Character used to mask type-in characters. Use the space character for no character echo (caret does not advance). Use the null character to disable masking.
PANEL_NOTIFY_LEVEL	Panel_setting	When to call the notify function. One of PANEL_NONE, PANEL_NON_PRINTABLE, PANEL_SPECIFIED, or PANEL_ALL. Default: PANEL_SPECIFIED (see *Text Notification*).
PANEL_NOTIFY_STRING	char *	String of characters which trigger notification when typed. Applies only when PANEL_NOTIFY_LEVEL is PANEL_SPECIFIED. Default: \n\r\t (newline, carriage return and tab).
PANEL_VALUE_STORED_LENGTH	int	Max number of characters to store in the value string. Default: 80.
PANEL_VALUE_DISPLAY_LENGTH	int	Max number of characters to display in the panel. Default: 80.
PANEL_VALUE	char *	Initial or new string value for the item.
PANEL_VALUE_FONT	Pixfont *	Font to use for the value string.

Table 19-22 *Panel Functions and Macros*

Definition	*Description*
`panel_accept_key(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells a text item to accept a keyboard event. Currently ignored by non-text panel items.
`panel_accept_menu(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells an item to display its menu and process the user's selection.
`panel_accept_preview(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells an item to do what it is supposed to do when it is selected. This may include completing feedback initiated by `panel_begin_preview()`.
`Panel_item` `panel_advance_caret(panel)` `Panel panel;`	Advance the caret to the next text item. If on the last text item, rotate back to the first. Returns the new caret item, or `NULL` if there are no text items.
`Panel_item` `panel_backup_caret(panel)` `Panel panel;`	Backup the caret to the previous text item. If on the first text item, rotate back to the first. Returns the new caret item, or `NULL` if there are no text items.
`panel_begin_preview(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells an item to begin any feedback which indicates tentative selection.
`Pixrect *` `panel_button_image(panel, string, width, font)` `Panel panel;` `char *string;` `int width;` `Pixfont *font;`	Creates a standard, button-like image from a string. The string is rendered in `font`, centered within a double-pixel border `width` characters wide. If `width` is too narrow for the string, the border will be expanded to contain the entire string. If `font` is 0, `panel`'s font is used.
`panel_cancel_preview(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells an item to cancel the feedback initiated by `panel_begin_preview()`.
`Panel_item` `panel_create_item(panel, item_type, attributes)` `Panel panel;` <*item type*> `item_type;` <*attribute-list*> `attributes;`	Creates and returns the opaque handle to a panel item. `item_type` is one of: `PANEL_MESSAGE`, `PANEL_BUTTON`, `PANEL_CHOICE`, `PANEL_CYCLE`, `PANEL_TOGGLE`, `PANEL_TEXT` or `PANEL_SLIDER`. `attributes` is a null-terminated attribute list.

Table 19-22 *Panel Functions and Macros— Continued*

Definition	*Description*
`panel_default_handle_event(object, event)` *<Panel or Panel_item>* `object;` `Event *event;`	The default event proc for panel items (`PANEL_EVENT_PROC`) and for the panel's background (`PANEL_BACKGROUND_PROC`). Implements the standard event-to-action mapping for the item types.
`panel_destroy_item(item)` `Panel_item item;`	Destroys `item`.
`panel_each_item(panel, item)` `Panel panel;` `Panel_item item;`	Macro to iterate over each item in a panel. The corresponding macro `panel_end_each` closes the loop opened by `panel_each_item()`.
`Event *` `panel_event(panel, event)` `Panel panel;` `Event *event;`	Translates the coordinates of `event` from the space of the panel subwindow to the space of the logical panel (which may be larger and scrollable).
`caddr_t` `panel_get(item, attribute[, optional_arg])` `Panel_item item;` `Panel_attribute attribute;` `Panel_attribute optional_arg;`	Retrieve the value of an attribute for `item`. `optional_arg` is used for a few attributes which require additional information, such as `PANEL_CHOICE_IMAGE`, `PANEL_CHOICE_STRING`, `PANEL_CHOICE_X`, `PANEL_CHOICE_Y`, `PANEL_MARK_X`, `PANEL_MARK_Y`, `PANEL_TOGGLE_VALUE`.
`caddr_t` `panel_get_value(item)` `Panel_item item;`	A macro, defined as: `panel_get(item, PANEL_VALUE)`
`panel_paint(panel_object, paint_behavior)` *<Panel_item or Panel>* `panel_object;` `Panel_setting paint_behavior;`	Paints an item or an entire panel. `paint_behavior` can be either `PANEL_CLEAR` or `PANEL_NO_CLEAR`. `PANEL_CLEAR` causes the area occupied by the panel or item to be cleared prior to painting.
`panel_set(item, attributes)` `Panel_item item;` *<attribute-list>* `attributes;`	Sets the value of one or more panel attributes. `attributes` is a null-terminated attribute list.
`panel_set_value(item, value)` `Panel_item item;` `caddr_t value;`	A macro, defined as: `panel_set(item, PANEL_VALUE, value, 0)`
`Panel_setting` `panel_text_notify(item, event)` `Panel_item item` `Event *event`	Default notify procedure for panel text items. Causes caret to advance on CR or tab, caret to backup on shift-CR or shift-tab, printable characters to be inserted into `item's` value, and all other characters to be discarded.

Table 19-22 *Panel Functions and Macros— Continued*

Definition	*Description*
`panel_update_preview(object, event)` <*Panel or Panel_item*> `object;` `Event *event;`	Action function which tells the item to update its previewing feedback (e.g. redraw the slider bar for a slider item).
`panel_update_scrolling_size(panel)` `Panel panel;`	Updates the scrollbar's notion of the panel's size, so the scrollbar's bubble will be the correct size.
`Event *` `panel_window_event(panel, event)` `Panel panel;` `Event *event;`	Translates the coordinates of `event` to the space of the panel subwindow from the space of the logical panel (which may be larger and scrollable).

Table 19-23 *Pixwin Drawing Functions and Macros*

Definition	*Description*
`pw_batch(pw, n)` `Pixwin *pw;` `Pw_batch_type n;`	Tells the batching mechanism to refresh the screen every n display operations.
`pw_batch_off(pw)` `Pixwin *pw;`	A macro to turn batching off in pw.
`pw_batch_on(pw)` `Pixwin *pw;`	A macro to turn batching on in pw.
`pw_batchrop(pw, dx, dy, op, items, n)` `Pixwin *pw;` `int dx, dy, op, n;` `struct pr_prpos items[];`	See the *Pixrect Reference Manual* for a full explanation of this function.
`pw_char(pw, x, y, op, font, c)` `Pixwin *pw;` `int x, y, op;` `Pixfont *font;` `char c;`	Writes character c into pw using the rasterop op. The left edge and baseline of c will be written at location (x, y).
`pw_close(pw)` `Pixwin *pw;`	Frees any dynamic storage associated with pw, including its retained memory pixrect, if any.
`pw_copy(dpw, dx, dy, dw, dh,` `op, spw, sx, sy)` `Pixwin *dpw, *spw;` `int op, dx, dy, dw, dh, sx, sy;`	Copies pixels from spw to dpw. Currently spw and dpw must be the same. This routine will cause problems if spw is obscured.
`int` `pw_get(pw, x, y)` `Pixwin *pw;` `int x, y;`	Returns the value of the pixel at (x, y) in pw.
`int` `pw_get_region_rect(pw, r)` `Pixwin *pw;` `Rect *r;`	Retrieves the rectangle occupied by the region pw into the rect pointed to by r.

Table 19-23 *Pixwin Drawing Functions and Macros— Continued*

Definition	*Description*
`pw_line(pw, x0, y0, x1, y1, brush, tex, op)` `Pixwin *pw;` `int x0, y0, x1, y1, op;` `struct pr_brush *brush;` `struct pr_texture *tex;`	Draws a solid or textured line between two points with a "brush" of a specified width.
`pw_lock(pw, r)` `Pixwin *pw;` `Rect *r;`	Acquires a lock for the user process making the call. `r` is the rectangle in `pw`'s coordinate system that bounds the area to be affected.
`pw_pfsysclose()`	Closes the system font opened with `pw_pfsysopen()`.
`Pixfont *` `pw_pfsysopen()`	Opens the system font.
`pw_polygon_2(pw, dx, dy, nbds, npts,` `vlist, op, spr, sx, sy)` `Pixwin *pw;` `int dx, dy, nbds, op, sx, sy;` `int npts[];` `struct pr_pos *vlist;` `Pixrect *spr;`	Draws a polygon in `pw`.
`pw_polyline(pw, dx, dy, npts,` `ptlist, mvlist, brush, tex, op)` `Pixwin *pw;` `int dx, dy, npts, op;` `struct pr_pos *ptlist;` `u_char *mvlist;` `struct pr_brush *brush;` `struct pr_texture *tex;`	Draws multiple lines of a specified width and texture in `pw`.
`pw_polypoint(pw, dx, dy, npts, ptlist, op)` `Pixwin *pw;` `int dx, dy, npts, op;` `struct pr_pos *ptlist;`	Draws an array of `npts` points in the pixwin `pw`
`pw_put(pw, x, y, value)` `Pixwin *pw;` `int x, y, value;`	Draws a pixel of `value` at `(x, y)` in `pw`.

Table 19-23 *Pixwin Drawing Functions and Macros— Continued*

Definition	***Description***
`pw_read(pr, dx, dy, dw, dh, op, pw, sx, sy)` `    Pixwin  *pw;` `    int      op, dx, dy, dw, dh, sx, sy;` `    Pixrect *pr;`	Reads pixels from the pixwin pw starting at offset (sx, sy), using rasterop op. The pixels are stored in the rectangle (dx, dy, dw, dh) in the pixrect pointed to by pr.
`Pixwin *` `pw_region(pw, x, y, width, height)` `    Pixwin *pw;` `    int     x, y, w, h;`	Creates a new pixwin refering to an area within the existing pixwin pw. The origin of the new region is given by (x, y), the dimensions by width and height.
`pw_replrop(pw, dx, dy, dw, dh,` `           op, pr, sx, sy)` `    Pixwin  *pw;` `    int      dx, dy, dw, dh, op, sx, sy;` `    Pixrect *pr;`	Replicates a pattern from a pixrect into a pixwin.
`pw_reset(pw)` `    Pixwin *pw;`	Macro which sets pw's lock count to 0 and releases its lock.
`pw_rop(pw, dx, dy, dw, dh,` `       op, sp, sx, sy)` `    Pixwin  *pw;` `    Pixrect *sp;` `    int      dx, dy, dw, dh, op, sx, sy;`	Performs the rasterop op from the source pixrect sp to the destination pixwin pw.
`int` `pw_set_region_rect(pw, r, use_same_pr)` `    Pixwin        *pw;` `    Rect          *r;` `    unsigned int  use_same_pr;`	The position and size of the region pw are set to the rect *r. If use_same_pr is 0 a new retained pixrect is allocated for the region.
`pw_show(pw)` `    Pixwin *pw;`	Macro to refresh the screen while batching, without affecting the batching mode.
`pw_stencil(dpw, dx, dy, dw, dh, op,` `           stpr, stx, sty, spr, sx, sy)` `    Pixwin  *dpw;` `    int      dx, dy, dw, dh, op, stx, sty, sx, sy;` `    Pixrect *stpr, *spr;`	Like pw_write(), except that the source pixrect spr is written through the stencil pixrect stpr, which functions as a spatial write enable mask. The raster operation op is only applied to destination pixels where the stpr is non-zero; other destination pixels remain unchanged.
`pw_text(pw, x, y, op, font, s)` `    Pixwin  *pw;` `    int      x, y, op;` `    Pixfont *font;` `    char    *s;`	Writes the string s into pw using the rasterop op. The left edge and baseline of the first character in s will appear at coordinates (x, y).

Table 19-23 *Pixwin Drawing Functions and Macros— Continued*

Definition	*Description*
`pw_traprop(pw, dx, dy, t, op, pr, sx, sy)` `Pixwin *pw;` `struct pr_trap t;` `Pixrect *pr;` `int dx, dy, op, sx, sy;`	Like `pw_rop()`, but operating on a trapezon rather than a rectangle.
`pw_ttext(pw, x, y, op, font, s)` `Pixwin *pw;` `int x, y, op;` `Pixfont *font;` `char *s;`	Like `pw_text()` except that it writes "transparent" text, i.e. it writes the shape of the letters without disturbing the background behind the letters.
`pw_unlock(pw)` `Pixwin *pw;`	Decrements the lock count for pw. If the lock count goes to 0, the lock is released.
`pw_vector(pw, x0, y0, x1, y1, op, value)` `Pixwin *pw;` `int op, x0, y0, x1, y1, value;`	Draws a vector of pixel `value` from `(x0, y0)` to `(x1, y1)` in pw using rasterop op.
`pw_write(pw, dx, dy, dw, dh, op, pr, sx, sy)` `Pixwin *pw;` `int dx, dy, dw, dh, op, sx, sy;` `Pixrect *pr;`	Writes pixels to pw in the rectangle defined by dx, dy, dw, dh, using rasterop op. Pixels to write are taken from the rectangle with its origin at `sx, sy` in the source pixrect pointed to by pr. Note: this is an alternative form of `pw_rop`.
`pw_writebackground(pw, dx, dy, dw, dh, op)` `Pixwin *pw;` `int dx, dy, dw, dh, op;`	Writes pixels with value zero into pw using the rasterop op. xd, yd, `width` and `height` specify the rectangle in pw which is affected.

Table 19-24 *Pixwin Color Manipulation Functions*

Definition	*Description*
`pw_blackonwhite(pw, min, max)` `    Pixwin *pw;` `    int    min, max;`	Sets the foreground to black, the background to white, for pixwin `pw`. `min` and `max` should be the first and last entries, respectively, in `pw`'s colormap segment.
`pw_cyclecolormap(pw, cycles, index, count)` `    Pixwin *pw;` `    int    cycles, index, count;`	Rotates the portion of `pw`'s colormap segment starting at `index` for `count` entries, rotating those entries among themselves `cycles` times.
`pw_dbl_access(pw)` `    Pixwin *pw;`	Resets the window's data structure so that the first frame will be rendered to the background.
`pw_dbl_flip(pw)` `    Pixwin *pw;`	Allows you to flip the display.
`pw_dbl_get(pw, attribute)` `    Pixwin           *pw;` `    Pw_dbl_attribute  attribute;`	Retrieves the value of the specified attribute.
`pw_dbl_release()` `    Pixwin *pw;`	Signifies the end of double-buffering by the window associated with the pixwin.
`pw_dbl_set(pw, attributes)` `    Pixwin    *pw;` <*attribute-list*> `attributes;`	Sets the pixwin hardware double-buffering attributes in `attributes`.
`pw_getattributes(pw, planes)` `    Pixwin *pw;` `    int    *planes;`	Retrieves the value of pw's access enable mask into the integer addressed by `planes`.
`pw_getcmsname(pw, cmsname)` `    Pixwin *pw;` `    char   cmsname[CMS_NAMESIZE];`	Copies the colormap segment name of pw into `cmsname`.
`pw_getcolormap(pw, index, count,` `               red, green, blue)` `    Pixwin        *pw;` `    int            index, count;` `    unsigned char  red[], green[], blue[];`	Retrieves the state of pw's colormap. The `count` elements of the pixwin's colormap segment starting at `index` (0 origin) are loaded into the first `count` values in the three arrays.

Table 19-24 *Pixwin Color Manipulation Functions— Continued*

Definition	*Description*
`pw_getdefaultcms(cms, map)` `struct colormapseg *cms;` `struct cms_map *map;`	Copies the data in the default colormap segment into the data pointed to by `cms` and `map`. Before the call, the byte pointers in `map` should be initialized to arrays of size 256.
`pw_putattributes(pw, planes)` `Pixwin *pw;` `int *planes;`	Sets the access enable mask of `pw`. Only those bits of the pixel corresponding to a 1 in the same bit position of `*planes` will be affected by pixwin operations.
`pw_putcolormap(pw, index, count, red, green, blue)` `Pixwin *pw;` `int index, count;` `unsigned char red[], green[], blue[];`	Sets the state of `pw`'s colormap. The `count` elements of the pixwin's colormap segment starting at `index` (0 origin) are loaded from the first `count` values in the three arrays.
`pw_reversevideo(pw, min, max)` `Pixwin *pw;` `int min, max;`	Reverses the foreground and background colors of `pw` `min` and `max` should be the first and last entries, respectively, in the colormap segment.
`pw_setcmsname(pw, cmsname)` `Pixwin *pw;` `char cmsname[CMS_NAMESIZE];`	`cmsname` is the name that `pw` will call its window's colormap segment. This call resets the colormap segment to `NULL`.
`pw_whiteonblack(pw, min, max)` `Pixwin *pw;` `int min, max;`	Sets the foreground to white, the background to black, for `pw`. `min` and `max` should be the first and last entries, respectively, in the colormap segment.

Table 19-25 *Scrollbar Attributes*

Attribute	Value Type	Description
SCROLL_ABSOLUTE_CURSOR	Cursor	Cursor to display on middle button down. Default: Right triangle if vert., down triangle if horiz.
SCROLL_ACTIVE_CURSOR	Cursor	Cursor to display when cursor is in bar rect. Default: Right arrow if vertical, down arrow if horiz.
SCROLL_ADVANCED_MODE	boolean	Whether notify proc reports all nine motions. Default: FALSE.
SCROLL_BACKWARD_CURSOR	Cursor	Cursor to display on right button down. Default: up arrow if vertical, left arrow if horiz.
SCROLL_BAR_COLOR	Scrollbar_setting	Color of bar, SCROLL_GREY (default) or SCROLL_WHITE.
SCROLL_BAR_DISPLAY_LEVEL	Scrollbar_setting	When bar is displayed. SCROLL_ALWAYS: always displayed SCROLL_ACTIVE: only displayed when cursor is in bar rect SCROLL_NEVER: never displayed Default: SCROLL_ALWAYS.
SCROLL_BORDER	boolean	Whether the scrollbar has a border.
SCROLL_BUBBLE_COLOR	Scrollbar_setting	Color of bubble, SCROLL_GREY (default) or SCROLL_BLACK.
SCROLL_BUBBLE_DISPLAY_LEVEL	Scrollbar_setting	When bubble is displayed. SCROLL_ALWAYS: always displayed SCROLL_ACTIVE: only displayed when cursor is in bar rect SCROLL_NEVER: never displayed Default: SCROLL_ALWAYS.
SCROLL_BUBBLE_MARGIN	int	Margin on each side of bubble in bar. Default: 0.
SCROLL_DIRECTION	Scrollbar_setting	Orientation of bar, SCROLL_VERTICAL (default) or SCROLL_HORIZONTAL.
SCROLL_END_POINT_AREA	int	The distance, in pixels, from the end of the scrollbar that forces a scroll to the beginning (or end) of the file. Default: 6.
SCROLL_FORWARD_CURSOR	Cursor	Cursor to display on left button down. Default: down arrow if vertical, right arrow if horiz.
SCROLL_GAP	int	Gap between lines. Default: current value of SCROLL_MARGIN.

Table 19-25 *Scrollbar Attributes— Continued*

Attribute	*Value Type*	*Description*
SCROLL_HEIGHT	int	r_height for scrollbar's rect.
SCROLL_LAST_VIEW_START	int	Offset of view into object prior to scroll. Get only.
SCROLL_LEFT	int	r_left for scrollbar's rect.
SCROLL_LINE_HEIGHT	int	Number of pixels from one line to the next. Default: 0.
SCROLL_MARGIN	int	Top margin after scroll, if SCROLL_NORMALIZE TRUE. Default: 4.
SCROLL_MARK	int	Position (in client units) undo will go to. Initial value: 0.
SCROLL_NOTIFY_CLIENT	caddr_t	Used by Notifier.
SCROLL_NORMALIZE	boolean	Whether the client wants normalized scrolling. Default: TRUE.
SCROLL_OBJECT	caddr_t	Pointer to the scrollable object.
SCROLL_OBJECT_LENGTH	int	Length of scrollable object, in client units. Default: 0. (Value must be > 0).
SCROLL_PAGE_BUTTONS	boolean	Whether the scrollbar has page buttons. Default: TRUE.
SCROLL_PAGE_BUTTON_LENGTH	int	Length in pixels of page buttons. Default: 15.
SCROLL_PAINT_BUTTONS_PROC	(procedure)	Procedure which paints page buttons: paint_buttons_proc(scrollbar) Scrollbar scrollbar; Setting the value to NULL resets it to the default button painting procedure.
SCROLL_PIXWIN	Pixwin *	Pixwin for scrollbar to write to.
SCROLL_PLACEMENT	Scrollbar_setting	Placement of the bar. SCROLL_WEST: vertical bar on left edge SCROLL_EAST: vertical bar on right edge SCROLL_NORTH: horizontal bar on top edge SCROLL_SOUTH: horizontal bar on bottom edge Default: SCROLL_WEST or SCROLL_NORTH.
SCROLL_RECT	Rect *	Rect for scrollbar, including buttons.

Table 19-25 *Scrollbar Attributes— Continued*

Attribute	*Value Type*	*Description*
SCROLL_REPEAT_TIME	int	The interval, in tenths of a second, that scrolling repeats in. This attribute is used only for the initial pressing down of the mouse. A value of 0 disables repeat scrolling. Default: 10.
SCROLL_REQUEST_MOTION	Scroll_motion	Scrolling motion requested by user.
SCROLL_REQUEST_OFFSET	int	Pixel offset of scrolling request into scrollbar. Default: 0.
SCROLL_THICKNESS	int	Thickness of bar. Default: 14.
SCROLL_TO_GRID	boolean	Whether the client wants scrolling aligned to multiples of SCROLL_LINE_HEIGHT. Default: FALSE.
SCROLL_TOP	int	r_top for scrollbar's rect.
SCROLL_VIEW_LENGTH	int	Length of viewing window, in client units. Default: 0.
SCROLL_VIEW_START	int	Current offset into scrollable object (client units). (Value must be > 0). Default: 0.
SCROLL_WIDTH	int	r_width for scrollbar's rect.

Table 19-26 *Scrollbar Functions*

Definition	*Description*
`Scrollbar` `scrollbar_create(attributes)` *<attribute-list>* `attributes;`	Creates and returns the opaque handle to a scrollbar.
`int` `scrollbar_destroy(scrollbar)` `Scrollbar scrollbar;`	Destroys `scrollbar`.
`caddr_t` `scrollbar_get(scrollbar, attribute)` `Scrollbar scrollbar;` `Scrollbar_attribute attribute;`	Retrieves the value for an attribute of `scrollbar`.
`int` `scrollbar_set(scrollbar, attributes)` `Scrollbar scrollbar;` *<attribute-list>* `attributes;`	Sets the value for one or more attributes of `scrollbar`. `attributes` is a null-terminated attribute list.
`void` `scrollbar_scroll_to(scrollbar, new_view_start)` `Scrollbar scrollbar;` `long new_view_start;`	For programmatic scrolling. Effect is as if the user had requested a scroll to `new_view_start` in the subwindow to which `scrollbar` is attached.
`int` `scrollbar_paint(scrollbar)` `Scrollbar scrollbar;`	Paints those portions of `scrollbar` (page buttons, bar proper, and bubble) which have been modified since they were last painted.
`int` `scrollbar_paint_clear(scrollbar)` `Scrollbar scrollbar;`	Clears and repaints all portions of `scrollbar`.
`int` `scrollbar_clear_bubble(scrollbar)` `Scrollbar scrollbar;`	Clears the bubble in `scrollbar`.
`int` `scrollbar_paint_bubble(scrollbar)` `Scrollbar scrollbar;`	Paints the bubble in `scrollbar`.

Table 19-27 *Text Subwindow Attributes*

Attribute	*Value Type*	*Description*
TEXTSW_ADJUST_IS_PENDING_DELETE	boolean	When TRUE, adjusting a selection causes the selection to be pending-delete. Default: FALSE.
TEXTSW_AGAIN_RECORDING	boolean	When FALSE, changes made to the textsw are not repeated when user invokes AGAIN. By disabling when not needed (e.g. for program-driven error logs) you can reduce memory overhead. Default: TRUE.
TEXTSW_AUTO_INDENT	boolean	When TRUE, a new line is automatically indented to match the previous line. Default: FALSE.
TEXTSW_AUTO_SCROLL_BY	int	Number of lines to scroll when type-in moves insert point below the view. Default: 1. Create, get.
TEXTSW_BLINK_CARET	boolean	Determines whether the caret blinks. Default: TRUE.
TEXTSW_BROWSING	boolean	When TRUE, prevents editing of the displayed text. If another file is loaded in, browsing stays on. Default: FALSE.
TEXTSW_CHECKPOINT_FREQUENCY	int	Number of edits between checkpoints. Set to 0 to disable checkpointing. Default: 0.
TEXTSW_CLIENT_DATA	char *	Pointer to arbitrary client data. Default: NULL.
TEXTSW_CONFIRM_OVERWRITE	boolean	A request to write to an existing file will require user confirmation. Default: TRUE.
TEXTSW_CONTENTS	char *	Contents of text subwindow. Default: NULL. For create and set, specifies the initial contents for non-file textsw. Get needs additional parameters: window_get(textsw, TEXTSW_CONTENTS, pos, buf, buf_len) Return value is next position to read at. buf[0...buf_len-1] is filled with the characters from textsw beginning at index pos, and is null-terminated only if there were too few characters to fill the buffer.
TEXTSW_CONTROL_CHARS_USE_FONT	boolean	If FALSE, control characters always display as an up arrow followed by a character, instead of whatever glyph is in the current font. Default: FALSE.
TEXTSW_DISABLE_CD	boolean	Stops textsw from changing current working directory (and grays out the associated items in the menu). Default: FALSE.

Table 19-27 *Text Subwindow Attributes— Continued*

Attribute	*Value Type*	*Description*
TEXTSW_DISABLE_LOAD	boolean	Prevents files being loaded into the textsw (and grays out the associated items in the menu). Default: FALSE.
TEXTSW_EDIT_COUNT	int	Monotonically incrementing count of the number of edits made to the textsw. Get.
TEXTSW_FILE	char *	File to load. Default: NULL. Create, set.
TEXTSW_FILE_CONTENTS	char *	initializes the text subwindow contents from a file yet still edits the contents in memory.
TEXTSW_FIRST	int	Zero-based index of first displayed character.
TEXTSW_FIRST_LINE	int	Zero-based index of first displayed line.
TEXTSW_HISTORY_LIMIT	int	Number of user action sequences that can be undone. Default: 50. Create, get.
TEXTSW_IGNORE_LIMIT	int	Number of edits textsw allows before vetoing destroy. Valid values are 0, meaning destroy will be vetoed if any edits have been done, and TEXTSW_INFINITY, meaning destroy will never be vetoed. Default: 0.
TEXTSW_INSERT_FROM_FILE	string	inserts the contents of a file into a text subwindow at the current insertion point.
TEXTSW_INSERT_MAKES_VISIBLE	Textsw_enum	Controls whether insertion causes repositioning to make inserted text visible. Possible values are TEXTSW_ALWAYS, TEXTSW_NEVER and TEXTSW_IF_AUTO_SCROLL. Default: TEXTSW_IF_AUTO_SCROLL.
TEXTSW_INSERTION_POINT	Textsw_index	Index of the current insertion point. Get, set.
TEXTSW_LEFT_MARGIN	int	Number of pixels in the margin on left. Default: 4. Create, get.
TEXTSW_LENGTH	int	Length of the textsw's contents. Get only.
TEXTSW_LINE_BREAK_ACTION	Textsw_enum	Determines how the textsw treats file lines too big to fit on one display line. Possible values are either TEXTSW_CLIP or TEXTSW_WRAP_AT_CHAR. Default: TEXTSW_WRAP_AT_CHAR. Create, set.
TEXTSW_LOWER_CONTEXT	int	Minimum # of lines to maintain between insertion point and the bottom of view. Used by auto scrolling when type-in would disappear off bottom of view. -1 means defeat auto scrolling. Default: 2.

Table 19-27 *Text Subwindow Attributes— Continued*

Attribute	*Value Type*	*Description*
TEXTSW_MEMORY_MAXIMUM	int	How much memory to use when not editing files. This attribute only takes effect at textsw window creation time or after the window has been reset via textsw_reset(). The lower bound of the attribute is 1000 bytes which is silently enforced. Default: 20,000 bytes. (If a great deal of text will be inserted into the text subwindow, either by the program or the user, you may need to increase this.)
TEXTSW_MENU	Menu	The text subwindow's menu. Get, set.
TEXTSW_MODIFIED	boolean	Whether or not the textsw has been modified. Get only.
TEXTSW_MULTI_CLICK_SPACE	int	Max # of pixels that can be between successive mouse clicks and still have the clicks be considered a multi-click. Default: 3.
TEXTSW_MULTI_CLICK_TIMEOUT	int	Max # of milliseconds that can be between successive mouse clicks and still have the clicks be considered a multi-click. Default: 390.
TEXTSW_NOTIFY_PROC	(procedure)	Notify procedure. Form is: `void` `notify_proc(textsw, avlist)` `Textsw textsw` `Attr_avlist avlist` Default: NULL, meaning standard procedure.
TEXTSW_READ_ONLY	boolean	When TRUE, prevents editing of the displayed text. If another file is loaded in, READ_ONLY is turned off again. Default: FALSE.
TEXTSW_SCROLLBAR	Scrollbar	Scrollbar to use for text subwindow scrolling. NULL means no scrollbar. Default: A scrollbar with default attributes. Note: text subwindow has a scrollbar by default, so you would only use this to get no scrollbar, or to get the scrollbar handle.
TEXTSW_STATUS	Textsw_status *	If set, specifies the address of a variable of type Textsw_status into which a value is written that reflects what happened during the call to window_create(). (For possible values, see the *Textsw_status Values* table).
TEXTSW_STORE_CHANGES_FILE	boolean	If TRUE, Store changes the file being edited to that named as the target of the Store. If FALSE, Store does not affect which file is being edited. Default: TRUE.
TEXTSW_STORE_SELF_IS_SAVE	boolean	Causes textsw to interpret a Store to the name of the current file as a Save. Default: FALSE. Create, get.

Table 19-27 *Text Subwindow Attributes— Continued*

Attribute	*Value Type*	*Description*
TEXTSW_UPDATE_SCROLLBAR	(no value)	Causes text subwindow to update the bubble in the scrollbar. Set only — get returns NULL.
TEXTSW_UPPER_CONTEXT	int	Min # of lines to maintain between the start of the selection and top of view. -1 means to defeat the normal actions. Default: 2.

Table 19-28 Textsw_action *Attributes*

Attribute	*Value Type*	*Description*
TEXTSW_ACTION_CAPS_LOCK	boolean	The user pressed the CAPS-lock function key to change the setting of the CAPS-lock (it is initially 0, meaning off).
TEXTSW_ACTION_CHANGED_DIRECTORY	char *	The current working directory for the process has been changed to the directory named by the provided string value.
TEXTSW_ACTION_EDITED_FILE	char *	The file named by the provided string value has been edited. Appears once per session of edits (see below).
TEXTSW_ACTION_EDITED_MEMORY	none	monitors whether an empty text subwindow has been edited.
TEXTSW_ACTION_FILE_IS_READONLY	char *	The file named by the provided string value does not have write permission.
TEXTSW_ACTION_LOADED_FILE	char *	The text subwindow is being used to view the file named by the provided string value.
TEXTSW_ACTION_TOOL_CLOSE	(no value)	The frame containing the text subwindow should become iconic.
TEXTSW_ACTION_TOOL_DESTROY	Event *	The tool containing the text subwindow should exit, without checking for a veto from other subwindows. The value is the user action that caused the destroy.
TEXTSW_ACTION_TOOL_QUIT	Event *	The tool containing the text subwindow should exit normally. The value is the user action that caused the exit.
TEXTSW_ACTION_TOOL_MGR	Event *	The tool containing the text subwindow should do the window manager operation associated with the provided event value.
TEXTSW_ACTION_USING_MEMORY	(no value)	The text subwindow is being used to edit a string stored in primary memory, not a file.

Table 19-29 Textsw_status *Values*

Value	*Description*
TEXTSW_STATUS_OKAY	The operation encountered no problems.
TEXTSW_STATUS_BAD_ATTR	The attribute list contained an illegal or unrecognized attribute.
TEXTSW_STATUS_BAD_ATTR_VALUE	The attribute list contained an illegal value for an attribute, usually an out of range value for an enumeration.
TEXTSW_STATUS_CANNOT_ALLOCATE	A call to calloc(2) or malloc(2) failed.
TEXTSW_STATUS_CANNOT_OPEN_INPUT	The specified input file does not exist or cannot be accessed.
TEXTSW_STATUS_CANNOT_INSERT_FROM_FILE	The operation encountered a problem when trying to insert from file.
TEXTSW_STATUS_OUT_OF_MEMORY	The operation ran out of memory while editing in memory.
TEXTSW_STATUS_OTHER_ERROR	The operation encountered a problem not covered by any of the other error indications.

Table 19-30 *Text Subwindow Functions*

Definition	***Description***
`Textsw_mark` `textsw_add_mark(textsw, position, flags)` `Textsw textsw;` `Textsw_index position;` `unsigned flags;`	Adds a new mark at `position`. `flags` can be either `TEXTSW_MARK_DEFAULTS` or `TEXTSW_MARK_MOVE_AT_INSERT`.
`int` `textsw_append_file_name(textsw, name)` `Textsw textsw;` `char *name;`	Returns 0 if `textsw` is editing a file, and if so appends the name of the file at the end of `name`.
`Textsw_index` `textsw_delete(textsw, first, last_plus_one)` `Textsw textsw;` `Textsw_index first, last_plus_one;`	Returns 0 if the operation fails. Removes the span of characters beginning with `first`, and ending one before `last_plus_one`.
`Textsw_index` `textsw_edit(textsw, unit, count, direction)` `Textsw textsw;` `unsigned unit, count, direction;`	Returns 0 if the operation fails. Erases a character, word or line, depending on whether `unit` is `SELN_LEVEL_FIRST`, `SELN_LEVEL_FIRST+1`, or `SELN_LEVEL_LINE`. If `direction` is 0, characters after the insertion point are affected, otherwise characters before the insertion point are affected. The operation will be done `count` times.
`Textsw_index` `textsw_erase(textsw, first, last_plus_one)` `Textsw textsw;` `Textsw_index first, last_plus_one;`	Returns 0 if the operation fails. Equivalent to `textsw_delete()`,but does not affect the global shelf.
`void` `textsw_file_lines_visible(textsw, top, bottom)` `Textsw textsw;` `int *top, *bottom;`	Fills in `top` and `bottom` with the file line indices of the first and last file lines being displayed in `textsw`.
`int` `textsw_find_bytes(textsw, first, last_plus_one,` `buf, buf_len, flags)` `Textsw textsw;` `Textsw_index *first, *last_plus_one;` `char *buf;` `unsigned buf_len, flags;`	Beginning at the position addressed by `first`, searches for the pattern specified by `buf` of length `buf_len`. Searches forwards if `flags` is 0, else searches backwards. Returns –1 if no match, else matching span placed in indices addressed by `first` and `last_plus_one`.

Table 19-30 *Text Subwindow Functions— Continued*

Definition	*Description*
`Textsw_index` `textsw_find_mark(textsw, mark)` `    Textsw      textsw;` `    Textsw_mark mark;`	Returns the current position of `mark`. If this operation fails, it will return TEXTSW_INFINITY.
`Textsw` `textsw_first(textsw)` `    Textsw textsw;`	Returns the first view into `textsw`.
`Textsw_index` `textsw_index_for_file_line(textsw, line)` `    Textsw textsw;` `    int    line;`	Returns the character index for the first character in the line given by `line`. If this operation fails, it will return TEXTSW_CANNOT_SET.
`Textsw_index` `textsw_insert(textsw, buf, buf_len)` `    Textsw  textsw;` `    char   *buf;` `    int     buf_len;`	Inserts characters in `buf` into `textsw` at the current insertion point. The number of characters actually inserted is returned — this will equal `buf_len` unless there was a memory allocation failure. If there was a failure, it will return 0.
`textsw_match_bytes(textsw, first, last_plus_one,` `                   start_sym, start_sym_len,` `                   end_sym, end_sym_len, field_flag)` `    Textsw         textsw;` `    Textsw_index  *first, *last_plus_one;` `    char          *start_sym, *end_sym;` `    int            start_sym_len, end_sym_len;` `    unsigned       field_flag;`	Searches for a block of text in the textsw's contents which starts with characters matching `start_sym` and ends with characters matching `end_sym`. This function places the starting index of the matching block in `first` and its ending index in `last`.
`Textsw` `textsw_next(textsw)` `    Textsw textsw;`	Returns the next view in the set of views into `textsw`.
`void` `textsw_normalize_view(textsw, position)` `    Textsw       textsw;` `    Textsw_index position;`	Repositions the text so that the character at `position` is visible and at the top of the subwindow.
`void` `textsw_possibly_normalize(textsw, position)` `    Textsw       textsw;` `    Textsw_index position;`	If the character at `position` is already visible, this function does nothing. If it is not visible, it repositions the text so that it is visible and at the top of the subwindow.

Table 19-30 *Text Subwindow Functions— Continued*

Definition	*Description*
`void` `textsw_remove_mark(textsw, mark)` `    Textsw      textsw;` `    Textsw_mark mark;`	Removes an existing mark from `textsw`.
`Textsw_index` `textsw_replace_bytes(textsw, first,` `                     last_plus_one,` `                     buf, buf_len)` `    Textsw       textsw;` `    Textsw_index  first;` `    char         *buf;` `    unsigned      buf_len;`	Replaces the character span from `first` to `last_plus_one` by the characters in `buf`. `last_plus_one`. The return value is the net number of bytes inserted. The number is negative if the original string is longer than the one that replaces it. If this operation fails, it will return a value of 0.
`void` `textsw_reset(textsw, x, y)` `    Textsw textsw;` `    int    x, y;`	Discards edits performed on the contents of `textsw`. If needed, a message box will be displayed at x, y.
`unsigned` `textsw_save(textsw, x, y)` `    Textsw textsw;` `    int    x, y;`	Saves any edits made to the file currently loaded into `textsw`.If needed, a message box will be displayed at x, y.
`int` `textsw_screen_line_count(textsw)` `    Textsw textsw;`	Returns the number of screen lines in `textsw`.
`void` `textsw_scroll_lines(textsw, count)` `    Textsw  textsw;` `    int     count;`	Moves the text up or down by `count` lines. If `count` is positive, then the text is scrolled up on the screen, (forward in the file); if negative, the text is scrolled down, (backward in the file).
`void` `textsw_set_selection(textsw, first, last_plus_one,` `                     type)` `    Textsw       textsw;` `    Textsw_index first, last_plus_one;` `    unsigned     type;`	Sets the selection to begin at `first` and include all characters up to `last_plus_one`.

Table 19-30 *Text Subwindow Functions— Continued*

Definition	*Description*
`unsigned` `textsw_store_file(textsw, filename, x, y)` `    Textsw  textsw;` `    char   *filename;` `    int     x, y;`	Stores the contents of `textsw` to the file named by `filename`. If needed, a message box will be displayed at `x`, `y`.

Table 19-31 *TTY Subwindow Attributes*

Attribute	Type	Description
TTY_ARGV	char **	Argument vector: name of the program running in the tty subwindow, followed by arguments for that program.
TTY_CONSOLE	boolean	If TRUE, tty subwindow is console. Set only. Default: FALSE.
TTY_PAGE_MODE	boolean	If TRUE, output will stop after each page. Default: FALSE.
TTY_QUIT_ON_CHILD_DEATH	boolean	If TRUE, window_done() is called on the subwindow when its child terminates. Set only. Default: FALSE.

Table 19-32 *TTY Subwindow Functions*

Definition	Description
int ttysw_input(tty, buf, len) Tty tty; char *buf; int len;	Appends len number of characters from buf onto tty's *input* queue. It returns the number of characters accepted.
int ttysw_output(tty, buf, len) Tty tty; char *buf; int len;	Appends len number of characters from buf onto tty's *output* queue, i.e. they are sent through the terminal emulator to the TTY. It returns the number of characters accepted.

Table 19-33 *TTY Subwindow Special Escape Sequences*

Escape Sequence[103]	*Description*
\E[1t	open frame.
\E[2t	close frame.
\E[3t	move frame with interactive feedback.
\E[3;TOP;LEFTt	move frame to location specified by (TOP,LEFT).
\E[4t	resize frame with interactive feedback.
\E[4;WIDTH;HEIGHTt	resize frame to WIDTH and HEIGHT.
\E[5t	expose.
\E[6t	hide.
\E[7t	redisplay.
\E[8;ROWS;COLSt	resize frame so its width and height are ROWS and COLS.
\E[11t	report if frame is open or closed by sending \[1t or \[2t, respectively.
\E[13t	report frame's position by sending the \E[3;*TOP*;*LEFT*t sequence.
\E[14t	report frame's size in pixels by sending the \E[3;*WIDTH*;*HEIGHT*t sequence.
\E[18t	report frame's size in characters by sending the \E[8;*ROWS*;*COLS*t sequence.
\E[20t	report the frame icon's label by sending the \E[L*label*\E\ sequence.
\E[21t	report frame's label by sending the \E]l*label*\E\ sequence.
\E]l*text*\E\	set frame's label to *text*.
\E]I*file*\E\	set frame's icon to the icon contained in *file*.
\E]L*label*\E\	set icon's label to *label*.
\E[>*OPT1*; . . .*OPTn*h	turn requested options on. The only currently defined option is 1, for TTY_PAGE_MODE.
\E[>*OPT1*; . .*OPTn*k	turn requested options off.

Table 19-33 *TTY Subwindow Special Escape Sequences— Continued*

Escape Sequence[103]	*Description*
`\E[>`*OPT1*`; . . .`*OPTn*`l`	report current option settings by sending `\E[>`*OPTx*`l` or `\E>`*OPT*`h` for each option *x*.

[103] In this table "\E" denotes the <ESC> character, as it does in *termcap*.

Table 19-34 *Window Attributes*

Attribute	*Value Type*	*Description*
WIN_BELOW	Window	Causes the window to be laid out below window given as the value.
WIN_BOTTOM_MARGIN	int	Margin at bottom of window.
WIN_CLIENT_DATA	caddr_t	Client's private data — for your use.
WIN_COLUMNS	int	Window's width (including left and right margins) in columns.
WIN_COLUMN_GAP	int	Gap between columns in the window.
WIN_COLUMN_WIDTH	int	Width of a column in the window.
WIN_CONSUME_KBD_EVENT	short	Window will receive this event.
WIN_CONSUME_KBD_EVENTS	list of short	Null terminated list of events window will receive. Create, set.
WIN_CONSUME_PICK_EVENT	short	Window will receive this pick event.
WIN_CONSUME_PICK_EVENTS	list of short	Null terminated list of pick events window will receive. Create, set.
WIN_CURSOR	Cursor	The window's cursor. **Note:** the pointer returned by `window_get()` points to per-process static storage.
WIN_DEVICE_NAME	char *	UNIX device name associated with window, consisting of a string and numeric part, e.g. `win10`. Get only.
WIN_DEVICE_NUMBER	int	Numeric component of device name. Get only.
WIN_ERROR_MSG	char *	Error message to print before `exit(1)`. Create only.
WIN_EVENT_PROC	(procedure)	Client's callback procedure which receives input events: `Notify_value` `event_proc(window, event, arg)` `    Window  window;` `    Event   *event;` `    caddr_t arg;`
WIN_EVENT_STATE	short	Gets the state of the specified event code. For buttons and keys, zero means "up," non-zero means "down." Get only.
WIN_FD	int	The UNIX file descriptor for the window. Get only.
WIN_FIT_HEIGHT	int	Causes window to fit its contents in the height dimension, leaving a margin specified by the value given.

Table 19-34 *Window Attributes— Continued*

Attribute	*Value Type*	*Description*
WIN_FIT_WIDTH	int	Causes window to fit its contents in the width dimension, leaving a margin specified by the value given.
WIN_FONT	Pixfont *	The window's font. Notes for the current release: tty subwindows don't use WIN_FONT. Frames don't use WIN_FONT to render their labels; however, they do use WIN_FONT in calculating WIN_COLUMNS and WIN_ROWS. Setting WIN_FONT does *not* cause the default system font to be set.
WIN_GRAB_ALL_INPUT	boolean	Window will get all events regardless of location.
WIN_HEIGHT	int	Window's height in pixels. Value of WIN_EXTEND_TO_EDGE causes subwindow to extend to bottom edge of frame. Default: WIN_EXTEND_TO_EDGE.
WIN_HORIZONTAL_SCROLLBAR	Scrollbar	Horizontal scrollbar.
WIN_IGNORE_KBD_EVENT	short	Window will not receive this event.
WIN_IGNORE_KBD_EVENTS	list of short	Null terminated list of events window will not receive. Create, set.
WIN_IGNORE_PICK_EVENT	short	Window will not receive this pick event.
WIN_IGNORE_PICK_EVENTS	list of short	Null terminated list of pick events window will not receive. Create, set.
WIN_INPUT_DESIGNEE	int	Window which gets events this window doesn't consume. (Note that the value must be the WIN_DEVICE_NUMBER of the designee).
WIN_KBD_FOCUS	boolean	Whether or not the window has the keyboard focus.
WIN_KBD_INPUT_MASK	Inputmask *	Window's keyboard inputmask. **Note:** the pointer returned by window_get() points to per-process static storage.
WIN_LEFT_MARGIN	int	Margin at left of window.
WIN_MENU	Menu	Window's menu. **Note:** In the current release this doesn't work for panels or tty subwindows.
WIN_MOUSE_XY	int, int	Mouse's position within the window. Set only.
WIN_NAME	char *	Name of window (currently unused by SunView).
WIN_OWNER	Window	Owner of window. Get only.
WIN_PERCENT_HEIGHT	int	Sets a subwindow's height as a percentage of the frame's height.

Table 19-34 *Window Attributes— Continued*

Attribute	*Value Type*	*Description*
WIN_PERCENT_WIDTH	int	Sets a subwindow's width as a percentage of the frame's width.
WIN_PICK_INPUT_MASK	Inputmask *	Window's pick inputmask. **Note:** the pointer returned by `window_get()` points to per-process static storage.
WIN_PIXWIN	Pixwin *	The window's pixwin. Get only.
WIN_RECT	Rect *	Rect of the window. For frames, same as FRAME_OPEN_RECT. **Note:** the pointer returned by `window_get()` for this attribute points to per-process static storage.
WIN_RIGHT_MARGIN	int	Margin at right of window.
WIN_RIGHT_OF	Window	Causes the window to be laid out just to the right of the window given as the value.
WIN_ROW_GAP	int	Gap between rows in the window.
WIN_ROW_HEIGHT	int	Height of a row in the window.
WIN_ROWS	int	Window's height (including top and bottom margins) in rows.
WIN_SCREEN_RECT	Rect *	Rect of the screen containing the window. Get only. **Note:** the pointer returned by `window_get()` for this attribute points to per-process static storage.
WIN_SHOW	boolean	Causes the window to be displayed or undisplayed.
WIN_TOP_MARGIN	int	Margin at top of window.
WIN_TYPE	Window_type	Type of window. One of FRAME_TYPE, PANEL_TYPE, CANVAS_TYPE, TEXTSW_TYPE or TTY_TYPE. Get only.
WIN_VERTICAL_SCROLLBAR	Scrollbar	Vertical scrollbar.
WIN_WIDTH	int	Window's width in pixels. Value of WIN_EXTEND_TO_EDGE causes subwindow to extend to right edge of frame. Default: WIN_EXTEND_TO_EDGE.
WIN_X	int	x position of window, relative to owner.
WIN_Y	int	y position of window, relative to owner.

Table 19-35 *Frame Attributes*

Attribute	Value Type	Description
FRAME_ARGS	int, char **	Interpret command line arguments. Strips -W command-line frame arguments out of argv. Create only.
FRAME_ARGC_PTR_ARGV	int *, char **	Interpret command line args. Strips -W command-line frame arguments out of argv, and decrements argc accordingly. Create only.
FRAME_BACKGROUND_COLOR	struct singlecolor *	Background color.
FRAME_CLOSED	boolean	Whether frame is currently closed.
FRAME_CLOSED_RECT	Rect *	Frame's rect when closed.
FRAME_CMDLINE_HELP_PROC	(procedure)	Called when user types the command-line argument -WH. Default: `frame_cmdline_help(program_name)` `char *program_name;`
FRAME_CURRENT_RECT	Rect *	Returns either FRAME_OPEN_RECT or FRAME_CLOSED_RECT, depending on the value of FRAME_CLOSED. Note: in the current release, there is a bug in the behavior of FRAME_CURRENT_RECT for subframes. It is set relative to the owner frame, but it is retrieved relative to the screen.
FRAME_DEFAULT_DONE_PROC	(procedure)	Default value of FRAME_DONE_PROC. Get only. The default procedure is to set the subframe to WIN_SHOW, FALSE.
FRAME_DONE_PROC	(procedure)	Client's proc called when user chooses 'Done' from subframe's menu: `done_proc(frame)` `Frame frame;`
FRAME_EMBOLDEN_LABEL	boolean	If TRUE, frame's label is rendered in bold.
FRAME_FOREGROUND_COLOR	struct singlecolor *	Foreground color.
FRAME_ICON	Icon	The frame's icon.
FRAME_INHERIT_COLORS	boolean	If TRUE, colormap of frame is inherited by subwindows.
FRAME_LABEL	char *	The frame's label.
FRAME_NO_CONFIRM	boolean	Set to TRUE before destroying a frame to defeat confirmation. Set only.
FRAME_NTH_SUBFRAME	int	Returns frame's nth (from 0) subframe. Get only.

Table 19-35 *Frame Attributes— Continued*

Attribute	*Value Type*	*Description*
FRAME_NTH_SUBWINDOW	int	Returns frame's nth (from 0) subwindow. Get only.
FRAME_NTH_WINDOW	int	Returns frame's nth (from 0) window, regardless of whether the window is a frame or a subwindow. Get only.
FRAME_OPEN_RECT	Rect *	Frame's rect when open.
FRAME_SHOW_LABEL	boolean	Whether the label is shown. Default: TRUE for base frames, FALSE for subframes.
FRAME_SUBWINDOWS_ADJUSTABLE	boolean	User can move subwindow boundaries. Default: TRUE.

Table 19-36 *Window Functions and Macros*

Definition	*Description*
`void` `window_bell(win)` `    Window  win;`	Queries the user defaults database to see if the user wants the bell to be sounded, the window to be flashed, or both.
`Window` `window_create(owner, type, attributes)` `    Window owner;` `    `*<window type>* `type;` `    `*<attribute-list>* `attributes;`	Creates a window and returns its handle. `type` is one of `FRAME`, `PANEL` `TEXTSW`, `TTY`, or `CANVAS`.
`void` `window_default_event_proc(window, event, arg)` `   Window window;` `   Event    *event;` `   caddr_t  arg;`	Calls the default event procedure. The arguments passed in are the window (canvas or panel), the event, and an optional argument pertaining to the event.
`window_destroy(win)` `    Window win;`	Destroys `win`, and any subwindows or subframes owned by `win`.
`window_done(win)` `    Window win;`	Destroys the entire hierarchy to which `win` belongs.
`window_fit(win)` `    Window win;`	Causes `win` to fit its contents in both dimensions. A macro, defined as: `window_set(win, WIN_FIT, 0, 0)`.
`window_fit_height(win)` `    Window win;`	Causes `win` to fit its contents in the vertical dimension. A macro, defined as: `window_set(win, WIN_FIT_HEIGHT, 0, 0)`.
`window_fit_width(win)` `    Window win;`	Causes `win` to fit its contents in the horizontal dimension. A macro, defined as: `window_set(win, WIN_FIT_WIDTH, 0, 0)`.
`caddr_t` `window_get(win, attribute)` `    Window win;` `    Window_attribute attribute;`	Retrieves the value of an attribute for `win`.

Table 19-36 *Window Functions and Macros— Continued*

Definition	***Description***
`caddr_t` `window_loop(subframe)` `    Frame subframe;`	Causes `subframe` to be displayed, and receive all input. The call will not return until `window_return()` is called from one of the application's notify procs.
`void` `window_main_loop(base_frame)` `    Frame base_frame;`	Displays `base_frame` on the screen and begins the processing of events by passing control to the Notifier.
`int` `window_read_event(window, event)` `    Window window;` `    Event *event;`	Reads the next input event for `window`. In case of error, sets the global variable `errno` and returns -1.
`void` `window_refuse_kbd_focus(window)` `    Window window;`	When your event handler receives a `KBD_REQUEST` event, call this function if you do not want your window to become the keyboard focus.
`void` `window_release_event_lock(window)` `    Window window;`	Releases the event lock, allowing other processes to receive input.
`void` `window_return(value)` `    caddr_t value;`	Usually called from one of the application's panel item notify procs. Causes `window_loop()` to return.
`window_set(win, attributes)` `    Window win;` <*attribute-list*> `attributes;`	Sets the value of one or more of `win`'s attributes. `attributes` is a null-terminated attribute list.

Table 19-37 *Command Line Frame Arguments*

Flag	*Long Flag*	*Arguments*	*Corresponding Attributes*
-Wb	**-background_color**	*red green blue*	FRAME_BACKGROUND_COLOR
-Wh	**-height**	*lines*	WIN_ROWS
-WH	**-help**	—	(Causes FRAME_CMDLINE_HELP_PROC to be called.)
-Wf	**-foreground_color**	*red green blue*	FRAME_FOREGROUND_COLOR
-Wg	**-set_default_color**	—	FRAME_INHERIT_COLORS, TRUE
-Wi	**-iconic**	—	FRAME_CLOSED, TRUE
-WI	**-icon_image**	*filename*	ICON_IMAGE of frame's icon[105]
-Wl	**-label**	*label*	FRAME_LABEL
-WL	**-icon_label**	*label*	ICON_LABEL of frame's icon
-Wn	**-no_label**	—	FRAME_SHOW_LABEL, FALSE
-Wp	**-position**	*x y*	WIN_X, WIN_Y
-WP	**-icon_position**	*x y*	FRAME_CLOSED_RECT
-Ws	**-size**	*x y*	WIN_WIDTH, WIN_HEIGHT
-Wt	**-font**	*filename*	(Sets system default font)
-WT	**-icon_font**	*filename*	ICON_FONT of frame's icon
-Ww	**-width**	*columns*	WIN_COLUMNS

[105] The **-WI** option will not work if the application's code does not already specify its icon.

A

Example Programs

A

Example Programs

Source Available

If the appropriate optional software category has been installed or mounted on your system, the source code for some of these examples programs is available on-line in `/usr/share/src/sun/suntool/examples`. In addition, the directory above this (`/usr/share/src/sun/suntool`) contains the source for many of the SunView 1 programs in the SunOS, such as `textedit`, `perfmeter`, and `iconedit`.

A.1. *filer*

This program is discussed in Chapter 4, *Using Windows*. It displays a listing in a tty subwindow, which the user manipulates through panel items.

If the user presses the [Props] key in the panel, or chooses 'Props' from the frame menu, or pushes the **Set ls flags** button, a pop-up subframe appears. *filer* uses the Selection Service to determine what file name the user has selected, and creates a pop-up text subwindow where that file is displayed.

filer uses the alerts package to ask the user for confirmation and put up messages. It also includes old code which mimics alerts by using `window_loop()` to put up a subframe, but programs written for SunOS Release 4.0 and beyond in general will have no need for this.

```
/****************************************************************************/
/*                          4.0     filer.c                                   */
/****************************************************************************/

#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/tty.h>
#include <suntool/textsw.h>
#include <suntool/seln.h>
#include <suntool/alert.h>
#include <sys/stat.h>       /* stat call needed to verify existence of files */

/* these objects are global so their attributes can be modified or retrieved */
Frame           base_frame, edit_frame, ls_flags_frame;
Panel           panel, ls_flags_panel;
Tty             ttysw;
Textsw          editsw;
Panel_item      dir_item, fname_item, filing_mode_item, done_item;
int             quit_confirmed_from_panel;

#define         MAX_FILENAME_LEN        256
#define         MAX_PATH_LEN            1024

char *getwd();

main(argc, argv)
    int    argc;
    char **argv;
{
    static Notify_value filer_destroy_func();
    void        ls_flags_proc();

    base_frame = window_create(NULL, FRAME,
                 FRAME_ARGS,            argc, argv,
                 FRAME_LABEL,           "filer",
                 FRAME_PROPS_ACTION_PROC, ls_flags_proc,
                 FRAME_PROPS_ACTIVE, TRUE,
                 FRAME_NO_CONFIRM,      TRUE,
                 0);
    (void) notify_interpose_destroy_func(base_frame, filer_destroy_func);

    create_panel_subwindow();
    create_tty_subwindow();
    create_edit_popup();
    create_ls_flags_popup();
    quit_confirmed_from_panel = 0;

    window_main_loop(base_frame);
    exit(0);
}

create_tty_subwindow()
{
    ttysw = window_create(base_frame, TTY, 0);
}

create_edit_popup()
{
```

```
    edit_frame = window_create(base_frame, FRAME,
                 FRAME_SHOW_LABEL, TRUE,
                 0);
    editsw = window_create(edit_frame, TEXTSW, 0);
}

create_panel_subwindow()
{
    void ls_proc(), ls_flags_proc(), quit_proc(), edit_proc(),
        edit_sel_proc(), del_proc();

    char current_dir[MAX_PATH_LEN];

    panel = window_create(base_frame, PANEL, 0);

    (void) panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(0),
        PANEL_LABEL_IMAGE,            panel_button_image(panel, "List Directory", 0, 0),
        PANEL_NOTIFY_PROC,            ls_proc,
        0);

    (void) panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,            panel_button_image(panel, "Set ls flags", 0, 0),
        PANEL_NOTIFY_PROC,            ls_flags_proc,
        0);

    (void) panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,            panel_button_image(panel, "Edit", 0, 0),
        PANEL_NOTIFY_PROC,            edit_proc,
        0);

    (void) panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,            panel_button_image(panel, "Delete", 0, 0),
        PANEL_NOTIFY_PROC,            del_proc,
        0);

    (void) panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,            panel_button_image(panel, "Quit", 0, 0),
        PANEL_NOTIFY_PROC, quit_proc,
        0);

    filing_mode_item = panel_create_item(panel, PANEL_CYCLE,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(1),
        PANEL_LABEL_STRING,           "Filing Mode:",
        PANEL_CHOICE_STRINGS,         "Use \"File:\" item",
                                      "Use Current Selection", 0,
        0);

    (void) panel_create_item(panel, PANEL_MESSAGE,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(2),
        0);

    dir_item = panel_create_item(panel, PANEL_TEXT,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(3),
```

```
        PANEL_VALUE_DISPLAY_LENGTH,     60,
        PANEL_VALUE,                    getwd(current_dir),
        PANEL_LABEL_STRING,             "Directory: ",
        0);

    fname_item = panel_create_item(panel, PANEL_TEXT,
        PANEL_LABEL_X,                  ATTR_COL(0),
        PANEL_LABEL_Y,                  ATTR_ROW(4),
        PANEL_LABEL_DISPLAY_LENGTH,     60,
        PANEL_LABEL_STRING,             "File:  ",
        0);

    window_fit_height(panel);

    window_set(panel, PANEL_CARET_ITEM, fname_item, 0);
}

create_ls_flags_popup()
{
    void done_proc();
    ls_flags_frame = window_create(base_frame, FRAME, 0);

    ls_flags_panel = window_create(ls_flags_frame, PANEL, 0);

    panel_create_item(ls_flags_panel, PANEL_MESSAGE,
            PANEL_ITEM_X,           ATTR_COL(14),
            PANEL_ITEM_Y,           ATTR_ROW(0),
            PANEL_LABEL_STRING,     "Options for ls command",
            PANEL_CLIENT_DATA,      "   ",
            0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
            PANEL_ITEM_X,           ATTR_COL(0),
            PANEL_ITEM_Y,           ATTR_ROW(1),
            PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
            PANEL_LABEL_STRING,     "Format:                        ",
            PANEL_CHOICE_STRINGS,   "Short", "Long", 0,
            PANEL_CLIENT_DATA,      " 1 ",
            0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
            PANEL_ITEM_X,           ATTR_COL(0),
            PANEL_ITEM_Y,           ATTR_ROW(2),
            PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
            PANEL_LABEL_STRING,     "Sort Order:                    ",
            PANEL_CHOICE_STRINGS,   "Descending", "Ascending", 0,
            PANEL_CLIENT_DATA,      " r ",
            0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
            PANEL_ITEM_X,           ATTR_COL(0),
            PANEL_ITEM_Y,           ATTR_ROW(3),
            PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
            PANEL_LABEL_STRING,     "Sort criterion:                ",
            PANEL_CHOICE_STRINGS,   "Name", "Modification Time",
                                    "Access Time", 0,
            PANEL_CLIENT_DATA,      " tu",
            0);
```

```
    panel_create_item(ls_flags_panel, PANEL_CYCLE,
                PANEL_ITEM_X,           ATTR_COL(0),
                PANEL_ITEM_Y,           ATTR_ROW(4),
                PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
                PANEL_LABEL_STRING,     "For directories, list:          ",
                PANEL_CHOICE_STRINGS,   "Contents", "Name Only", 0,
                PANEL_CLIENT_DATA,      " d ",
                0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
                PANEL_ITEM_X,           ATTR_COL(0),
                PANEL_ITEM_Y,           ATTR_ROW(5),
                PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
                PANEL_LABEL_STRING,     "Recursively list subdirectories? ",
                PANEL_CHOICE_STRINGS,   "No", "Yes", 0,
                PANEL_CLIENT_DATA,      " R ",
                0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
                PANEL_ITEM_X,           ATTR_COL(0),
                PANEL_ITEM_Y,           ATTR_ROW(6),
                PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
                PANEL_LABEL_STRING,     "List '.' files?                  ",
                PANEL_CHOICE_STRINGS,   "No", "Yes", 0,
                PANEL_CLIENT_DATA,      " a ",
                0);

    panel_create_item(ls_flags_panel, PANEL_CYCLE,
                PANEL_ITEM_X,           ATTR_COL(0),
                PANEL_ITEM_Y,           ATTR_ROW(6),
                PANEL_DISPLAY_LEVEL,    PANEL_CURRENT,
                PANEL_LABEL_STRING,     "Indicate type of file?           ",
                PANEL_CHOICE_STRINGS,   "No", "Yes", 0,
                PANEL_CLIENT_DATA,      " F ",
                0);
    done_item = panel_create_item(ls_flags_panel, PANEL_BUTTON,
                PANEL_ITEM_X,           ATTR_COL(0),
                PANEL_ITEM_Y,           ATTR_ROW(7),
                PANEL_LABEL_IMAGE,      panel_button_image(panel, "Done", 0, 0),
                PANEL_NOTIFY_PROC,      done_proc,
                0);

    window_fit(ls_flags_panel); /* fit panel around its items */
    window_fit(ls_flags_frame); /* fit frame around its panel */
}

char *
compose_ls_options()
{
    static char  flags[20];
    char        *ptr;
    char         flag;
    int          first_flag = TRUE;
    Panel_item   item;
    char        *client_data;
    int          index;

    ptr = flags;
```

```
    panel_each_item(ls_flags_panel, item)
        if (item != done_item) {
            client_data = panel_get(item, PANEL_CLIENT_DATA, 0);
            index = (int)panel_get_value(item);
            flag = client_data[index];
            if (flag != ' ') {
                if (first_flag) {
                    *ptr++     = '-';
                    first_flag = FALSE;
                }
                *ptr++ = flag;
            }
        }
    panel_end_each
    *ptr = '\0';
    return flags;
}

void
ls_proc()
{
    static char previous_dir[MAX_PATH_LEN];
    char *current_dir;
    char cmdstring[100];        /* dir_item's value can be 80, plus flags */

    current_dir = (char *)panel_get_value(dir_item);

    if (strcmp(current_dir, previous_dir)) {
        chdir((char *)panel_get_value(dir_item));
        strcpy(previous_dir, current_dir);
    }
    sprintf(cmdstring, "ls %s %s/%s\n",
                compose_ls_options(),
                current_dir,
                panel_get_value(fname_item));
    ttysw_input(ttysw, cmdstring, strlen(cmdstring));
}

void
ls_flags_proc()
{
    window_set(ls_flags_frame, WIN_SHOW, TRUE, 0);
}

void
done_proc()
{
    window_set(ls_flags_frame, WIN_SHOW, FALSE, 0);
}

/* return a pointer to the current selection */
char *
get_selection()
{
    static char   filename[MAX_FILENAME_LEN];
    Seln_holder   holder;
    Seln_request *buffer;
```

```
    holder = seln_inquire(SELN_PRIMARY);
    buffer = seln_ask(&holder, SELN_REQ_CONTENTS_ASCII, 0, 0);
    strncpy(
        filename, buffer->data + sizeof(Seln_attribute), MAX_FILENAME_LEN);
    return(filename);
}

/* return 1 if file exists, else print error message and return 0 */
stat_file(filename)
    char   *filename;
{
    static char previous_dir[MAX_PATH_LEN];
    char   *current_dir;
    char    this_file[MAX_PATH_LEN];
    struct stat statbuf;

    current_dir = (char *)panel_get_value(dir_item);

    if (strcmp(current_dir, previous_dir)) {
        chdir((char *)panel_get_value(dir_item));
        strcpy(previous_dir, current_dir);
    }
    sprintf(this_file, "%s/%s", current_dir, filename);
    if (stat(this_file, &statbuf) < 0) {
        char buf[MAX_FILENAME_LEN+11];  /* big enough for message */
        sprintf(buf, "%s not found.", this_file);
        msg(buf, 1);
        return 0;
    }
    return 1;
}

void
edit_proc()
{
    void edit_file_proc(), edit_sel_proc();
    int file_mode = (int)panel_get_value(filing_mode_item);

    if (file_mode) {
        (void)edit_sel_proc();
    } else {
        (void)edit_file_proc();
    }
}

void
edit_file_proc()
{
    char *filename;

    /* return if no selection */
    if (!strlen(filename = (char *)panel_get_value(fname_item))) {
        msg("Please enter a value for \"File:\".", 1);
        return;
    }

    /* return if file not found */
    if (!stat_file(filename))
```

```
        return;

    window_set(editsw, TEXTSW_FILE, filename, 0);

    window_set(edit_frame, FRAME_LABEL, filename, WIN_SHOW, TRUE, 0);
}

void
edit_sel_proc()
{
    char *filename;

    /* return if no selection */
    if (!strlen(filename = get_selection())) {
        msg("Please select a file to edit.", 0);
        return;
    }

    /* return if file not found */
    if (!stat_file(filename))
        return;

    window_set(editsw, TEXTSW_FILE, filename, 0);

    window_set(edit_frame, FRAME_LABEL, filename, WIN_SHOW, TRUE, 0);
}

void
del_proc()
{
    char    buf[300];
    char   *filename;
    int     result;
    Event   event;   /* unused */
    int     file_mode = (int)panel_get_value(filing_mode_item);

    /* return if no selection */
    if (file_mode) {
        if (!strlen(filename = get_selection())) {
            msg("Please select a file to delete.", 1);
            return;
        }
    } else {
        if (!strlen(filename = (char *)panel_get_value(fname_item))) {
            msg("Please enter a file name to delete.", 1);
            return;
        }
    }

    /* return if file not found */
    if (!stat_file(filename))
        return;

    /* user must confirm the delete */
    result = alert_prompt(base_frame, &event,
        ALERT_MESSAGE_STRINGS,
            "Ok to delete file:",
            filename,
```

```
            0,
        ALERT_BUTTON_YES,       "Confirm, delete file",
        ALERT_BUTTON_NO,        "Cancel",
        0);
    switch (result) {
        case ALERT_YES:
            unlink(filename);
            sprintf(buf, "%s deleted.", filename);
            msg(buf, 0);
            break;
        case ALERT_NO:
            break;
        case ALERT_FAILED: /* not likely to happen unless out of FDs */
            sprintf(buf, "Ok to delete file %s?", filename);
            result = confirm_yes(buf);
            if (result) {
                unlink(filename);
                sprintf(buf, "%s deleted.", filename);
                msg(buf, 1);
            }
            break;
    }
}

int
confirm_quit()
{
    int     result;
    Event   event;   /* unused */
    char    *msg = "Are you sure you want to Quit?";

    result = alert_prompt(base_frame, &event,
        ALERT_MESSAGE_STRINGS,
            "Are you sure you want to Quit?",
            0,
        ALERT_BUTTON_YES,       "Confirm",
        ALERT_BUTTON_NO,        "Cancel",
        0);
    switch (result) {
        case ALERT_YES:
            break;
        case ALERT_NO:
            return 0;
        case ALERT_FAILED: /* not likely to happen unless out of FDs */
            result = confirm_yes(msg);
            if (!result) {
                return 0;
            }
            break;
    }
    return 1;
}

static Notify_value
filer_destroy_func(client, status)
    Notify_client       client;
    Destroy_status      status;
{
```

```
    if (status == DESTROY_CHECKING) {
        if (quit_confirmed_from_panel) {
            return(notify_next_destroy_func(client, status));
        } else if (confirm_quit() == 0) {
            (void) notify_veto_destroy((Notify_client)(LINT_CAST(client)));
            return(NOTIFY_DONE);
        }
    }
    return(notify_next_destroy_func(client, status));
}

void
quit_proc()
{
    if (confirm_quit()) {
        quit_confirmed_from_panel = 1;
        window_destroy(base_frame);
    }
}

msg(msg, beep)
    char *msg;
    int   beep;
{
    char    buf[300];
    int     result;
    Event   event;   /* unused */
    char    *contine_msg = "Press \"Continue\" to proceed.";

    result = alert_prompt(base_frame, &event,
        ALERT_MESSAGE_STRINGS,
            msg,
            contine_msg,
            0,
        ALERT_NO_BEEPING,  (beep) ? 0:1,
        ALERT_BUTTON_YES,  "Continue",
        ALERT_TRIGGER,     ACTION_STOP, /* allow either YES or NO answer */
        0);
    switch (result) {
        case ALERT_YES:
        case ALERT_TRIGGERED: /* result of ACTION_STOP trigger */
            break;
        case ALERT_FAILED: /* not likely to happen unless out of FDs */
            sprintf(buf, "%s  Press \"Continue\" to proceed.", msg);
            result = confirm_ok(buf);
            break;
    }
}

/* confirmer routines to be used if alert fails for any reason */

static Frame    init_confirmer();
static int      confirm();
static void     yes_no_ok();

int
confirm_yes(message)
    char        *message;
```

```
{
    return confirm(message, FALSE);
}

int
confirm_ok(message)
    char         *message;
{
    return confirm(message, TRUE);
}

static int
confirm(message, ok_only)
    char         *message;
    int          ok_only;
{
    Frame        confirmer;
    int          answer;

    /* create the confirmer */
    confirmer = init_confirmer(message, ok_only);
    /* make the user answer */
    answer = (int) window_loop(confirmer);
    /* destroy the confirmer */
    window_set(confirmer, FRAME_NO_CONFIRM, TRUE, 0);
    window_destroy(confirmer);
    return answer;
}

static Frame
init_confirmer(message, ok_only)
    char         *message;
    int           ok_only;
{
    Frame               confirmer;
    Panel               panel;
    Panel_item          message_item;
    int                 left, top, width, height;
    Rect                *r;
    struct pixrect      *pr;

    confirmer    = window_create(0, FRAME, FRAME_SHOW_LABEL, FALSE, 0);
    panel        = window_create(confirmer, PANEL, 0);
    message_item = panel_create_item(panel, PANEL_MESSAGE,
                        PANEL_LABEL_STRING, message, 0);

    if (ok_only) {
        pr = panel_button_image(panel, "Continue", 8, 0);
        width = pr->pr_width;
    } else {
        pr = panel_button_image(panel, "Cancel", 8, 0);
        width = 2 * pr->pr_width + 10;
    }

    /* center the yes/no or ok buttons under the message */
    r = (Rect *) panel_get(message_item, PANEL_ITEM_RECT);
    left = (r->r_width - width) / 2;
    if (left < 0)
```

```
        left = 0;
    top = rect_bottom(r) + 5;

    if (ok_only) {
        panel_create_item(panel, PANEL_BUTTON,
            PANEL_ITEM_X, left, PANEL_ITEM_Y, top,
            PANEL_LABEL_IMAGE, pr,
            PANEL_CLIENT_DATA, 1,
            PANEL_NOTIFY_PROC, yes_no_ok,
            0);
    } else {
        panel_create_item(panel, PANEL_BUTTON,
            PANEL_ITEM_X, left, PANEL_ITEM_Y, top,
            PANEL_LABEL_IMAGE, pr,
            PANEL_CLIENT_DATA, 0,
            PANEL_NOTIFY_PROC, yes_no_ok,
            0);
        panel_create_item(panel, PANEL_BUTTON,
            PANEL_LABEL_IMAGE, panel_button_image(panel, "Confirm", 8, 0),
            PANEL_CLIENT_DATA, 1,
            PANEL_NOTIFY_PROC, yes_no_ok,
            0);
    }

    window_fit(panel);
    window_fit(confirmer);

    /* center the confirmer frame on the screen */
    r           = (Rect *) window_get(confirmer, WIN_SCREEN_RECT);
    width       = (int) window_get(confirmer, WIN_WIDTH);
    height      = (int) window_get(confirmer, WIN_HEIGHT);
    left        = (r->r_width - width) / 2;
    top         = (r->r_height - height) / 2;
    if (left < 0)
        left = 0;
    if (top < 0)
        top = 0;
    window_set(confirmer, WIN_X, left, WIN_Y, top, 0);

    return confirmer;
}

static void
yes_no_ok(item, event)
    Panel_item  item;
    Event       *event;
{
    window_return(panel_get(item, PANEL_CLIENT_DATA));
}
```

A.2. *image_browser_1*

The following program is discussed in Chapter 4, *Using Windows*. It lets the user browse through icons and display them. It shows a more complex subwindow layout.

```
/****************************************************************************/
/*                           image_browser_1.c                              */
/****************************************************************************/

#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/tty.h>
#include <stdio.h>
#include <suntool/icon_load.h>
#include <suntool/seln.h>

Frame frame;
Panel control_panel, display_panel;
Tty   tty;

Panel_item dir_item, fname_item, image_item;

ls_proc(), show_proc(), quit_proc();

char *get_selection();

#define MAX_PATH_LEN 1024
#define MAX_FILENAME_LEN 256

main(argc, argv)
int argc;
char **argv;
{
    frame = window_create(NULL, FRAME,
                          FRAME_ARGS,  argc, argv,
                          FRAME_LABEL, "image_browser_1",
                          0);
    init_tty();
    init_control_panel();
    init_display_panel();
    window_fit(frame);
    window_main_loop(frame);
    exit(0);
}

init_tty()
{
    tty = window_create(frame, TTY,
                        WIN_COLUMNS, 30,
                        WIN_ROWS,    20,
                        0);
}
```

```
init_control_panel()
{
    char *getwd();
    char current_dir[1024];

    control_panel = window_create(frame, PANEL, 0);

    dir_item = panel_create_item(control_panel, PANEL_TEXT,
        PANEL_VALUE_DISPLAY_LENGTH, 13,
        PANEL_LABEL_STRING,         "Dir: ",
        PANEL_VALUE,                getwd(current_dir),
        0);

    fname_item = panel_create_item(control_panel, PANEL_TEXT,
        PANEL_ITEM_X,               ATTR_COL(0),
        PANEL_ITEM_Y,               ATTR_ROW(1),
        PANEL_VALUE_DISPLAY_LENGTH, 13,
        PANEL_LABEL_STRING,         "File:",
        0);

    panel_create_item(control_panel, PANEL_BUTTON,
        PANEL_ITEM_X,       ATTR_COL(0),
        PANEL_ITEM_Y,       ATTR_ROW(2),
        PANEL_LABEL_IMAGE,  panel_button_image(control_panel,"List",0,0),
        PANEL_NOTIFY_PROC,  ls_proc,
        0);

    panel_create_item(control_panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,  panel_button_image(control_panel,"Show",0,0),
        PANEL_NOTIFY_PROC,  show_proc,
        0);

    panel_create_item(control_panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE,  panel_button_image(control_panel,"Quit",0,0),
        PANEL_NOTIFY_PROC,  quit_proc,
        0);

    window_fit(control_panel);
}
```

```
ls_proc()
{
   static char previous_dir[MAX_PATH_LEN];
   char *current_dir;
   char cmdstring[100];

   current_dir = (char *)panel_get_value(dir_item);

   if (strcmp(current_dir, previous_dir)) {
       chdir(current_dir);
       sprintf(cmdstring, "cd %s\n", current_dir);
       ttysw_input(tty, cmdstring, strlen(cmdstring));
       strcpy(previous_dir, current_dir);
   }

   sprintf(cmdstring, "ls -1 %s\n", panel_get_value(fname_item));
   ttysw_input(tty, cmdstring, strlen(cmdstring));
}

quit_proc()
{
   window_destroy(frame);
}

show_proc()
{
    char *filename;

    if (!strlen(filename = get_selection()))
        return;

    load_image(filename);
}

load_image(filename)
char *filename;
{
    Pixrect *image;
    char error_msg[IL_ERRORMSG_SIZE];

    if (image = icon_load_mpr(filename, error_msg)) {
        panel_set(image_item,
                  PANEL_ITEM_X,      ATTR_COL(5),
                  PANEL_ITEM_Y,      ATTR_ROW(4),
                  PANEL_LABEL_IMAGE, image,
                  0);
    }
}
```

```
init_display_panel()
{
    display_panel = window_create(frame, PANEL,
                            WIN_BELOW,     control_panel,
                            WIN_RIGHT_OF, tty,
                            0);
    image_item = panel_create_item(display_panel, PANEL_MESSAGE, 0);
}

char *
get_selection()
{
    static char    filename[MAX_FILENAME_LEN];
    Seln_holder    holder;
    Seln_request   *buffer;

    holder = seln_inquire(SELN_PRIMARY);
    buffer = seln_ask(&holder, SELN_REQ_CONTENTS_ASCII, 0, 0);
    strncpy(filename, buffer->data + sizeof(Seln_attribute), MAX_FILENAME_LEN);
    return (filename);
}
```

A.3. *image_browser_2*

The following program is discussed in Chapter 4, *Using Windows*. It is a more complex icon browser than the previous example It illustrate how you can use *row/column space* to specify the size of a subwindow.

```
/******************************************************************************/
#ifndef lint
static char sccsid[] = "@(#)image_browser_2.c 1.3 86/09/15 Copyr 1986 Sun Micro";
#endif
/******************************************************************************/

#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/tty.h>
#include <stdio.h>
#include <suntool/icon_load.h>
#include <suntool/seln.h>
#include <suntool/expand_name.h>
#include <suntool/scrollbar.h>

static char namebuf[100];
static int file_count, image_count;
static struct namelist *name_list;
#define get_name(i) name_list->names[(i)]

Frame frame;
Panel control_panel, display_panel;
Tty   tty;

Panel_item dir_item, fname_item, image_item;

show_proc(), browse_proc(), quit_proc();

Pixrect *get_image();

char *get_selection();

#define MAX_PATH_LEN 1024
#define MAX_FILENAME_LEN 256

main(argc, argv)
int argc;
char **argv;
{
    frame = window_create(NULL, FRAME,
                          FRAME_ARGS,  argc, argv,
                          FRAME_LABEL, "image_browser_2",
                          0);
    init_control_panel();
    init_display_panel();
    window_set(control_panel,
               WIN_WIDTH, window_get(display_panel, WIN_WIDTH, 0),
               0);
    window_fit(frame);
    window_main_loop(frame);
    exit(0);
}
```

```
init_control_panel()
{
    char current_dir[MAX_PATH_LEN];

    control_panel = window_create(frame, PANEL, 0);

    dir_item = panel_create_item(control_panel, PANEL_TEXT,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(0),
        PANEL_VALUE_DISPLAY_LENGTH, 23,
        PANEL_VALUE,                  getwd(current_dir),
        PANEL_LABEL_STRING,           "Dir: ",
        0);

    (void) panel_create_item(control_panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(control_panel,"Browse",0,0),
        PANEL_NOTIFY_PROC, browse_proc,
        0);

    fname_item = panel_create_item(control_panel, PANEL_TEXT,
        PANEL_LABEL_X,                ATTR_COL(0),
        PANEL_LABEL_Y,                ATTR_ROW(1),
        PANEL_VALUE_DISPLAY_LENGTH, 23,
        PANEL_LABEL_STRING,           "File:",
        0);

    (void) panel_create_item(control_panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(control_panel,"Quit",6,0),
        PANEL_NOTIFY_PROC, quit_proc,
        0);

    window_fit_height(control_panel);

    window_set(control_panel, PANEL_CARET_ITEM, fname_item, 0);
}
```

```
browse_proc()
{
   Panel_item   old_item;
   register int i;
   int          len;
   Pixrect     *image;
   int          previous_image_count;
   register int row, col;

   set_directory();
   match_files();

   panel_each_item(display_panel, old_item)
       pr_destroy ((Pixrect *)panel_get(old_item, PANEL_LABEL_IMAGE));
       panel_free(old_item);
   panel_end_each

   previous_image_count = image_count;
   for (row = 0, image_count = 0; image_count < file_count; row++)
       for (col = 0; col < 4 && image_count < file_count; col++) {
         if (image = get_image(image_count)) {
            panel_create_item(display_panel, PANEL_MESSAGE,
                              PANEL_ITEM_Y,      ATTR_ROW(row),
                              PANEL_ITEM_X,      ATTR_COL(col),
                              PANEL_LABEL_IMAGE, image, 0);
            image_count++;
         }
       }

   if (image_count <= previous_image_count)
      panel_update_scrolling_size(display_panel);

   panel_paint(display_panel, PANEL_CLEAR);

   free_namelist(name_list);
}

set_directory()
{
   static char previous_dir[MAX_PATH_LEN];
   char *current_dir;

   current_dir = (char *)panel_get_value(dir_item);

   if (strcmp(current_dir, previous_dir)) {
       chdir(current_dir);
       strcpy(previous_dir, current_dir);
   }
}

Pixrect *
get_image(i)
int i;
{
   char error_msg[IL_ERRORMSG_SIZE];
   return (icon_load_mpr(get_name(i), error_msg));
}
```

```
match_files()
{
   char *val;

   val = (char *)panel_get_value(fname_item);
   strcpy(namebuf, val);
   name_list  = expand_name(namebuf);
   file_count = name_list->count;
}

quit_proc()
{
   window_destroy(frame);
}

show_proc()
{
    char *filename;

    if (!strlen(filename = get_selection()))
        return;

    load_image(filename);
}

load_image(filename)
char *filename;
{
    Pixrect *image;
    char error_msg[IL_ERRORMSG_SIZE];

    if (image = icon_load_mpr(filename, error_msg)) {
        panel_set(image_item,
                  PANEL_ITEM_X,       ATTR_COL(5),
                  PANEL_ITEM_Y,       ATTR_ROW(4),
                  PANEL_LABEL_IMAGE, image,
                  0);
    }
}
```

```
init_display_panel()
{
  int width;
  Scrollbar sb = scrollbar_create(SCROLL_MARGIN,10,0);
  width = (int)scrollbar_get(sb, SCROLL_THICKNESS, 0);
  display_panel = window_create(frame, PANEL,
                  WIN_BELOW,                control_panel,
                  WIN_X,                    0,
                  WIN_VERTICAL_SCROLLBAR,   sb,
                  WIN_ROW_HEIGHT,           64,
                  WIN_COLUMN_WIDTH,         64,
                  WIN_ROW_GAP,              10,
                  WIN_COLUMN_GAP,           10,
                  WIN_LEFT_MARGIN,          width + 10,
                  WIN_TOP_MARGIN,           10,
                  WIN_ROWS,                 4,
                  WIN_COLUMNS,              4,
                  0);
   window_set(display_panel, WIN_LEFT_MARGIN, 10, 0);
}

char *
get_selection()
{
    static char   filename[MAX_FILENAME_LEN];
    Seln_holder   holder;
    Seln_request  *buffer;

    holder = seln_inquire(SELN_PRIMARY);
    buffer = seln_ask(&holder, SELN_REQ_CONTENTS_ASCII, 0, 0);
    strncpy(filename, buffer->data + sizeof(Seln_attribute), MAX_FILENAME_LEN);
    return (filename);
}
```

A.4. *tty_io*

The following program demonstrates the use of `ttysw_input()`, `ttysw_output()` and TTY escape sequences. These functions are explained in Chapter 11, *TTY Subwindows*.

tty_io creates a panel and a tty subwindow. You can send arbitrary character sequences to the latter as input or output by manipulating panel items. There is also a button that sends the current time within the escape sequence to set the frame label. Try sending different sequences to the tty subwindow. Press CTRL-R to see the difference between what appears on the screen and what was input to the pseudo-tty. Also try starting the tool with a program such as *vi* as a command line argument.

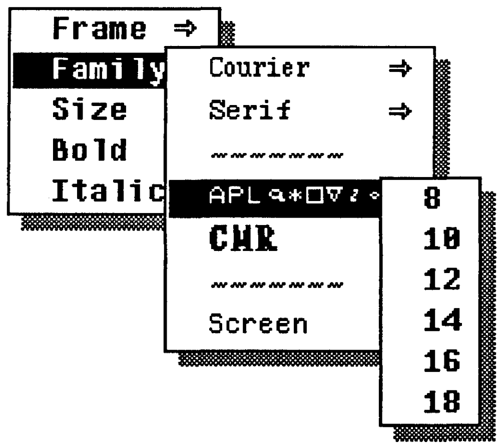
```
/*****************************************************************************/
#ifndef lint
static char sccsid[] = "@(#)tty_io.c 1.4 87/11/19 Copyr 1986 Sun Micro";
#endif
/*****************************************************************************/

#include <stdio.h>
#include <suntool/sunview.h>
#include <suntool/tty.h>
#include <suntool/panel.h>

#define TEXT_ITEM_MAX_LENGTH 25

Tty             tty;
Panel_item      text_item;
char            tmp_buf[80];

static void     input_text();
static void     output_text();
static void     output_time();

main(argc, argv)
    int             argc;
    char          **argv;
{
    Frame           frame;
    Panel           panel;

    frame = window_create(NULL, FRAME,
                          FRAME_ARGS,          argc, argv,
                          WIN_ERROR_MSG,       "Can't create tool frame",
                          0);
    panel = window_create(frame, PANEL, 0);

    /* set up a simple panel subwindow */
    panel_create_item(panel, PANEL_BUTTON,
                      PANEL_LABEL_IMAGE, panel_button_image(panel, "Input text", 11, 0),
                      PANEL_NOTIFY_PROC, input_text,
                      0);
    panel_create_item(panel, PANEL_BUTTON,
                      PANEL_LABEL_IMAGE, panel_button_image(panel, "Output text", 11, 0),
                      PANEL_NOTIFY_PROC, output_text,
                      0);
    text_item = panel_create_item(panel, PANEL_TEXT,
                                  PANEL_LABEL_STRING, "Text:",
                                  PANEL_VALUE, "Hello hello",
                                  PANEL_VALUE_DISPLAY_LENGTH, TEXT_ITEM_MAX_LENGTH,
                                  0);
    panel_create_item(panel, PANEL_BUTTON,
                      PANEL_LABEL_IMAGE, panel_button_image(panel, "Show time", 11, 0),
                      PANEL_NOTIFY_PROC, output_time,
                      0);

    window_fit_height(panel);
```

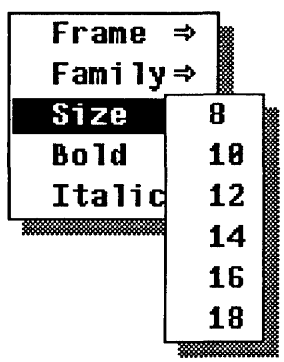
```
    /* Assume rest of arguments are for tty subwindow, except FRAME_ARGS leaves the
     * program_name as argv[0], and we don't want to pass this to the tty subwindow.
     */
    argv++;
    tty = window_create(frame, TTY,
                        TTY_ARGV,       argv,
                        WIN_ROWS,       24,
                        WIN_COLUMNS,    80,
                        0);

    window_fit(frame);

    ttysw_input(tty, "echo my pseudo-tty is `tty`\n", 28);

    window_main_loop(frame);
    exit(0);
}

static void
input_text(item, event)
    Panel_item      item;
    Event          *event;
{
    strcpy(tmp_buf, (char *) panel_get_value(text_item));
    ttysw_input(tty, tmp_buf, strlen(tmp_buf));
}

static void
output_text(item, event)
    Panel_item      item;
    Event          *event;
{
    strcpy(tmp_buf, (char *) panel_get_value(text_item));
    ttysw_output(tty, tmp_buf, strlen(tmp_buf));
}
```

```
static void
output_time(item, event)
    Panel_item      item;
    Event           *event;
{
#include <sys/time.h>
#define ASCTIMELEN      26

    struct timeval  tp;

    /* construct escape sequence to set frame label */
    tmp_buf[0] = '\033';
    tmp_buf[1] = ']';
    tmp_buf[2] = 'l';
    tmp_buf[2 + ASCTIMELEN + 1] = '\033';
    tmp_buf[2 + ASCTIMELEN + 2] = '\\';
    gettimeofday(&tp, NULL);
    strncpy(&tmp_buf[3], ctime(&tp.tv_sec), ASCTIMELEN);
    ttysw_output(tty, tmp_buf, ASCTIMELEN + 5);
}
```

A.5. *font_menu*

The next program, *font_menu*, builds on several of the examples given in Chapter 12, *Menus*. Examples of the font menu it creates are shown below:





```
/******************************************************************************/
#ifndef lint
static char sccsid[] = "@(#)font_menu.c 1.2 86/09/15 Copyr 1986 Sun Micro";
#endif
/******************************************************************************/

#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/walkmenu.h>

void set_family(), set_size(), set_on_off(), toggle_on_off(), open_fonts();
Menu new_menu(), initialize_on_off();
char *int_to_str();
extern char * sprintf();
extern char * malloc();

Panel_item feedback_item;
char *family, *size, *bold, *italic;
Pixfont *cour, *serif, *apl, *cmr, *screen;

/******************************************************************************/
/* main                                                                       */
/* First create the base frame, the feedback panel and feedback item. The    */
/* feedback item is initialized to "gallant 8".                               */
/* Then get the frame's menu, call new_menu() to create a new menu with the  */
/* original frame menu as a pullright, and give the new menu to the frame.   */
/******************************************************************************/

main(argc, argv)
        int argc;
        char *argv[];
{
    Frame frame;
    Panel panel;
    Menu  menu;
    int   defaults;

    frame = window_create(NULL, FRAME, FRAME_LABEL, "Menu Test -- Try frame menu.", 0);
    panel = window_create(frame, PANEL, WIN_ROWS, 1, 0);
    feedback_item = panel_create_item(panel, PANEL_MESSAGE, PANEL_LABEL_STRING, "", 0);

   family = "Gallant", size = "8", bold = italic = "";
   update_feedback();

    /* remember if user gave -d flag */
    if (argc >= 2) defaults = strcmp(argv[1], "-d") == 0;

    menu = (Menu)window_get(frame, WIN_MENU);
    menu = new_menu(menu, defaults);
    window_set(frame, WIN_MENU, menu, 0);

    window_main_loop(frame);
}
```

```
/****************************************************************************/
/* new_menu -- returns a new menu with 'original menu' as a pullright.      */
/****************************************************************************/

Menu
new_menu(original_menu, defaults)
        Menu original_menu;
        int defaults;
{
    Menu new_menu, family_menu, size_menu, on_off_menu;
    int i;

    /* create the on-off menu, which will be used as a pullright
     * for both the bold and italic items to the new menu.
    */
    on_off_menu = menu_create(MENU_STRING_ITEM, "On", 1,
                         MENU_STRING_ITEM,      "Off", 0,
                         MENU_GEN_PROC,         initialize_on_off,
                         MENU_NOTIFY_PROC,      set_on_off,
                         0);

    /* create the new menu which will eventually be returned */

    open_fonts(); /* first open the needed fonts */
    new_menu = menu_create(
                     MENU_PULLRIGHT_ITEM,
                       "Frame",
                       original_menu,
                     MENU_PULLRIGHT_ITEM,
                       "Family",
                       family_menu = menu_create(
                         MENU_ITEM,
                            MENU_STRING, "Courier",
                            MENU_FONT,   cour,
                            0,
                         MENU_ITEM,
                            MENU_STRING, "Serif",
                            MENU_FONT,   serif,
                            0,
                         MENU_ITEM,
                            MENU_STRING, "aplAPLGIJ",
                            MENU_FONT,   apl,
                            0,
                         MENU_ITEM,
                            MENU_STRING, "CMR",
                            MENU_FONT,   cmr,
                            0,
```

```
                    MENU_ITEM,
                       MENU_STRING, "Screen",
                       MENU_FONT,   screen,
                       0,
                    MENU_NOTIFY_PROC, set_family,
                  0),
                MENU_PULLRIGHT_ITEM,
                  "Size", size_menu = menu_create(0),
                MENU_ITEM,
                  MENU_STRING,      "Bold",
                  MENU_PULLRIGHT,   on_off_menu,
                  MENU_NOTIFY_PROC, toggle_on_off,
                  MENU_CLIENT_DATA, &bold,
                  0,
                MENU_ITEM,
                  MENU_STRING,      "Italic",
                  MENU_PULLRIGHT,   on_off_menu,
                  MENU_NOTIFY_PROC, toggle_on_off,
                  MENU_CLIENT_DATA, &italic,
                  0,
                0);

/* give each item in the family menu the size menu as a pullright */
for (i = (int)menu_get(family_menu, MENU_NITEMS); i > 0; --i)
    menu_set(menu_get(family_menu, MENU_NTH_ITEM, i),
             MENU_PULLRIGHT, size_menu, 0);

/* put non-selectable lines inbetween groups of items in family menu */
menu_set(family_menu,
         MENU_INSERT, 2, menu_create_item(MENU_STRING,     "-------",
                                          MENU_INACTIVE,   TRUE,
                                          0),
         0);
menu_set(family_menu,
         MENU_INSERT, 5, menu_get(family_menu, MENU_NTH_ITEM, 3),
         0);

/* The size menu was created with no items.  Now give it items representing */
/*  the point sizes 8, 10, 12, 14, 16, and 18.                              */
for (i = 8; i <= 18; i += 2)
    menu_set(size_menu, MENU_STRING_ITEM, int_to_str(i), i, 0);

/* give the size menu a notify proc to update the feedback */
menu_set(size_menu, MENU_NOTIFY_PROC, set_size, 0);
```

```
    /* if the user did not give the -d flag, make all the menus come
     * up with the initial and default selections the last selected
     * item, and the initial selection selected.
    */
    if (!defaults) {
        menu_set(new_menu,
                 MENU_DEFAULT_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION_SELECTED, TRUE,
                 0);
        menu_set(family_menu,
                 MENU_DEFAULT_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION_SELECTED, TRUE,
                 0);
        menu_set(size_menu,
                 MENU_DEFAULT_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION_SELECTED, TRUE,
                 0);
        menu_set(on_off_menu,
                 MENU_DEFAULT_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION, MENU_SELECTED,
                 MENU_INITIAL_SELECTION_SELECTED, TRUE,
                 0);
    }

    return (new_menu);
}
```

```
/****************************************************************************/
/* set_family -- notify proc for family menu.  Get the current family and   */
/* display it in the feedback panel.  Note that we first get the value      */
/* of the menu item.  This has the side effect of causing any pullrights    */
/* further to the right of mi to be evaluated.  Specifically, the value of  */
/* each family item is the value of its pullright -- namely the size menu.  */
/* When the size menu is evaluated, the notify proc set_size() is called,   */
/* which updates the feedback for the size.                                 */
/****************************************************************************/

/*ARGSUSED*/
void
set_family(m, mi)
        Menu m;
        Menu_item mi;
{
    menu_get(mi, MENU_VALUE);  /* force pullrights to be evaluated */
    family = menu_get(mi, MENU_STRING);
    update_feedback();
}


/****************************************************************************/
/* set_size -- notify proc for the size menu.                               */
/****************************************************************************/

/*ARGSUSED*/
void
set_size(m, mi)
        Menu m;
        Menu_item mi;
{
    size =  menu_get(mi, MENU_STRING);
    update_feedback();
}
```

```
/*****************************************************************************/
/* initialize_on_off -- generate proc for the on_off menu.                   */
/* The on-off menu is a pullright of both the bold and the italic menus.     */
/* We want it to toggle -- if its parent was on, it should come up with      */
/* "Off" selected, and vice-versa.  We can do that by first getting the      */
/* parent menu item, then, indirectly through its client data attribute,     */
/* seeing if the string representing the bold or italic state is null.       */
/* If the string was null, we set the first item ("On") to be selected,      */
/* else we set the second item ("Off") to be selected.                       */
/*****************************************************************************/

Menu
initialize_on_off(m, op)
        Menu m; Menu_generate op;
{
    Menu_item parent_mi;
    char **name;

    if (op != MENU_CREATE) return (m);

    parent_mi = (Menu_item)menu_get(m, MENU_PARENT);
    name = (char **)menu_get(parent_mi, MENU_CLIENT_DATA);

    if (**name == NULL)
        menu_set(m, MENU_SELECTED, 1, 0);
    else
        menu_set(m, MENU_SELECTED, 2, 0);
    return (m);
}
```

```
/****************************************************************************/
/* set_on_off -- notify proc for on-off menu.                               */
/* Set the feedback string -- italic or bold -- appropriately depending on  */
/* the current setting.  Note that the "On" item was created to return a    */
/* value of 1, and the "Off" item will return a value of 0.                 */
/****************************************************************************/

void
set_on_off(m, mi)
        Menu m; Menu_item mi;
{
    Menu_item parent_mi;
    char **name;

    parent_mi = (Menu_item)menu_get(m, MENU_PARENT);
    name = (char **)menu_get(parent_mi, MENU_CLIENT_DATA);
    if (menu_get(mi, MENU_VALUE))
        *name = (char *)menu_get(parent_mi, MENU_STRING);
    else
        *name = "";
    update_feedback();
}

/****************************************************************************/
/* toggle_on_off -- notify proc for the "Bold" and "Italic" menu items.     */
/* Using a notify proc for the menu item allows toggling without bringing   */
/* up the on-off pullright.                                                 */
/****************************************************************************/

/*ARGSUSED*/
void
toggle_on_off(m, mi)
        Menu m;
        Menu_item mi;
{
    char **name;

    name = (char **)menu_get(mi, MENU_CLIENT_DATA);

    if (**name == NULL)
        *name = (char *)menu_get(mi, MENU_STRING);
    else
        *name = "";

    update_feedback();
}
```

```
update_feedback()
{
    char buf[30];

    sprintf(buf, "%s %s %s %s", bold, italic, family, size);
    panel_set(feedback_item, PANEL_LABEL_STRING, buf, 0);
}

char *
int_to_str(n)
{
    char *r = malloc(4);
    sprintf(r, "%d", n);
    return (r);
}

void
open_fonts()
{
    cour = pf_open("/usr/lib/fonts/fixedwidthfonts/cour.r.10");
    serif = pf_open("/usr/lib/fonts/fixedwidthfonts/serif.r.10");
    apl = pf_open("/usr/lib/fonts/fixedwidthfonts/apl.r.10");
    cmr = pf_open("/usr/lib/fonts/fixedwidthfonts/cmr.b.8");
    screen = pf_open("/usr/lib/fonts/fixedwidthfonts/screen.r.11");
}
```

A.6. *resize_demo*

This program demonstrates how to resize the subwindows of a frame yourself if you need to use a complicated topology.

The particular subwindow layout used here has four subwindows. One has a fixed width and height in pixels, another has a fixed width in characters (using the user-set default font), and the other two fill up the empty space. One of the subwindows also has a scrollbar.

This program interposes in front of the frame's client event handler. If the event is `WIN_RESIZE`, the program's own `resize()` procedure is called, which sets the subwindow positions explicitly.

For a discussion of interposing and the Notifier, see Chapter 17, *The Notifier*. The simpler case of using window attributes to layout subwindows is described under *Explicit Subwindow Layout* in Chapter @NumberOf(window), *@TitleOf(window)*.

```
/***************************************************************************/
#ifndef lint
static char sccsid[] = "%Z%%M% %I% %E% Copyr 1986 Sun Micro";
#endif
/***************************************************************************/

#include <suntool/sunview.h>
#include <suntool/canvas.h>
#include <suntool/scrollbar.h>

Canvas Canvas_1, Canvas_2, Canvas_3, Canvas_4;
Pixwin *Pixwin_1, *Pixwin_2, *Pixwin_3, *Pixwin_4;
Rect framerect;
PIXFONT *font;

extern char * sprintf();
/*
 * font macros:
 *      font_offset(font) gives the vertical distance between
 *                        the font origin and the top left corner
 *                        of the bounding box of the string displayed
 *                        (see Text Facilities for Pixrects in the
 *                        Pixrect Reference Manual)
 *      font_height(font) gives the height of the font
 */

#define font_offset(font)       (-font->pf_char['n'].pc_home.y)
#define font_height(font)       (font->pf_defaultsize.y)

/*
 * SunView-dependent size definitions
 */

#define LEFT_MARGIN     5               /* margin on left side of frame */
#define RIGHT_MARGIN    5               /* margin on right side of frame */
#define BOTTOM_MARGIN   5               /* margin on bottom of frame */
#define SUBWINDOW_SPACING       5       /* space in between adjacent
                                           subwindows */

/*
 * application-dependent size definitions
 */

#define CANVAS_1_WIDTH  320             /* width in pixels of canvas 1 */
#define CANVAS_1_HEIGHT 160             /* height in pixels of canvas 1 */
#define CANVAS_3_COLUMNS        30      /* width in characters of canvas 3 */


main(argc, argv)
int argc;
char **argv;
{
        Frame frame;
        static Notify_value catch_resize();
        static void draw_canvas_1(), draw_canvas_3();

        /*
         * create the frame and subwindows, and open the font
```

```
         * no size attributes are given yet
         */

        frame = window_create(NULL, FRAME,
                        FRAME_ARGS, argc, argv,
                        WIN_ERROR_MSG, "Can't create tool frame",
                        FRAME_LABEL, "Resize Demo",
                        0);
        Canvas_1 = window_create(frame, CANVAS,
                        CANVAS_RESIZE_PROC, draw_canvas_1,
                        0);
        Canvas_2 = window_create(frame, CANVAS,
                        0);
        Canvas_3 = window_create(frame, CANVAS,
                        WIN_VERTICAL_SCROLLBAR, scrollbar_create(
                                SCROLL_PLACEMENT,       SCROLL_EAST,
                                0),
                        CANVAS_RESIZE_PROC, draw_canvas_3,
                        0);
        Canvas_4 = window_create(frame, CANVAS,
                        0);
        Pixwin_1 = canvas_pixwin(Canvas_1);
        Pixwin_2 = canvas_pixwin(Canvas_2);
        Pixwin_3 = canvas_pixwin(Canvas_3);
        Pixwin_4 = canvas_pixwin(Canvas_4);
        font = pf_default();

        /*
         * now that the frame and font sizes are known, set the initial
         * subwindow sizes
         */

        resize(frame);

        /*
         * insert an interposer so that whenever the window changes
         * size we will know about it and handle it ourselves
         */

        (void) notify_interpose_event_func(frame, catch_resize, NOTIFY_SAFE);

        /*
         * start execution
         */

        window_main_loop(frame);
        exit(0);
}

/*
 * catch_resize
 *
 * interposed function which checks all input events passed to the frame
 * for resize events; if it finds one,  resize() is called to refit
 * the subwindows; checking is done AFTER the frame processes the
 * event because if the frame changes its size due to this event (because
 * the window has been opened or closed for instance) we want to fit
 * the subwindows to the new size
```

```
 */

static Notify_value
catch_resize(frame, event, arg, type)
    Frame frame;
    Event *event;
    Notify_arg arg;
    Notify_event_type type;
{
        Notify_value value;

        value = notify_next_event_func(frame, event, arg, type);
        if (event_action(event) == WIN_RESIZE)
                resize(frame);
        return(value);
}

/*
 * resize
 *
 * fit the subwindows of the frame to its new size
 */

resize(frame)
    Frame frame;
{
        Rect *r;
        int canvas_3_width;     /* the width in pixels of canvas 3 */
        int stripeheight;       /* the height of the frame's name stripe */

        /* if the window is iconic, don't do anything */

        if ((int)window_get(frame, FRAME_CLOSED))
                return;

        /* find out our new size parameters */

        r = (Rect *) window_get(frame, WIN_RECT);
        framerect = *r;
        stripeheight = (int) window_get(frame, WIN_TOP_MARGIN);

        canvas_3_width = CANVAS_3_COLUMNS * font->pf_defaultsize.x
                + (int) scrollbar_get(SCROLLBAR, SCROLL_THICKNESS);
        window_set(Canvas_2,
                WIN_X,          0,
                WIN_Y,          0,
                WIN_WIDTH,      framerect.r_width - canvas_3_width
                                - LEFT_MARGIN - SUBWINDOW_SPACING
                                - RIGHT_MARGIN,
                WIN_HEIGHT,     framerect.r_height - CANVAS_1_HEIGHT
                                - stripeheight - SUBWINDOW_SPACING -
                                BOTTOM_MARGIN,
                0);
        window_set(Canvas_1,
                WIN_X,          0,
                WIN_Y,          framerect.r_height - CANVAS_1_HEIGHT -
                                SUBWINDOW_SPACING - stripeheight,
                WIN_WIDTH,      CANVAS_1_WIDTH,
```

```
                WIN_HEIGHT,     CANVAS_1_HEIGHT,
                0);
        window_set(Canvas_4,
                WIN_X,          CANVAS_1_WIDTH + SUBWINDOW_SPACING,
                WIN_Y,          framerect.r_height - CANVAS_1_HEIGHT
                                - SUBWINDOW_SPACING - stripeheight,
                WIN_WIDTH,      framerect.r_width - canvas_3_width
                                - CANVAS_1_WIDTH - LEFT_MARGIN
                                - 2 * SUBWINDOW_SPACING - RIGHT_MARGIN,
                WIN_HEIGHT,     CANVAS_1_HEIGHT,
                0);
        window_set(Canvas_3,
                WIN_X,          framerect.r_width - canvas_3_width
                                - LEFT_MARGIN - SUBWINDOW_SPACING,
                WIN_Y,          0,
                WIN_WIDTH,      canvas_3_width,
                WIN_HEIGHT,     framerect.r_height - stripeheight
                                - BOTTOM_MARGIN,
                0);
}

/*
 * draw_canvas_1
 * draw_canvas_3
 *
 * draw simple messages in the canvases
 */

static void
draw_canvas_1()
{
        char buf[64];

        sprintf(buf, "%d by %d pixels",
                                CANVAS_1_WIDTH, CANVAS_1_HEIGHT);
        pw_text(Pixwin_1, 5, font_offset(font), PIX_SRC, font,
                                "This subwindow is always ");
        pw_text(Pixwin_1, 5, font_offset(font) + font_height(font),
                                PIX_SRC, font, buf);
}

static void
draw_canvas_3()
{
        char buf[64];

        sprintf(buf, "%d characters wide",
                                CANVAS_3_COLUMNS);
        pw_text(Pixwin_3, 5, font_offset(font), PIX_SRC, font,
                                "This subwindow is always ");
        pw_text(Pixwin_3, 5, font_offset(font) + font_height(font), PIX_SRC,
                                font, buf);
}
```

A.7. *dctool*

dctool is a simple reverse-polish notation calculator which demonstrates how to use pipes to write a SunView-based front end for an existing non-SunView program. *dctool* consists of a panel with buttons for each digit, the four arithmetic operations, and an enter key. The digits you hit are displayed in a message item and are sent via a pipe to ,`dc(1)` a UNIX desk calculator. When `dc` computes an answer, it is sent back to *dctool* via a second pipe and it is displayed.

Note also the use of a single notify procedure for all of the digit buttons. The actual digit associated with each button is stored as the client data for each panel item, so the notify procedure can determine which button was pressed by looking at the client data. This value is then passed directly to dc. The operation buttons also all use a single notify procedure.

When you run *dctool*, remember that it is a reverse-polish notation calculator. For instance, to compute 3 * 5 you must hit the buttons 3, Enter, 5, and * in that order. If you prefer infix notation, you could easily adapt *dctool* to use `bc(1)` instead of `dc`.

```
/****************************************************************/
#ifndef lint
static char sccsid[] = "@(#)dctool.c 1.4 86/09/15 Copyr 1986 Sun Micro";
#endif
/****************************************************************/

#include <stdio.h>
#include <suntool/sunview.h>
#include <suntool/panel.h>

static Frame      frame;
static Panel      panel;
static Panel_item digit_item[10], enter_item;
static Panel_item add_item, sub_item, mul_item, div_item;
static Panel_item display_item;

static char       display_buf[512] = "";  /* storage for the
                                            * numbers currently on
                                            * the display (stored as
                                            * a string) */

static FILE      *fp_tochild;      /* fp of pipe to child (write
                                    * data on it) */
static FILE      *fp_fromchild;    /* fp of pipe from child (read
                                    * data from it) */
static int        tochild;         /* associated file descriptors */
static int        fromchild;

static int        childpid;        /* pid of child process */

static int        dead = 0;        /* set to 1 if child process has
                                    * died */

main(argc, argv)
    int             argc;
    char          **argv;
{
    static Notify_value pipe_reader();
    static Notify_value dead_child();

    frame = window_create(NULL, FRAME,
                          FRAME_ARGS, argc, argv,
                          WIN_ERROR_MSG, "Cannot create frame",
                          FRAME_LABEL, "dctool - RPN Calculator",
                          0);

    panel = window_create(frame, PANEL,
                          0);
    create_panel_items(panel);

    window_fit(panel);
    window_fit(frame);

    /* start the child process and tell the notifier about it */
    start_dc();
    /*
     * note that notify_set_input_func takes a file descriptor,
     * not a file pointer used by the standard I/O library
```

```
     */
    (void) notify_set_input_func(frame, pipe_reader, fromchild);
    (void) notify_set_wait3_func(frame, dead_child, childpid);

    window_main_loop(frame);
    exit(0);
}

static
create_panel_items(panel)
    Panel           panel;
{
    int             c;
    char            name[2];
    static void     digit_proc(), op_proc();
    static struct {
        int             col, row;
    }               positions[10] = {
            { 0, 3 }, { 0, 0 }, { 6, 0 }, { 12, 0 },
                      { 0, 1 }, { 6, 1 }, { 12, 1 },
                      { 0, 2 }, { 6, 2 }, { 12, 2 }
             };

    name[1] = '\0';
    for (c = 0; c < 10; c++) {
        name[0] = c + '0';
        digit_item[c] = panel_create_item(panel, PANEL_BUTTON,
          PANEL_LABEL_IMAGE, panel_button_image(panel, name, 3, 0),
          PANEL_NOTIFY_PROC, digit_proc,
          PANEL_CLIENT_DATA, (caddr_t) (c + '0'),
          PANEL_LABEL_X,     ATTR_COL(positions[c].col),
          PANEL_LABEL_Y,     ATTR_ROW(positions[c].row),
          0);
    }
    add_item = panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "+", 3, 0),
        PANEL_NOTIFY_PROC, op_proc,
        PANEL_CLIENT_DATA, (caddr_t) '+',
        PANEL_LABEL_X,     ATTR_COL(18),
        PANEL_LABEL_Y,     ATTR_ROW(0),
        0);
    sub_item = panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "-", 3, 0),
        PANEL_NOTIFY_PROC, op_proc,
        PANEL_CLIENT_DATA, (caddr_t) '-',
        PANEL_LABEL_X,     ATTR_COL(18),
        PANEL_LABEL_Y,     ATTR_ROW(1),
        0);
    mul_item = panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "*", 3, 0),
        PANEL_NOTIFY_PROC, op_proc,
        PANEL_CLIENT_DATA, (caddr_t) '*',
        PANEL_LABEL_X,     ATTR_COL(18),
        PANEL_LABEL_Y,     ATTR_ROW(2),
        0);
    div_item = panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "/", 3, 0),
        PANEL_NOTIFY_PROC, op_proc,
```

```
        PANEL_CLIENT_DATA, (caddr_t) '/',
        PANEL_LABEL_X,     ATTR_COL(18),
        PANEL_LABEL_Y,     ATTR_ROW(3),
        0);
    enter_item = panel_create_item(panel, PANEL_BUTTON,
        PANEL_LABEL_IMAGE, panel_button_image(panel, "Enter", 7, 0),
        PANEL_NOTIFY_PROC, op_proc,
        PANEL_CLIENT_DATA, (caddr_t) ' ',
        PANEL_LABEL_X,     ATTR_COL(6),
        PANEL_LABEL_Y,     ATTR_ROW(3),
        0);
    display_item = panel_create_item(panel, PANEL_MESSAGE,
        PANEL_LABEL_STRING, "0",
        PANEL_LABEL_X,      ATTR_COL(0),
        PANEL_LABEL_Y,      ATTR_ROW(4),
        0);
}

/* callback procedure called whenever a digit button is pressed */

static void
digit_proc(item, event)
    Panel_item      item;
    Event          *event;
{
    int             digit_name = (int) panel_get(item,
                                                PANEL_CLIENT_DATA);
    char            buf[2];

    buf[0] = digit_name;        /* display digit */
    buf[1] = '\0';
    strcat(display_buf, buf);
    panel_set(display_item, PANEL_LABEL_STRING, display_buf, 0);
    send_to_dc(digit_name);     /* send digit to dc */
}

/*
 * callback procedure called whenever an operation button is
 * pressed
 */

static void
op_proc(item, event)
    Panel_item      item;
    Event          *event;
{
    int             op_name = (int) panel_get(item,
                                                 PANEL_CLIENT_DATA);

    display_buf[0] = '\0';      /* don't erase display yet; wait
                                 * until the answer comes back */
    send_to_dc(op_name);
    if (item != enter_item)
        send_to_dc('p');        /* send a p so the answer will be
                                 * printed by dc */
    send_to_dc('\n');
}
```

```
/*
 * start the child process
 */

static
start_dc()
{
    int             pipeto[2], pipefrom[2];
    int             c, numfds;

    if (pipe(pipeto) < 0 || pipe(pipefrom) < 0) {
        perror("dctool");
        exit(1);
    }
    switch (childpid = fork()) {

    case -1:
        perror("dctool");
        exit(1);

    case 0:                     /* this is the child process */
        /*
         * use dup2 to set the child's stdin and stdout to the
         * pipes
         */

        dup2(pipeto[0], 0);
        dup2(pipefrom[1], 1);

        /*
         * close all other fds (except stderr) since the child
         * process doesn't know about or need them
         */

        numfds = getdtablesize();
        for (c = 3; c < numfds; c++)
            close(c);

        /* exec the child process */

        execl("/usr/bin/dc", "dc", 0);
        perror("dctool (child)");       /* shouldn't get here */
        exit(1);

    default:                    /* this is the parent */
        close(pipeto[0]);
        close(pipefrom[1]);
        tochild = pipeto[1];
        fp_tochild = fdopen(tochild, "w");
        fromchild = pipefrom[0];
        fp_fromchild = fdopen(fromchild, "r");

        /*
         * the pipe to dc must be unbuffered or dc will not get
         * any data until 1024 characters have been sent
         */

        setbuf(fp_tochild, NULL);
```

```
            break;
        }
    }

    /*
     * notify proc called whenever there is data to read on the pipe
     * from the child process; in this case it is an answer from dc,
     * so we display it
     */

    static          Notify_value
    pipe_reader(frame, fd)
        Frame           frame;
        int             fd;
    {
        char            buf[512];

        fgets(buf, 512, fp_fromchild);
        buf[strlen(buf) - 1] = '\0';/* remove newline */
        panel_set(display_item, PANEL_LABEL_STRING, buf, 0);
        display_buf[0] = '\0';
        return (NOTIFY_DONE);
    }

    /*
     * notify proc called if the child dies
     */

    static          Notify_value
    dead_child(frame, pid, status, rusage)
        Frame           frame;
        int             pid;
        union wait     *status;
        struct rusage  *rusage;
    {
        panel_set(display_item, PANEL_LABEL_STRING, "Child died!", 0);
        dead = 1;

        /*
         * tell the notifier to stop reading the pipe (since it is
         * invalid now)
         */

        (void) notify_set_input_func(frame, NOTIFY_FUNC_NULL,
                                     fromchild);
        close(tochild);
        close(fromchild);
        return (NOTIFY_DONE);
    }

    /* send a character over the pipe to dc */

    static
    send_to_dc(c)
        char            c;
    {
        if (dead)
            panel_set(display_item,
```

```
                    PANEL_LABEL_STRING, "Child is dead!",
                    0);
     else
         putc(c, fp_tochild);
}
```

A.8. *typein*

This program shows how to replace the functionality of the Graphics Tool and gfxsw package previously available under SunWindows. *typein* provides a tty emulator for interaction with the user and a canvas to draw on. To demonstrate it, a simple application is included which allows the user to input coordinates in the tty emulator and then draws the vectors in the canvas.

typein uses a tty subwindow and a canvas. Normally, the tty subwindow is used to allow a child process to run in a window; in this case, we would like the same process to write in that window. To accomplish this, we tell the tty subwindow not to fork a child process with the `TTY_ARGV_DO_NOT_FORK` value for `TTY_ARGV`. *typein* uses `dup2`(2) to set its stdin and stdout to the `TTY_FD`. When the user types something in the tty subwindow, *typein*'s `read_input()` routine is called.

NOTE When using this mechanism, be careful of the following problems. First, you must use the Notifier (unlike the old gfxsw). Second, if you use the standard I/O package, be sure to either use `fflush` carefully or to remove all buffering with `setbuf` because the package will think you are sending data to a file and not to a tty. Finally, be sure you never block on a read because the program will hang (either use non-blocking I/O or only read one line at a time).

```
/******************************************************************/
#ifndef lint
static char sccsid[] = "@(#)typein.c 1.5 87/01/07 Copyr 1986 Sun Micro";
#endif
/******************************************************************/

#include <stdio.h>
#include <suntool/sunview.h>
#include <suntool/canvas.h>
#include <suntool/tty.h>
#include <ctype.h>

static Frame     frame;
static Canvas    canvas;
static Tty       tty;
static Pixwin   *pw;

static Notify_client    my_client;

#define STDIN_FD        0
#define STDOUT_FD       1
#define BUFSIZE         1000

main(argc, argv)
int     argc;
char  **argv;
{
        static Notify_value read_input();
        int     tty_fd;

        frame = window_create(NULL, FRAME,
                FRAME_ARGS,     argc, argv,
                WIN_ERROR_MSG,  "Cannot create frame",
                FRAME_LABEL,    "typein",
                0);

        tty = window_create(frame, TTY,
                WIN_PERCENT_HEIGHT,     50,
                TTY_ARGV,               TTY_ARGV_DO_NOT_FORK,
                0);

        tty_fd = (int)window_get(tty, TTY_TTY_FD);
        dup2(tty_fd, STDOUT_FD);
        dup2(tty_fd, STDIN_FD);

        canvas = window_create(frame, CANVAS,
                        0);
        pw = canvas_pixwin(canvas);

        /*
         * Set up a notify proc so that whenever there is input to read on
         * stdin (fd 0), we are called to read it.
         * Notifier needs a unique handle: give it the address of tty.
         */
        my_client = (Notify_client) &tty;
        notify_set_input_func(my_client, read_input, STDIN_FD);

        printf("Enter first coordinate:\nx? ");
```

```
        window_main_loop(frame);
        exit(0);
}

/*
 * This section implements a simple application which writes prompts to
 * stdin and reads coordinates from stdout, drawing vectors with the
 * supplied coordinates.  It uses a state machine to keep track of what
 * number to read next.
 */
#define GET_X_1         0
#define GET_Y_1         1
#define GET_X_2         2
#define GET_Y_2         3
int state = GET_X_1;
int x1, y1, x2, y2;


/* ARGSUSED */
static Notify_value
read_input(client, in_fd)
Notify_client   client;         /* unused since this must be from ttysw */
int             in_fd;          /* unused since this is stdin */
{
        char    buf[BUFSIZE];
        char   *ptr, *gets();

        ptr = gets(buf);   /* read one line per call so that we
                                     don't ever block */
                                   /* ^^^^^ does this matter any more?? */
        /* handle end of file */
        if (ptr==NULL) {
                /* Note: could have been a read error */
                window_set(frame, FRAME_NO_CONFIRM, TRUE, 0);
                window_done(tty);
        } else {
                switch (state) {
                case GET_X_1:
                        if (sscanf(buf, "%d", &x1) != 1) {
                                printf("Illegal value!\nx? ");
                                fflush(stdout);
                        } else {
                                printf("y? ");
                                fflush(stdout);
                                state++;
                        }
                        break;
                case GET_Y_1:
                        if (sscanf(buf, "%d", &y1) != 1) {
                                printf("Illegal value!\ny? ");
                                fflush(stdout);
                        } else {
                                printf("Enter second coordinate:\nx? ");
                                fflush(stdout);
                                state++;
                        }
                        break;
                case GET_X_2:
```

```
                        if (sscanf(buf, "%d", &x2) != 1) {
                                printf("Illegal value!\nx? ");
                                fflush(stdout);
                        } else {
                                printf("y? ");
                                fflush(stdout);
                                state++;
                        }
                        break;
                case GET_Y_2:
                        if (sscanf(buf, "%d", &y2) != 1) {
                                printf("Illegal value!\ny? ");
                                fflush(stdout);
                        } else {
                                printf("Vector from (%d, %d) to (%d, %d)\n",
                                        x1, y1, x2, y2);
                                pw_vector(pw, x1, y1, x2, y2, PIX_SET, 1);
                                printf("\nEnter first coordinate:\nx? ");
                                fflush(stdout);
                                state = GET_X_1;
                        }
                        break;
                }
        }
        return(NOTIFY_DONE);
}
```

A.9. Programs that Manipulate Color

The following two programs work with color. You can run them on a monochrome workstation to no ill-effect, but you won't see much of interest.

The techniques employed by these two programs are explained in the *Color* section of Chapter 7, *Imaging Facilities: Pixwins*.

When using these programs, try invoking them with different colors using the frame's command line arguments. Also, run *showcolor* (listed in the pixwin chapter) to see how the screen's colormap changes as different color programs are run simultaneously.

coloredit

The first program, *coloredit*, puts up sliders that let the user modify its colors.

```
/***************************************************************************/
#ifndef lint
static char sccsid[] = "@(#)coloredit.c 1.4 86/09/15 Copyr 1986 Sun Micro";
#endif
/***************************************************************************/

#include <suntool/sunview.h>
#include <suntool/panel.h>
#include <suntool/canvas.h>

#define MYFRAME         0
#define MYPANEL         1
#define MYCANVAS        2

/* colormap sizes for the three windows.  Canvas is still the biggest */
mycms_sizes[3] = {
        2, 2, 4
};
#define MYCMS_SIZE      4
/* color arrays; initialize them with the canvas colors */
unsigned char   red[MYCMS_SIZE] = {0, 0, 255, 255};
unsigned char   green[MYCMS_SIZE] = {0, 255, 0, 192};
unsigned char   blue[MYCMS_SIZE] = {255, 0, 0, 192};

static void     getcms();
static void     setcms();
static void     cycle();
static void     editcms();
static void     set_color();
static void     change_value();

Panel_item      text_item;
Panel_item      color_item;
Panel_item      red_item, green_item, blue_item;

Pixwin         *pixwins[3];
Pixwin         *pw;


main(argc, argv)
        int             argc;
        char          **argv;
{
        Frame           base_frame;
        Panel           panel;
        Canvas          canvas;

        Attr_avlist     sliderdefaults;

        /* the cmsname is copied, so this array can be reused */
        char            cmsname[CMS_NAMESIZE];

        int             counter;
        int             xposition;
        char            buf[40];

        base_frame = window_create(NULL, FRAME,
                                   FRAME_LABEL,         "coloredit",
```

```
                                FRAME_ARGS,           argc, argv,
                                0);

        /* set up the panel */
        panel = window_create(base_frame, PANEL,
                              0);
        /* create a reusable attribute list for my slider attributes */
        sliderdefaults = attr_create_list(
                                PANEL_SHOW_ITEM,        TRUE,
                                PANEL_MIN_VALUE,        0,
                                PANEL_MAX_VALUE,        255,
                                PANEL_SLIDER_WIDTH,     512,
                                PANEL_SHOW_RANGE,       TRUE,
                                PANEL_SHOW_VALUE,       TRUE,
                                PANEL_NOTIFY_LEVEL,     PANEL_ALL,
                                0);


        panel_create_item(panel, PANEL_CYCLE,
                          PANEL_LABEL_STRING,   "Edit colormap:",
                          PANEL_VALUE,          MYCANVAS,
                          PANEL_CHOICE_STRINGS, "Frame", "Panel", "Canvas", 0,
                          PANEL_NOTIFY_PROC,    editcms,
                          0);


        text_item = panel_create_item(panel, PANEL_TEXT,
                                PANEL_VALUE_DISPLAY_LENGTH,     CMS_NAMESIZE,
                                PANEL_VALUE_STORED_LENGTH,      CMS_NAMESIZE,
                                0);


        color_item = panel_create_item(panel, PANEL_SLIDER,
                                       ATTR_LIST,               sliderdefaults,
                                       PANEL_LABEL_STRING,      "color:",
                                       PANEL_NOTIFY_PROC,       set_color,
                                       0);

        red_item = panel_create_item(panel, PANEL_SLIDER,
                                     ATTR_LIST,                 sliderdefaults,
                                     PANEL_LABEL_STRING,        "  red:",
                                     PANEL_NOTIFY_PROC,         change_value,
                                     0);

        green_item = panel_create_item(panel, PANEL_SLIDER,
                                       ATTR_LIST,               sliderdefaults,
                                       PANEL_LABEL_STRING, "green:",
                                       PANEL_NOTIFY_PROC, change_value,
                                       0);

        blue_item = panel_create_item(panel, PANEL_SLIDER,
                                      ATTR_LIST,                sliderdefaults,
                                      PANEL_LABEL_STRING, " blue:",
                                      PANEL_NOTIFY_PROC, change_value,
                                      0);

        panel_create_item(panel, PANEL_BUTTON,
                          PANEL_LABEL_IMAGE,
```

```
                    panel_button_image(panel, "Cycle colormap", 12, NULL),
                        PANEL_NOTIFY_PROC, cycle,
                        0);

        window_fit(panel);
        window_fit_width(base_frame);

        /* free the slider attribute list */
        free(sliderdefaults);

        /* set up the canvas */
        canvas = window_create(base_frame, CANVAS, 0);

        /* get pixwins */
        pixwins[MYFRAME] = (Pixwin *) window_get(base_frame, WIN_PIXWIN);
        pixwins[MYPANEL] = (Pixwin *) window_get(panel, WIN_PIXWIN);
        pw = pixwins[MYCANVAS] = (Pixwin *) canvas_pixwin(canvas);

        /* set up the canvas' colormap */
        sprintf(cmsname, "coloredit%D", getpid());
        pw_setcmsname(pw, cmsname);
        pw_putcolormap(pw, 0, mycms_sizes[MYCANVAS], red, green, blue);

        /* draw in the canvas */
        /* don't draw color 0 -- it is the background */
        for (counter = 1; counter < mycms_sizes[MYCANVAS]; counter++) {
                xposition = counter * 100;
                pw_rop(pw, xposition, 50, 50, 50,
                       PIX_SRC | PIX_COLOR(counter), NULL, 0, 0);
                sprintf(buf, "%d", counter);
                pw_text(pw, xposition + 5, 70, PIX_SRC ^ PIX_DST, 0, buf);
        }
        pw_text(pw, 100, 150,
                PIX_SRC | PIX_COLOR(mycms_sizes[MYCANVAS] - 1), 0,
                "This is written in the foreground color");

        /* initialize to edit the first canvas color */
        editcms(NULL, MYCANVAS, NULL);

        window_main_loop(base_frame);
        exit(0);
}

static int      cur_cms = -1;
/* ARGSUSED */
static void
editcms(item, value, event)
        Panel_item      item;
        unsigned int    value;
        Event          *event;
{
        int             planes;
        struct colormapseg cms;
        char            cmsname[CMS_NAMESIZE];

        if (value == cur_cms)
                return;
```

```
        cur_cms = value;
        /* get the new cmsname */
        pw_getcmsname(pixwins[cur_cms], cmsname);
        panel_set_value(text_item, cmsname);

        pw = pixwins[cur_cms];

        /* get the new colormap */
        /*
         * first have to get its size there is NO DOCUMENTED procedure to do
         * this.
         */
        pw_getcmsdata(pw, &cms, &planes);

        pw_getcolormap(pw, 0, cms.cms_size, red, green, blue);

        panel_set(color_item,
                  PANEL_VALUE, 0,
                  PANEL_MAX_VALUE, cms.cms_size - 1,
                  0);
        /* call the proc to set the colors */
        set_color(NULL, 0, NULL);
}

int             cur_color;
/* ARGSUSED */
static void
set_color(item, color, event)
        Panel_item      item;
        unsigned int    color;
        struct inputevent *event;
{
        panel_set_value(red_item, red[color]);
        panel_set_value(green_item, green[color]);
        panel_set_value(blue_item, blue[color]);
        cur_color = (unsigned char) color;

}

/* ARGSUSED */
static void
change_value(item, value, event)
        Panel_item      item;
        int             value;
        struct inputevent *event;
{
        if (item == red_item)
                red[cur_color] = (unsigned char) value;
        else if (item == green_item)
                green[cur_color] = (unsigned char) value;
        else
                blue[cur_color] = (unsigned char) value;
        /*
         * pw_putcolormap expects arrays of colors, but this only sets one
         * color
         */
        pw_putcolormap(pw, cur_color, 1,
                       &red[cur_color], &green[cur_color], &blue[cur_color]);
```

```
}

/* ARGSUSED */
static void
cycle(item, event)
        Panel_item      item;
        Event          *event;
{
        pw_cyclecolormap(pw, 1, 0, mycms_sizes[cur_cms]);
}
```

animatecolor

This program demonstrates smooth animation via the technique of software double-buffering. Two colormaps for the canvas are set up so that while one is being written two, the other is being displayed. This allows smoother animation.

The routines that set up the colormaps and swap them, `doublebuff_init()` and `doublebuff_swap()`, are general enough to be used in other programs that alternate two colormaps. You need only set up a similar `colorstuff` structure to use these routines in another program.

The logic involved in creating the colormaps is complex. The colormaps created for *animatecolor* are given in the table *Sample Colormap to Isolate Planes* in the pixwin chapter.

```
/****************************************************************/
#ifndef lint
static char sccsid[] = "@(#)animatecolor.c 1.4 88/03/09 Copyr 1986 Sun Micro";
#endif
/****************************************************************/

#include <suntool/sunview.h>
#include <suntool/canvas.h>


/****************************************************************/
/* You set MYCOLORS & MYNBITS according to how many colors     */
/* you are using; rest is just boilerplate, more or less;      */
/* it you define your colors.                                  */
/****************************************************************/
/*
 * define the colors I want in the canvas; max 16, must be a
 * power of 2
 */
#define MYCOLORS        4
/*
 * define the number of bits my colors take up -- MYCOLORS log 2;
 * maximum for animation to be possible is half screen's bits per
 * pixel -- 4 bits on current Sun color displays.
 */
#define MYNBITS         2
/*
 * to "hide" one set of planes while displaying another takes a
 * large cms -- the square of the number of colors
 */
#define MYCMS_SIZE      (MYCOLORS * MYCOLORS)

/*
 * when you write out a color pixel, you must write the color in
 * the appropriate planes.  This macro writes it in both sets
 */
#define usecolor(i)     ( (i) | ((i) << colorstuff.colorbits) )

struct colorstuff {
    /* desired colors */
    unsigned char   redcolors[MYCOLORS];
    unsigned char   greencolors[MYCOLORS];
    unsigned char   bluecolors[MYCOLORS];
    /* number of bits the desired colors take up */
    int             colorbits;
    /* colormap segment size */
    int             cms_size;
    /* 2 colormaps to support it */
    unsigned char   red[2][MYCMS_SIZE];
    unsigned char   green[2][MYCMS_SIZE];
    unsigned char   blue[2][MYCMS_SIZE];
    /* 2 masks to support it */
    int             enable_0_mask;
    int             enable_1_mask;
    /* current colormap -- 0 or 1 */
    int             cur_buff;
    /* plane mask to control which planes are written to */
    int             plane_mask;
```

```
};

struct colorstuff colorstuff = {
/* desired red colors */
                                {0, 0, 255, 255},
/* desired green colors */
                                {0, 255, 0, 192},
/* desired blue colors */
                                {255, 0, 0, 192},
/* number of planes these colors take up */
                                MYNBITS,
/* colormap segment size */
                                MYCMS_SIZE,
/* rest filled in later */
};

static void     resize_proc();

/* stuff needed to do random numbers */
extern void     srandom();
extern int      getpid();
extern long     random();
extern char    *sprintf();

static Notify_value my_frame_interposer();
static Notify_value my_draw();

static Pixwin  *pw;
static int      times_drawn;
static int      Xmax, Ymax;

main(argc, argv)
    int             argc;
    char          **argv;
{
    Frame           base_frame;
    Canvas          canvas;

    base_frame = window_create(NULL, FRAME,
                              FRAME_LABEL, "animatecolor",
                              FRAME_ARGS, argc, argv,
                              0);
    canvas = window_create(base_frame, CANVAS,
                          CANVAS_RETAINED, TRUE,
                          CANVAS_RESIZE_PROC, resize_proc,
                          0);
    pw = (Pixwin *) canvas_pixwin(canvas);

    /* set up the canvas' colormap */
    doublebuff_init(&colorstuff);

    /* run the drawing routine as often as possible */
    (void) notify_set_itimer_func(base_frame, my_draw,
                                 ITIMER_REAL,
                                 &NOTIFY_POLLING_ITIMER,
                                 ((struct itimerval *) 0));

    /* initialize the random function */
```

```
    srandom(getpid());
    window_main_loop(base_frame);
    exit(0);
}

/* ARGSUSED */
static          Notify_value
my_draw(client, itimer_type)
    Notify_client   client;
    int             itimer_type;
{
    /*
     * draw the squares, then swap the colormap to animate them
     */
#define SQUARESIZE      50
#define MAX_VEL         (SQUARESIZE / 5)
    /* number of squares to animate */
#define NUMBER  (MYCOLORS - 1)

    static int      posx[NUMBER], posy[NUMBER];
    static int      vx[NUMBER], vy[NUMBER];
    static int      prevposx[NUMBER], prevposy[NUMBER];
    int             i;

    /* set the plane mask to be that which we are not viewing */
    pw_putattributes(pw, (colorstuff.cur_buff == 1) ?
      &(colorstuff.enable_1_mask): &(colorstuff.enable_0_mask));

    /* write to invisible planes */
    for (i = 0; i < NUMBER; i++) {
        if (!times_drawn) {
            /* first time drawing */

            posx[i] = (i + 1) * 100;
            posy[i] = 50;
            vx[i] = r(-MAX_VEL, MAX_VEL);
            vy[i] = r(-MAX_VEL, MAX_VEL);
        }
        if (abs(vx[i]) > MAX_VEL) {
            printf("Weird value (%d) for vx[%d]\n", vx[i], i);
            vx[i] = r(-MAX_VEL, MAX_VEL);
        }
        posx[i] = posx[i] + vx[i];
        if (posx[i] < 0) {
            /* Bounce off the left wall */
            posx[i] = 0;
            vx[i] = -vx[i];
        } else if (posx[i] > Xmax - SQUARESIZE) {
            /* Bounce off the right wall */
            vx[i] = -vx[i];
            posx[i] = posx[i] + vx[i];
        }
        posy[i] = posy[i] + vy[i];
        if (posy[i] > Ymax - SQUARESIZE) {
            /* Bounce off the top */
            posy[i] = Ymax - SQUARESIZE;
            vy[i] = -vy[i];
        } else if (posy[i] < 0) {
```

```
            /* Bounce off the bottom */
            posy[i] = 0;
            vy[i] = -vy[i];
        }
        /* draw the square you can't see */
        pw_rop(pw, posx[i], posy[i], SQUARESIZE, SQUARESIZE,
               PIX_SRC | PIX_COLOR(usecolor(i + 1)), NULL, 0, 0);
    }
    /*
     * swap the colormaps, and hey presto! should appear smoothly
     */
    doublebuff_swap(&colorstuff);
    times_drawn++;

    /* set the plane mask to be that which we are not viewing */
    pw_putattributes(pw, (colorstuff.cur_buff == 1) ?
      &(colorstuff.enable_1_mask): &(colorstuff.enable_0_mask));

    /* erase now invisible planes */
    for (i = 0; i < NUMBER; i++) {

        if (times_drawn > 1) {
            /* squares have been drawn before */
            /* erase in the one you can't see */
            pw_rop(pw, prevposx[i], prevposy[i],
                   SQUARESIZE, SQUARESIZE, PIX_CLR, NULL, 0, 0);
        }
        /* remember so can erase later */
        prevposx[i] = posx[i];
        prevposy[i] = posy[i];
    }

    /*
     * set the plane mask to be that which we are viewing, in
     * case screen has to be repaired between now an when we are
     * called again.
     */
    pw_putattributes(pw, (colorstuff.cur_buff == 1) ?
      &(colorstuff.enable_0_mask): &(colorstuff.enable_1_mask));

}


/* random number calculator */
int
r(minr, maxr)
    int             minr, maxr;
{
    int             i;

    i = random() % (maxr - minr + 1);
    if (i < 0)
        return (i + maxr + 1);
    else
        return (i + minr);
}
```

```
/* ARGSUNUSED */
static void
resize_proc(canvas, width, height)
{
    times_drawn = 0;
    /* remember, pixels start at 0, not 1, in the pixwin */
    Xmax = width - 1;
    Ymax = height - 1;
}

/*
 * Do double buffering by changing the write enable planes and
 * the color maps. The application draws into a buffer which is
 * not visible and when the buffers are swapped the invisible one
 * become visible and the other become invis.
 *
 * Start out drawing into buffer 1 which is the low-order buffer;
 * ie. the low-order planes. Things would not work if this is not
 * done because the devices start out be drawing with color 1
 * which will only hit the low-order planes.
 *
 * Init double buffering: Allocate color maps for both buffers. Fill
 * in color maps.
 */


doublebuff_init(colorstuff)
    struct colorstuff *colorstuff;
{
    /*
     * user has defined desired colors.  Set them up in the two
     * colormap segments
     */
    int             index_1;
    int             index_2;
    int             i;
    char            cmsname[CMS_NAMESIZE];

    /* name colormap something unique */
    sprintf(cmsname, "animatecolor%D", getpid());
    pw_setcmsname(pw, cmsname);

    /*
     * for each index in each color table, figure out how it maps
     * into the original color table.
     */
    for (i = 0; i < colorstuff->cms_size; i++) {
        /*
         * first colormap will show color X whenever low order
         * bits of color index are X
         */
        index_1 = i & ((1 << colorstuff->colorbits) - 1);
        /*
         * second colormap will show color X whenever high order
         * bits of color index are X
         */
        index_2 = i >> colorstuff->colorbits;
```

```
        colorstuff->red[0][i] = colorstuff->redcolors[index_1];
        colorstuff->green[0][i] = colorstuff->greencolors[index_1];
        colorstuff->blue[0][i] = colorstuff->bluecolors[index_1];

        colorstuff->red[1][i] = colorstuff->redcolors[index_2];
        colorstuff->green[1][i] = colorstuff->greencolors[index_2];
        colorstuff->blue[1][i] = colorstuff->bluecolors[index_2];
    }
    colorstuff->enable_1_mask = ((1 << colorstuff->colorbits) - 1)
        << colorstuff->colorbits;
    colorstuff->enable_0_mask = ((1 << colorstuff->colorbits) - 1);

    /*
     * doublebuff_swap sets up the colormap. We want the drawing
     * to start off drawing into the 1st buffer, so set the
     * current buffer to 1 so that when doublebuff_swap is called
     * it will set up the first ([0] ) colormap.
     */
    colorstuff->cur_buff == 1;
    doublebuff_swap(colorstuff);
}


/*
 * Routine to swap buffers by loading a color map that will show
 * the contents of the buffer that was not visible. Also, set the
 * write enable plane so that future writes will only effect the
 * planes which are not visible.
 */
doublebuff_swap(colorstuff)
    struct colorstuff *colorstuff;
{
    if (colorstuff->cur_buff == 0) {
        /* display first buffer while writing to 2nd */
        /*
         * Careful!  pw_putcolormap() wants an array or pointer
         * passed, but the colormap arrays are 2-d
         */
        pw_putcolormap(pw, 0, colorstuff->cms_size,
                       colorstuff->red[0],
                       colorstuff->green[0],
                       colorstuff->blue[0]);
        /* set plane mask to write to second buffer */
        colorstuff->plane_mask = colorstuff->enable_1_mask;
        colorstuff->cur_buff = 1;
    } else {
        /* display second buffer while writing to first */
        pw_putcolormap(pw, 0, colorstuff->cms_size,
                       colorstuff->red[1],
                       colorstuff->green[1],
                       colorstuff->blue[1]);

        /* set plane mask to write to first buffer */
        colorstuff->plane_mask = colorstuff->enable_0_mask;
        colorstuff->cur_buff = 0;
    }
}
```

A.10. Two gfx subwindow–based programs converted to use SunView

The following two programs are the Sun demo programs *bouncedemo* and *spheresdemo* converted from using `gfxsw_init()` to canvases in SunView.

The code for the SunWindows–based programs is in `/usr/share/src/sun/suntool` so you can contrast that code with the SunView versions printed here.

Techniques used to convert programs such as these to SunView 1 are described in Appendix C, *Converting SunWindows Programs to SunView*.

bounce

The first program is *bouncedemo* converted to draw in a canvas and to call `notify_dispatch()` periodically. Like the original *bouncedemo*, it restarts drawing after any damage (if not retained) or resizing.

```
#ifndef lint
static char sccsid[] = "@(#)bounce.c 1.5 88/02/26 Copyr 1986 Sun Micro";
#endif

/*
 * Overview:    Bouncing ball demo in window.
 * Converted to use SunView by simulating the gfxsubwindow structure.
 */

/* this replaces all includes */
#include <suntool/sunview.h>
#include <suntool/canvas.h>

/* straight from the Canvas chapter */
static void     repaint_proc();
static void     resize_proc();

/* straight from the Notifier chapter */
static Notify_value my_notice_destroy();
extern Notify_error notify_dispatch();

static int      my_done;

/* define my own gfxsubwindow struct */
struct gfxsubwindow {
        int             gfx_flags;
#define GFX_RESTART     0x01
#define GFX_DAMAGED     0x02
        int             gfx_reps;
        struct pixwin  *gfx_pixwin;
        struct rect     gfx_rect;
}               mygfx;
struct gfxsubwindow *gfx = &mygfx;
```

```
main(argc, argv)
        int             argc;
        char          **argv;
{
        short           x, y, vx, vy, z, ylastcount, ylast;
        short           Xmax, Ymax, size;
        /* WIN_RECT attribute returns a pointer */
        Rect           *rect;

        /* have to handle this arg that gfxsw_init used to process */
        int             retained;

        /*
         * replace this call if (gfx == (struct gfxsubwindow *)0) exit(1);
         * with ...
         */

        Frame           frame;
        Canvas          canvas;
        Pixwin         *pw;

        /* this arg was also dealt with by gfxsw_init */
        gfx->gfx_reps = 200000;

        frame = window_create(NULL, FRAME,
                              FRAME_LABEL, "bounce",
                              FRAME_ARGC_PTR_ARGV, &argc, argv,
                              WIN_ERROR_MSG, "Can't create frame",
                              0);
        for (--argc, ++argv; *argv; argv++) {
                /*
                 * handle the arguments that gfxsw_init(0, argv) used to do
                 * for you
                 */
                if (strcmp(*argv, "-r") == 0)
                        retained = 1;
                if (strcmp(*argv, "-n") == 0)
                        if (argc > 1) {
                                (void) sscanf(*(++argv), "%hD", &gfx->gfx_reps);
                                argc++;
                        }
        }

        canvas = window_create(frame, CANVAS,
                               CANVAS_RETAINED, retained,
                               CANVAS_RESIZE_PROC, resize_proc,
                               CANVAS_FAST_MONO, TRUE,
                               WIN_ERROR_MSG, "Can't create canvas",
                               0);

        /* only need to define a repaint proc if not retained */
        if (!retained) {
                window_set(canvas,
                           CANVAS_REPAINT_PROC, repaint_proc,
                           0);
        }
        pw = canvas_pixwin(canvas);
```

```
        gfx->gfx_pixwin = canvas_pixwin(canvas);

        /* Interpose my proc so I know that the tool is going away. */
        (void) notify_interpose_destroy_func(frame, my_notice_destroy);

        /*
         * Note: instead of window_main_loop, just show the frame. The
         * drawing loop is in control, not the notifier.
         */
        window_set(frame, WIN_SHOW, TRUE, 0);
```

```
Restart:
        rect = (Rect *) window_get(canvas, WIN_RECT);
        Xmax = rect_right(rect);
        Ymax = rect_bottom(rect);
        if (Xmax < Ymax)
                size = Xmax / 29 + 1;
        else
                size = Ymax / 29 + 1;
        /*
         * the following were always 0 in a gfx subwindow (bouncedemo
         * is confused on this point
         */
        x = 0;
        y = 0;

        vx = 4;
        vy = 0;
        ylast = 0;
        ylastcount = 0;
        pw_writebackground(pw, 0, 0, rect->r_width, rect->r_height,
                           PIX_SRC);
        /*
         * Call notify_dispatch() to dispatch events to the frame
         * regularly.  This will call my resize and repaint procs and
         * interposed notify_destroy_func if necessary.  The latter will
         * set my_done to TRUE if it's time to finish.
         */
        while (gfx->gfx_reps) {
                (void) notify_dispatch();
                if (my_done)
                        break;
                /*
                 * this program is not concerned with damage, because either
                 * the canvas repairs the damage (if retained) or it just
                 * restarts, which is handled by GFX_RESTART
                 */
                /*
                 * if (gfx->gfx_flags&GFX_DAMAGED) gfxsw_handlesigwinch(gfx);
                 */
                if (gfx->gfx_flags & GFX_RESTART) {
                        gfx->gfx_flags &= ~GFX_RESTART;
                        goto Restart;
                }
                if (y == ylast) {
                        if (ylastcount++ > 5)
                                goto Reset;
                } else {
                        ylast = y;
                        ylastcount = 0;
                }
                pw_writebackground(pw, x, y, size, size,
                                   PIX_NOT(PIX_DST));
                x = x + vx;
                if (x > (Xmax - size)) {
                        /*
                         * Bounce off the right edge
                         */
                        x = 2 * (Xmax - size) - x;
```

```
                        vx = -vx;
                } else if (x < 0) {
                        /*
                         * bounce off the left edge
                         */
                        x = -x;
                        vx = -vx;
                }
                vy = vy + 1;
                y = y + vy;
                if (y >= (Ymax - size)) {
                        /*
                         * bounce off the bottom edge
                         */
                        y = Ymax - size;
                        if (vy < size)
                                vy = 1 - vy;
                        else
                                vy = vy / size - vy;
                        if (vy == 0)
                                goto Reset;
                }
                for (z = 0; z <= 1000; z++);
                continue;
Reset:
                if (--gfx->gfx_reps <= 0)
                        break;
                x = 0;
                y = 0;
                vx = 4;
                vy = 0;
                ylast = 0;
                ylastcount = 0;
        }
}
```

```
static void
repaint_proc( /* Ignore args */ )
{
        /* if repainting is required, just restart */
        gfx->gfx_flags |= GFX_RESTART;
}

static void
resize_proc( /* Ignore args */ )
{
        gfx->gfx_flags |= GFX_RESTART;
}

/* this is straight from the Notifier chapter */
static          Notify_value
my_notice_destroy(frame, status)
        Frame           frame;
        Destroy_status  status;
{
        if (status != DESTROY_CHECKING) {
                /* set my flag so that I terminate my loop soon */
                my_done = 1;
                /* Stop the notifier if blocked on read or select */
                (void) notify_stop();
        }
        /* Let frame get destroy event */
        return (notify_next_destroy_func(frame, status));
}
```

spheres

This is an example of a program that has been converted to use `window_main_loop()`. It displays a fixed-sized image in a canvas that has scrollbars. It continues drawing its image when its window is damaged or resized. However, it stops drawing when it is iconic.

You will have to create your own icon for this called `spheres.icon`.

```
#ifndef lint
static char sccsid[] = "@(#)spheres.c 1.4 88/02/05 Copyr 1986 Sun Micro";
#endif
/*
 * spheres -- draw a bunch of shaded spheres Algorithm was done
 * by Tom Duff, Lucasfilm Ltd., 1982
 * Revised to use SunView canvas instead of gfxsw.
 */

#include <suntool/sunview.h>
#include <suntool/canvas.h>
#include <suntool/scrollbar.h>
#include <sunwindow/cms_rainbow.h>

static Notify_value my_frame_interposer();
static Notify_value my_animation();
static void     sphere();
static void     demoflushbuf();

#define ITIMER_NULL     ((struct itimerval *)0)

/*
 * (NX, NY, NZ) is the light source vector -- length should be
 * 100
 */
#define NX 48
#define NY -36
#define NZ 80

#define BUF_BITWIDTH    16

static struct pixrect *mpr;
static int      width;
static int      height;
static int      counter;
static Frame    frame;
static Canvas   canvas;
static int      cmssize;
static Pixwin  *pw;

static short    spheres_image[256] = {
#include "spheres.icon"
};

mpr_static(spheres_pixrect, 64, 64, 1, spheres_image);


main(argc, argv)
    int             argc;
    char          **argv;
{
    char          **args;
    int             usefullgray = 0;
    Icon            icon;

    icon = icon_create(ICON_IMAGE, &spheres_pixrect, 0);
    frame = window_create(NULL, FRAME,
                          FRAME_LABEL,          "spheres",
```

```
                            FRAME_ICON,           icon,
                            FRAME_ARGC_PTR_ARGV,  &argc, argv,
                            0);
    canvas = window_create(frame, CANVAS,
      CANVAS_AUTO_EXPAND,       0,
      CANVAS_AUTO_SHRINK,       0,
      CANVAS_AUTO_CLEAR,        0,
      /*
       * Set SCROLL_LINE_HEIGHT to 1 so that clicking LEFT or RIGHT
       * in the scroll buttons scrolls the canvas by one pixel.
       */
      WIN_VERTICAL_SCROLLBAR,   scrollbar_create(SCROLL_LINE_HEIGHT, 1,
                                                 0),
      WIN_HORIZONTAL_SCROLLBAR, scrollbar_create(SCROLL_LINE_HEIGHT, 1,
                                                 0),
      0);
    for (args = argv; *args; args++) {
        if (strcmp(*args, "-g") == 0)
            usefullgray = 1;
    }
    /* Interpose in front of the frame's client event handler */
    (void) notify_interpose_event_func(frame, my_frame_interposer,
                                       NOTIFY_SAFE);
    (void) notify_set_itimer_func(frame, my_animation,
            ITIMER_REAL, &NOTIFY_POLLING_ITIMER, ITIMER_NULL);

    width = (int) window_get(canvas, CANVAS_WIDTH);
    height = (int) window_get(canvas, CANVAS_HEIGHT);
    pw = canvas_pixwin(canvas);
    cmssize = (usefullgray) ? setupfullgraycolormap(pw) :
        setuprainbowcolormap(pw);
    mpr = mem_create(BUF_BITWIDTH, height, pw->pw_pixrect->pr_depth);
    window_main_loop(frame);
    exit(0);
}

static int      radius;
static int      x0;             /* x center */
static int      y0;             /* y center */
static int      color;
static int      x;
static int      y;
static int      maxy;
static int      mark;
static int      xbuf;

/* ARGSUSED */
static          Notify_value
my_animation(client, itimer_type)
    Notify_client   client;
    int             itimer_type;
{
    register        i;

    if (x >= radius) {
        radius = r(0, min(width / 2, height / 2));
        x0 = r(0, width);
        y0 = r(0, height);
```

```
        color = r(0, cmssize + counter++) % cmssize;
        x = -radius;
        xbuf = 0;

        /*
         * Don't use background colored sphere.
         */
        if (color == 0)
            color++;
        /*
         * Don't use tiny sphere.
         */
        if (radius < 8)
            radius = 8;
    }
    for (i = 0; i < 5; i++) {
        xbuf++;
        maxy = sqroot(radius * radius - x * x);
        pw_vector(pw, x0 + x, y0 - maxy, x0 + x, y0 + maxy,
                  PIX_CLR, 0);
        for (y = -maxy; y <= maxy; y++) {
            mark = r(0, radius * 100) <= NX * x + NY * y
                + NZ * sqroot(radius * radius - x * x - y * y);
            if (mark)
                pr_put(mpr, xbuf, y + y0, color);
        }
        if (xbuf == (mpr->pr_width - 1)) {
            demoflushbuf(mpr, PIX_SRC | PIX_DST,
                         x + x0 - mpr->pr_width, pw);
            xbuf = 0;
            x++;
            return (NOTIFY_DONE);
        }
        x++;
    }
    if (x >= radius)
        demoflushbuf(mpr, PIX_SRC | PIX_DST, x + x0 - (xbuf + 2),
                     pw);
    return (NOTIFY_DONE);
}


static void
demoflushbuf(mpr, op, x, pixwin)
    struct pixrect *mpr;
    int             op;
    int             x;
    struct pixwin  *pixwin;
{
    register u_char *sptr, *end;

    sptr = mprd8_addr(mpr_d(mpr), 0, 0, mpr->pr_depth);
    end = mprd8_addr(mpr_d(mpr), mpr->pr_width - 1,
                     mpr->pr_height - 1, mpr->pr_depth);
    /*
     * Flush the mpr to the pixwin.
     */
    pw_write(pixwin, x, 0, mpr->pr_width, mpr->pr_height, op,
```

```
            mpr, 0, 0);
    /*
     * Clear mpr with 0's
     */
    while (sptr <= end)
        *sptr++ = 0;
    /* Let user interact with tool */
    notify_dispatch();
}


static int
setuprainbowcolormap(pw)
    Pixwin         *pw;
{
    register u_char red[CMS_RAINBOWSIZE];
    register u_char green[CMS_RAINBOWSIZE];
    register u_char blue[CMS_RAINBOWSIZE];

    /*
     * Initialize to rainbow cms.
     */
    pw_setcmsname(pw, CMS_RAINBOW);
    cms_rainbowsetup(red, green, blue);
    pw_putcolormap(pw, 0, CMS_RAINBOWSIZE, red, green, blue);
    return (CMS_RAINBOWSIZE);
}

static int
setupfullgraycolormap(pw)
    Pixwin         *pw;
{
#define CMS_FULLGRAYSIZE        256
#define CMS_FULLGRAY    "fullgray"
    register u_char red[CMS_FULLGRAYSIZE];
    register u_char green[CMS_FULLGRAYSIZE];
    register u_char blue[CMS_FULLGRAYSIZE];
    register        i;

    /*
     * Initialize to rainbow cms.
     */
    pw_setcmsname(pw, CMS_FULLGRAY);
    for (i = 0; i < CMS_FULLGRAYSIZE; i++) {
        red[i] = green[i] = blue[i] = i;
    }
    pw_putcolormap(pw, 0, CMS_FULLGRAYSIZE, red, green, blue);
    return (CMS_FULLGRAYSIZE);
}


static          Notify_value
my_frame_interposer(frame, event, arg, type)
    Frame           frame;
    Event          *event;
    Notify_arg      arg;
    Notify_event_type type;
{
```

```
    int             closed_initial, closed_current;
    Notify_value    value;

    /* Determine initial state of frame */
    closed_initial = (int) window_get(frame, FRAME_CLOSED);
    /* Let frame operate on the event */
    value = notify_next_event_func(frame, event, arg, type);
    /* Determine current state of frame */
    closed_current = (int) window_get(frame, FRAME_CLOSED);
    /* Change animation if states differ */
    if (closed_initial != closed_current) {
        if (closed_current) {
            /* Turn off animation because closed */
            (void) notify_set_itimer_func(frame, my_animation,
                         ITIMER_REAL, ITIMER_NULL, ITIMER_NULL);
        } else {
            /* Turn on animation because opened */
            (void) notify_set_itimer_func(frame, my_animation,
                            ITIMER_REAL, &NOTIFY_POLLING_ITIMER,
                                          ITIMER_NULL);
        }
    }
    return (value);
}
```

B

Sun User Interface Conventions

B

Sun User Interface Conventions

The window programs released by Sun follow some standard user interface conventions. These conventions are described here so that, if you choose, you can design your interfaces with them in mind.

B.1. Program Names

Here are some guidelines for naming programs:

- A window-based version of an existing tty-based program has *tool* appended to the end of the existing program. For example `mailtool` is a window-based version of the tty-based program `mail(1)`.
- A program without a tty version should not end with *tool*. Thus the icon editor is called `iconedit` and not *icontool*.
- Since tools are normally invoked from command files or menus, descriptive names are better than short cryptic ones. Thus *iconedit* is better than *ied*.

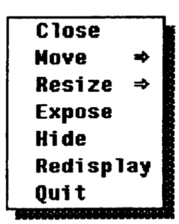
B.2. Frame Headers

The frame header should contain the name of the program, optionally followed by a dash and additional information, as in:

B.3. Menus

Capitalization

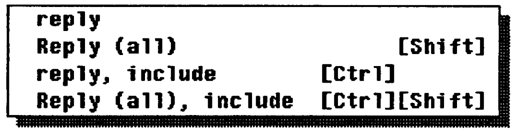
The words in menus should be capitalized as they would be in a chapter heading:



This convention can be bent when the names in the menu correspond to already existing, non-capitalized command names.

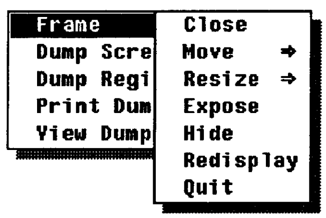
Menus Showing Button Modifiers

When the behavior of a panel button depends on whether the user holds down a shift key, the button should have a menu summarizing the different actions, as in this menu from the **Reply** button in `mailtool`:



Interaction with Standard Menus

Standard SunView menus, such as the frame menu, should not be modified. When a user is used to seeing 'Quit' at the end of the frame menu, it is confusing to see a frame menu with a new item tacked on at the end. Equally confusing is a frame menu that comes up with an item other than 'Close' at the top. Thus, instead of deleting an item from a standard menu, applications should render the item inactive and "grayed-out." And instead of adding a new item to a standard menu, applications should make a new menu, with the name of the standard menu at the top, followed by the application-specific commands. The standard menu then becomes a pullright subordinate to the custom menu, as in the example below:



Enable/Disable Menu Items

Sometimes a menu has two different states, with different words appearing in the same position in a menu, depending on the current state. When the two states correspond to something being on or off, the words 'Enable' and 'Disable' should be used. Thus `shelltool` uses 'Enable Page Mode' and 'Disable Page Mode'.

Multi-Column Menus

Overly long menus should be avoided. Use menus with more than one column instead.

B.4. Panels

The defaults for panel items given in this section are intended to promote consistency across applications and provide convenient building blocks for programmers who don't want to put a great deal of effort into designing fancy panels. The intent is not to rule out the use of non-default panel items.

Buttons

The proper use of buttons is to allow the user to initiate commands. Button items should not be used to represent categories, modes or options — for these kinds of choices that imply a change of state, you should use toggle, choice or cycle items, as described in the next three sections.

When creating a button, use the routine `panel_button_image()` to create a button-like image, as in:

[Dump Screen]

As with menu entries, capitalize buttons unless the button name matches something else (for example, `dbx`(1) commands in `dbxtool`). If the button's meaning can be modified by [Control] or [Shift] these modifiers should be indicated in the button's menu. (For an example, see the picture of the **Reply** menu from `mailtool`, at the top of the preceding page.)

In most cases, a button will remain visible all the time. However, when a tool has different states, and a button can only be used in some of those states, it is usually best to make the button invisible when it can not be invoked. Thus in `mailtool`, the **Cancel** button only appears when a letter is being composed.

List of Non-Exclusive Choices

A list of choices in which more than one choice can be selected at a time is best implemented with the item type `PANEL_TOGGLE`. The default for toggles is a list of check boxes:

Optional Software:

☑ **Database**

☐ **Demos**

☑ **Document Preparation Tools**

☐ **Games**

☑ **Productivity Tools**

The example shows a vertical list; vertical or horizontal are both acceptable.

List of Exclusive Choices

A list of choices in which only one choice can be selected at a time can be displayed with all choices visible or with only the current choice visible. To show all the choices, use the item type `PANEL_CHOICE`. The default for choice items is a list of square pushbuttons, with the current choice marked by a darkened pushbutton:

Drawing Mode: ▢ **Point** ■ **Line** ▢ **Rectangle** ▢ **Circle** ▢ **Text**

To show only the current choice, use `PANEL_CYCLE`. This item type provides a symbol consisting of two circular arrows, which indicate to the user that he can cycle through choices, and serves to distinguish cycle items from text items:

Category ↻ **SunView**

Binary Choices

An item that is either on or off may be created using either `PANEL_TOGGLE`, `PANEL_CYCLE` or `PANEL_CHOICE`. The picture on the left below is a toggle, the two in the middle are cycles, and the one on the right is a choice:

Grid   Show Grid Yes   Grid On   Grid: On Off

Text Items

Text items should have a colon after the label.

For text items, it is recommended to have one or more buttons which cause the text item's value to be acted on. In `iconedit`, for example, the user first enters a filename into the **File:** field, then presses the **Load**, **Store**, or **Browse** button in order to act on that filename.

`iconedit` also allows the user to type Control-L, Control-S, or Control-B into the **File:** field as accelerators for the buttons. Use of such accelerators (including carriage return to mean "enter") is *not* recommended, as it conflicts with future plans for the use of non-printable characters.

For the sake of consistency, whenever a tool reads from and writes to a file, it should label these buttons with **Load** and **Store** .

Allocation of Function Between Buttons and Menus

Selecting a menu item is normally the same as either selecting a button or picking from a choice item. `boggletool`(6), for example, has a menu for restarting the game (as well as other things) but has no buttons. Each of the four menu items could have been represented by a button instead. `life`(6) does not have a choice item, but rather lets you choose a starting pattern with a menu. Thus the question of when to use a button (or choice) and when to use a menu arises. Here are some rules of thumb:

- Items on the frame menu should not be duplicated as buttons, with the possible exception of a **Quit** button (see next paragraph).
- Some tools typically run all the time, such as `mailtool`. Others are normally invoked only long enough to do a job, such as `iconedit`. Tools in the second category, if they have any other buttons, should also have a **Quit** button.
- If a tool has a commit operation, then it may have a **Done** button, which is a combination of close[106] plus commit. Thus `mailtool` has a **Done** button.
- A tool should never have a **Close** button, since this operation is already available via both a menu and the keyboard.
- If a custom menu is provided, the menu items should not all be duplicated as panel items (buttons or choices). `boggletool` and `life` are examples of programs that have functionality in custom menus that are not duplicated as panel items.
- When a button and a menu item perform the same function, their labels should be identical.

[106] If the panel is in a subframe, the **Done** operation implies disappearing from the screen rather than closing, since subframes can't become iconic.

B.5. Mouse Button Usage

Allocation of Function Between Mouse Buttons

Use of mouse buttons should be consistent with the rest of SunView. The left button should only be used to make selections. The right button should only be used to bring up menus.[107]

There is some discretion involved in the use of the middle button, however. In most of SunView, the middle button is used to adjust a selection. In text and shell windows, for example, the left button is used to mark the starting point of a selection, and the middle button is used to extend the selection. Similarly, in a pixel editor that allowed you to select regions, clicking the left button on a region could select just that region, and clicking the middle button on another region could add that region to the selection. On the other hand, in a tool that allowed you to move objects, the middle button could move an object, and [Control]-MIDDLE button could re-size it, which would be consistent with the way icons and frames are moved and re-sized. As a third alternative, in the `iconedit` drawing program the left button draws pixels (which is a kind of selecting) and the middle button erases.

The best use of the middle button is still being discussed. Future versions of this guideline may specify more exactly how the middle button should be used. For now, the most common use is to extend the selection, and the next-most common is to move a graphic object.

Using Mouse Buttons for Accelerators

It is acceptable to use the mouse buttons as accelerators for common operations. The only caveat is that any accelerators should also be available from a menu or panel item. Thus in SunView clicking on a tool with the middle button moves the tool, but you can also move a tool using the frame menu.

Some operations, on the other hand, cannot be invoked from a menu or panel button. In such cases the mouse is the only means of invoking the operation. For example, in `iconedit` you use the mouse for drawing, and the drawing operations are not available from a menu or button.

B.6. Cursors

An application program should not do anything other than change the shape of the cursor when the cursor is moved into a new window. `textedit` presents a good example of using the cursor to alert the user that input is interpreted differently in different regions: The cursor is a thin diagonal arrow in the textsubwindow, a fat horizontal arrow in the scrollbar, and a diamond in the scrollbar buttons.

B.7. Icons

Tools should pack as much information as possible into their icons. `clock` and `perfmeter` are examples of tools that make good use of icon real estate. `textedit` is an example of a tool that could make better use of its icon. For example, it could contain a representation of the text being editing in a 1 point font. Small as that is, you can tell at a glance if you are editing C code or a mail message.

[107] People who want to hold the mouse with their left hand can put the "menu button" on the left and the "select button" on the right by setting the *Left_Handed* option in the *Input* category of `defaultsedit`.

Some icons, like the round face used by `clock` and the page with the protruding pencil used by `textedit`, have images with non-square outlines. These icons have the area outside of the image outline filled in with the root grey pattern so that the icons will blend in with the default SunView background. While this looks good when the background is in fact the default pattern, it is not recommended, since users can choose an arbitrary background pattern for SunView.

C

Converting SunWindows Programs to SunView

C

Converting SunWindows Programs to SunView

This appendix gives some guidelines for converting programs written using SunWindows to SunView. There are two classes of programs covered: those that create a tool and subwindows, and programs that call `gfxsw_init()` to take over an existing window or the console.

Programs that fall outside these classes are probably UNIX-style programs that do not use windows at all. The conversion of such programs is in effect the subject of this whole manual. If you want to convert such a program to SunView, pay particular attention to Chapter 2, *The SunView Model*, and the specific discussion of Notifier interaction under *Porting Programs to SunView* in Chapter 17, *The Notifier*. You may also find some of the discussion later on in this appendix under Section C.2, *Converting Gfxsubwindow–Based Code*, helpful.

C.1. Converting Tools

It is reasonably straightforward to convert tools that create windows in SunWindows to the SunView interface because they should already have the appropriate architecture. SunView programs, like SunWindows programs, have three parts: initialization of static objects, starting up window system interaction, and the routines that are called after the tool is running in the window system.

General Comments

When porting to SunView, you should look through all of your code for SunWindows function calls. If you see one, the odds are that you are going to have others. Look for every occurrence of the call and then change it to the new format. Since the SunView libraries are mixed in with the SunWindows libraries, you can mix the two types of functions calls, and not get any compilation errors. But you *will* get some inconsistent results.

Programming Style Changes

Object `typedefs`

The capitalized `typedefs` for window system objects (applied to `Panels`, `Panel_items` and `Panel_settings` in 2.0 SunWindows) have been extended to nearly all SunView objects, including:

```
Canvas        Pixrect
Cursor        Pixwin
Frame         Rect
Icon          Rectlist
Menu          Scrollbar
Panel         Textsw
Panel_item    Tty
Pixfont       Window
```

You should convert to using these data types in the interests of future compatibility. See *Object Handles* in Chapter 3, *Interface Outline*, for more information on these types.

Attribute Value Interface

In SunView, the attribute value interface, introduced for panel subwindows in 2.0 SunWindows, has been extended to all types of windows. Attributes for all window types are set and obtained with the same two calls, `window_set()` and `window_get()`.

All window types are created with the same call, `window_create()`.

CAUTION **The most frequently used SunView calls use attribute lists, and therefore must be null-terminated. SunView will only complain about a malformed attribute list at run time.**

New Objects

Most of the data types in the above list are objects new in SunView. Many objects in SunWindows correspond to objects in SunView, for example:

```
tool    ⇒   Frame
ttysw   ⇒   Tty
```

Some objects such as the graphics subwindow and empty subwindow are not supported in SunView[108]. There are new objects that partially take their place.

Canvas Subwindows

The canvas subwindow is a general-purpose drawing subwindow, which can replace gfx subwindows and empty subwindows. The size of the canvas you draw on need not be the same as the size of the window it is displayed in; you can create scrollbars to let the user adjust the visible part of the canvas. For a demonstration of the various canvas attributes, run the program */usr/demo/canvas_demo*

Text Subwindows

These allow for the display and editing of text in a scrollable window. The user can perform various actions on the text, including saving the text, searching in the text, and editing the text without the programmer having to deal with these interactions.

Since there was no such window in SunWindows, your application may have had to use a gfx subwindow, a set of panel message items, or some strange technique involving `ttysw_input()` or piping to a tty subwindow to display text; the text subwindow can replace all these uses.

Scrollbars

Scrollbars can be attached to windows. In particular, the use of scrollbars with retained canvases makes it very easy to draw a fixed-size image without regard for window size changes.

[108] You can still compile and run code that uses these, but Sun does not intend to develop them further.

Objects in Common between SunView and SunWindows

Cursors

Cursors have changed. They are now type `Cursor`, and all calls relating to them have changed. Type `Cursor` should be looked at as a pointer to the structure containing the cursor information. Here is how you would define a cursor:

```
static short int help_bits [] = {
#include "help.curs"
};
mpr_static(help_pr, 16, 16, 1, help_bits);
```

Once having created a cursor, you call `window_set()` to add it to a window, as in the following code fragment:

```
Cursor  help_cursor;

main()
{
    /* make windows */
    ...
    init_cursor();
    ...
}

init_cursor()
{
    help_cursor = cursor_create(CURSOR_IMAGE, &help_pr,
                                CURSOR_XHOT,  8,
                                CURSOR_YHOT,  8,
                                CURSOR_OP,    XOR,
                                0);
    window_set(window, WIN_CURSOR, help_cursor, 0);
}
```

You now refer to all your cursors by the handle you get from `cursor_create()`. Cursors have their own create, destroy, copy, set, and get routines, as well as a number of attributes with no corresponding functionality in SunWindows.

Icons

Icons have changed. They follow the same pattern as cursors; you define the data, create a pixrect, and then call `icon_create()` at run time. These also have their own create, destroy, set and get routines, although there are fewer attributes associated with them.

Menus

The new walking menu package uses the attribute value interface. It has many more features than the old menu package. It does not support the stacking menu style of SunWindows.[109]

Menus also have their own routines and are created via function calls instead of being user-loaded data structures. They use the pointer type `Menu` for their handles instead of `struct menuptr`. One way to create them is to write a special `menu_init()` proc which loads them into their structures correctly. In your `menu_init()`, you have something like

```
    m1_items = menu_create(
                    MENU_STRING_ITEM, "insert",       INSERT,
                    MENU_STRING_ITEM, "copy",         COPY  ,
                    MENU_STRING_ITEM, "replace",      REPLACE,
                    MENU_STRING_ITEM, "move",         XLATE ,
                    MENU_STRING_ITEM, "delete",       DELETE,
                    MENU_STRING_ITEM, "HELP",         DRAW_HELP,
          0);
```

Menu values from `menu_get()` or `menu_show()` are returned as `caddr_t`'s. Be sure your types match.

NOTE The old `menu_display()` and the new `menu_show()` routines have a different order for the arguments.

Input Events

The `inputevent` structure has not changed. However, you no longer have to generate events yourself in "selectedroutines via calls to `input_readevent()`. Instead, windows now have event handlers that are passed pointers to `Event` structures.

There are a number of macros for making input events easier to deal with in SunView, so instead of having something like `ie->ie_code` you have `event_id(ie)`, resulting in more readable code.

`Event` types are not pointers, so you have to distinguish between

```
Event *ie;
```

and

```
Event ie;
```

in your code. You can use either, because the event functions don't just manipulate a handle as, for example, the cursor functions do. See *Object Handles* in Chapter 3, *Interface Outline*, for an explanation of when handles are pointers and when not.

[109] This is still available in the frame and root menus if you disable *SunView/Walking_Menus* in `defaultsedit`.

Setting up Input Event Handling

All the input events can be set up from the `window_create()` call or `window_set()` calls. Calls to `win_*inputmask()` are all replaced by these `window_set()` and `window_create()` calls.

The distinction between "pick" and "keyboard" events is new in SunView, having been added to support the notion of a split input focus.

CAUTION **Be careful that when you are setting mouse events, you are modifying the** `WIN_*_PICK_EVENTS` **and when you are setting keyboard events you modify** `WIN_*_KEYBOARD_EVENTS`**. You may get inconsistent results if you modify pick events on the keyboard mask.**

Sigwinch Handling

Canvas event procedures no longer need all the gfx support for flag checking. Resize and repaint events are separately handled by the procedures you supply via the `CANVAS_RESIZE_PROC` and `CANVAS_REPAINT_PROC` attributes. These procedures mean you should not try to catch sigwinch signals (and in fact, if you do, you will have problems; see below).

Windows

Making windows is very straightforward in SunView. Each window type has a handle — so instead of the inconsistent use of handles and fd's to describe a window and manipulate it, you only use the window handle. You need to go through your code and update all the reference to the old `tool_`... handle types in the code. After you find them, locate all the function calls referring to them and update them to SunView `window_set()` and `window_get()` calls. Almost every window operation is supported by the attribute value interface; however, some low-level routines that are documented in the *SunView 1 System Programmer's Guide* may still require window names or fd's.

`window_get()` is used to get an attribute of a window. It returns a `caddr_t` back to you, which must be cast into the appropriate type. So loading something into a `rect` struct would involve something like:

```
Rect    win_size;
Canvas  canvas;

canvas = window_create( base_frame, CANVAS, 0);
win_size= *((Rect *)window_get(canvas, WIN_RECT));
```

NOTE *Be sure to cast values returned from* `get()` *routines to the correct type.* The above `*((Rect *)...)` is needed otherwise you will get an 'incompatible type' message from the compiler.

Panels

Most of the panel interface was already using an attribute value interface in 2.0 SunWindows. `panel_create()` `panel_set()` and `panel_get()` should be changed to `window_create()`, `window_set()` and `window_get()`.

The `PANEL_CU()` macro was superseded by `ATTR_COL()` and `ATTR_ROW()`.

Signals

If you are catching signals, then you should read the documentation on signals in Section 17.2, *Restrictions*, in the *Notifier* chapter. There are several that the Notifier now catches on your behalf.

You should no longer be catching SIGWINCH signals. If you do, your program may never appear on the screen as it will start catching the signals and redrawing endlessly on the screen, which may not be visible.

Prompts

Instead of using the menu_prompt() facility of SunWindows, you should use the alerts package to prompt the user, or if necessary use pop-up subframes and window_loop(popup_frame) when prompting the user. The *filer* example programs in Chapter 4, *Windows*, uses the alerts package to implement a pop-up confirmer.

menu_prompt() is documented here for completeness. The definitions used by menu_prompt() are:

```
struct prompt {
    Rect     prt_rect;
    Pixfont *prt_font;
    char    *prt_text;
}

menu_prompt(prompt, event, windowfd)
    struct prompt     *prompt;
    struct inputevent *event;
    int                windowfd;
```

menu_prompt() displays the string addressed by prompt->prt_text using the font prompt->prt_font. prompt->prt_rect is relative to windowfd. If either the r_width or the r_height fields of prompt->prt_rect has the value PROMPT_FLEXIBLE, that dimension is chosen to accommodate all the characters in prompt->prt_text.

The fullscreen access method is used to display the prompt. After displaying the prompt, menu_prompt() waits for any input event other than mouse motion. It then removes the prompt, and returns the event which caused the return in event. windowfd is the file descriptor of the window from which input is taken while the prompt is up.

Table C-1 *SunWindows ⇒ SunView Equivalences*

In SunWindows	*In Sunview*
`tool = tool_make()`	`Frame frame = window_create(NULL, FRAME,..., 0);`
`tool_parse_all`	`FRAME_ARGS` or `FRAME_ARGC_PTR_ARGV` attributes to `window_create(NULL, FRAME, ..., 0)`
`tool_install()` `tool_select()` `tool_destroy()`	`window_main_loop(frame);`
or, individually,	
`tool_install()`	`WIN_SHOW` attribute
`tool_select()`	`window_main_loop(), notify_dispatch() or notify_start()`
`tool_destroy()`	`window_destroy(baseframe)` or `window_done(`*any_window*`)`
`signal(SIGWINCH, sigwinch)`	`RESIZE_PROC` and `REPAINT_PROC` attribute
`TOOLSW_EXTENDTOEDGE`	`WIN_EXTEND_TO_EDGE`
`win_grabio()`	`WIN_GRAB_ALL_INPUT` attribute
`struct tool_io`	`WIN_EVENT_PROC` for window events. Other events, timers, etc. handled by individual calls to the Notifier to set up or interpose specific procs.

C.2. Converting Gfxsubwindow–Based Code

Programs that run in gfxsubwindows are designed to take over an existing window. In SunView you must create a tool for such programs to run in. One limitation of this approach is that the SunView version of the application must run under `suntools`; the old `gfxsw_init()` call would create a SunWindows environment if run on the "bare" Sun console. One major advantage gained by moving to SunView is that your code can use scrollbars.

Basic Steps

- Include `<suntool/sunview.h>` and `<suntool/canvas.h>`.
- Remove all window-related `#include` statements; these will probably be included by `sunview.h`.
- Declare a `Frame` and a `Canvas`.
- Replace `gfxsw_init()` with calls to create the frame and canvas.

Replacing Tool Interaction

Styles of Damage Checking

Many gfx subwindow programs (and many of the Sun demos) call `gfxsw_init()` to take over a window, then run in a loop as they compute and draw an image in the gfx subwindow. At some point in the loop they check for damage to or alteration of the size of the gfx subwindow and handle it accordingly.

In SunView, the coexistence of your program with the window system is less hidden from you. Read Chapter 2, *The SunView Model*, to understand how this coexistence works. In converting programs, you must ensure the Notifier runs at regular intervals so that window events such as close, quit, etc. are handled appropriately.

Consult Chapter 17, *The Notifier*, for more information.

You can either (1) set up your program so that, after initialization, control passes to the Notifier, which you have set up to call your imaging/computation routine periodically, or (2) let control continue to pass to your code, and change the program to call the Notifier at regular intervals.

Either the Notifier Takes Over

In the first case, you set up your imaging/computation routine as a function that is called when a timer expires. Do this by calling `notify_set_itimer_func()`. If you want your imaging/computation routine to blaze away non-stop (causing other programs to run more sluggishly), you request the timer function be called as soon as the Notifier has handled window events for you by giving the timer the special value `&NOTIFY_POLLING_ITIMER`.

```
(void) notify_set_itimer_func(frame, my_animation,
        ITIMER_REAL, &NOTIFY_POLLING_ITIMER, ITIMER_NULL);
```

If your code `sleep()`'s on a regular basis, then you should be able to modify it so that the Notifier calls your imaging/computation routine at the same interval.

The program *spheres* in Appendix A, *Example Programs*, is an example of this style of interaction.

Or Your Code Stays in Control

On the other hand, if your program just loops, perhaps while `(--gfx_reps)`, then you could add to the loop a call to `notify_dispatch()`. This will handle window system events and return.

The program *bounce* in Appendix A, *Example Programs*, is an example of this style of interaction.

If you do this then your program has to detect when the user has 'Quit' from the menu: see *Finishing Up* below.

NOTE `gfx_reps` in a gfx subwindow program is set to a large number (200,000), but the user can change it through the command line argument **-n** *number_of_repetitions*.

Handling Damage

The Notifier will handle moving the window, resizing it, etc. However, resulting damage to your canvas may need to be repaired. In the gfx subwindow, `GFX_DAMAGED` is set whenever a `SIGWINCH` is received. In addition `GFX_RESTART` is set if the size of the window has changed or if the window is not retained. `GFX_DAMAGED` is set as a hint for you to call `gfxsw_handlesigwinch()`, which would clear up the damaged list and if the window was retained it would repaint the image for you. `GFX_RESTART` is set as a hint that the window had to be rebuilt, either because of damage and the window is not retained, or because of a resize.

Many situations that you would need to handle yourself in a gfx subwindow are rendered superfluous by attributes of the canvas subwindow, such as `CANVAS_AUTO_CLEAR`, etc. For starters, canvases are retained by default; if your canvas has scrollbars and is retained, then you need not be concerned with resize events. Nevertheless, you may need to be aware when you must rebuild or repair your image. Read the *Canvases* chapter for more information.

Rather than setting a flag, SunView calls your own procedure if you specify one with the `CANVAS_REPAINT_PROC` and `CANVAS_RESIZE_PROC` attributes. These are called with useful parameters for their tasks.

You can modify your code so that the repair activity that used to take place after noticing the flags have been set now takes place in the procs themselves, or you can write the procs so they set flags similar to the `GFX_RESTART` and `GFX_REPAINT` flags and return, and leave your repair code almost untouched. Or, depending on your application, you can set up your canvas so that the window system handles all damage.

The `gfxsw` Structure

The `gfxsw` structure has fields in it that carry useful information. Comparable information is available in SunView, so you can declare and setup a comparable structure in SunView. The *bounce* program in Appendix A, *Example Programs*, does this.

Gfx subwindow-based programs use the `gfx->gfxsw_rect` to determine the geometry of the window they are drawing in. Since the starting point of this was relative to the gfxsw, it was always 0.[110] In SunView the width and height of the canvas you draw in are available through the canvas attributes CANVAS_WIDTH and CANVAS_HEIGHT. The fields of the gfx->gfxsw_rect correspond to these attributes as follows:

coord	r_left, r_top;	are both = 0
short	r_width, r_height;	are the CANVAS_WIDTH and CANVAS_HEIGHT attributes.

As described above, you can use your own GFX_RESTART and GFX_REPAINT flags.

If you care about the gfxsw command line arguments, insert code into your program's argv, argc parsing loop to handle the gfx options that used to be taken care of for you. The *bounce* program has reasonable code to do this.

Finishing Up

If your imaging routine is in control and periodically calls the Notifier, then when the window is quit your routine must know that this has occurred. Otherwise, the imaging routine will continue to draw in a window that has been destroyed, and you will see error messages like

```
WIN ioctl number C0146720: Bad file number
```

until you kill the program.

What you must do is interpose in front of the frame's destroy event handler so that your program will know when the frame goes away. See the item on *Getting Out* in *Porting Programs to SunView* in the *Notifier* chapter.

If your program exits on its own, then it can call window_done() to destroy its windows. This will invoke your interposed notice-destroy routine (which may or may not matter depending on what it does). It will also call the standard

```
Are you sure you want to Quit?
```

alert unless you set FRAME_NO_CONFIRM.

Miscellaneous

gfxsw_getretained() is equivalent to the CANVAS_RETAINED attribute. Canvases are retained by default.

gfxsw_init() doesn't consume the gfxsw command line options **-r**, **-n** *Number_of_repetitions*, etc; your code may do strange things with its arguments to deal with this.

[110] Many of the demos supplied by Sun are confused on this point and go through unnecessary steps.

Two Examples

Listings of two programs converted from SunView are in Appendix A, *Example Programs.*

bounce

The first is a new version of `bouncedemo`(6). It now draws its bouncing square in a canvas. It has code to parse the standard gfx subwindow command line arguments. It preserves the original `while (gfx->gfx_reps) {...}` loop structure of *bouncedemo* by calling `notify_dispatch()` at the top of the loop. Because it is running in a loop it must detect when the user has 'Quit' the window, so it interposes before its frame's destroy routine using `notify_interpose_destroy_func()`. The routine that is called just sets a flag so the program knows to exit from the loop.

spheres

The second is a version of `spheresdemo`(6). It now draws its shaded spheres in a canvas with scrollbars, so you can see all the image in a small window. It handles the notification of SunView events by asking the Notifier to call the drawing routine (`my_animation()`) as often as possible, using

```
(void) notify_set_itimer_func(frame, my_animation,
       ITIMER_REAL, &NOTIFY_POLLING_ITIMER, ITIMER_NULL);
```

Since the drawing operation is under the control of the Notifier, the Notifier can control the program, so the `while (gfx->gfx_reps) {...}` loop structure is replaced by a call to `window_main_loop()`; this will terminate the program when the user chooses 'Quit' from the frame menu.

Detecting when the Program is Iconic

spheres detects when it is made iconic by interposing in front of the frame's client event handler using `notify_interpose_event_func()`. The routine that is called calls the normal `event_func`, then checks to see if the frame has changed state: if it has been closed it turns the notify timer off altogether, so the drawing routine is no longer called; if it has been opened the timer is set back to immediate polling.

bounce should do this also — there is little point in drawing when iconic unless you are drawing a single compute-intensive image.

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