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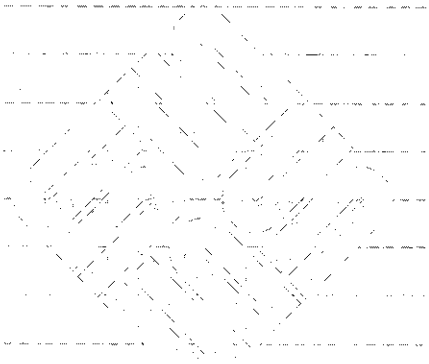
Programmer's Reference Manual *for* SunCore



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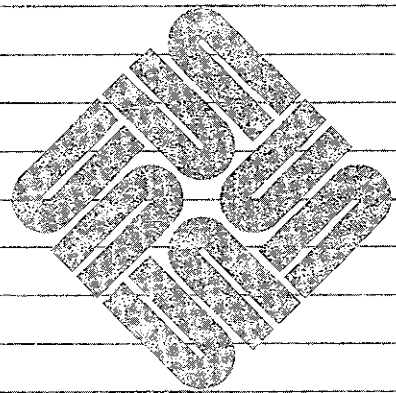

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Revision F of 15 May, 1985

Acknowledgements

The software in **SunCore** is an extended version of a merging of two software packages, namely LEGS and CLICS. LEGS (Library of Engineering Graphics Software) was built at Sun Microsystems between May 1982 and August 1982. LEGS consisted of 3-D transformations, clipping, and region fill, plus text, line, and marker output primitives for the Sun Workstation. CLICS (**C** Language Implementation of the Core System) was a 2-D implementation of the Core written by Mike Garrett, Drew Greenholt, and others. CLICS supported dynamic segment handling, error handling, and device independence, but lacked input primitives, 3-D capabilities, textured lines, and device independent text. CLICS was released to the public via the UNIX User's Group (the precursor of USENIX) software distribution channel. CLICS plus LEGS became the **SunCore** graphics package at Sun Microsystems by November 1982, bringing the package up to output level 3C, input level 2, and dimension level 3-D, with raster extensions for polygons and bitmaps.

Revision History

Rev	Date	Comments
A	15 December 1982	First release of this Programmer's Reference Manual.
B	1 March 1983	Many minor corrections. Added ***set_viewport_3*** function to viewing operations. Added ***inquire_inverse_composite_matrix*** function to viewing operations. Added saving and restoring segments on disk to segmentation and naming. Added ***get_mouse_state*** function to input primitives. Added discussions on 3-D polygon shading parameters.
C	15 May 1983	Many minor corrections. Made changes to **SunCore** routines to bring **SunCore** into strict compliance with the ACM Core specification. The following list of items is a guide: 1– Normalized device coordinates are now **float** values in the range 0.0 to 1.0. 2– ***initialize_view_surface*** takes different arguments — surface names were character strings, now they are pointers to the device drivers for the specified view surface. 3– routines for creating and closing segments now match the Core specification. 4– the ***set_color_index*** function is replaced by the color raster extensions ***set_line_index***, ***set_fill_index***, and ***set_text_index***. 5– the ***display list*** (pseudo display file) is now a virtual memory array of 500,000 bytes. Therefore, disk space must be available for these pages when running **SunCore** programs. The z-buffer is also a virtual array, hence more disk is used. 6– ***set_image_transformation_type*** now replaces ***set_segment_type***. 7– Defined constants for the ***set_char_precision*** argument have changed.

Revision History, continued

Rev	Date	Comments
D	1 November 1983	Many minor corrections. Changed viewsurface names to reflect use of new low-level device-interface routines and window system support. Old name ***sunbitmap*** replaced by ***bw1dd*** when running program without window system, and ***pixwindd*** for use in windows. Old name ***suncolor*** replaced by ***cg1dd***. Changed ***initialize_view_surface*** — adding 2 to type argument value suppresses clearing the screen. ***await_keyboard*** returns input_string null-terminated 'after' the newline character instead of before the newline character. Bitmap Frame-Buffer RasterOps of Appendix B replaced by pixrect operations. See ***Sun Window System Manual*** for details. Documentation for COP routines was confusing and has been clarified. Fixed all bugs reported to date. Also fixed some reported capability shortcomings.
E	7 January 1984	Added new types of view surfaces. View-surface names are now structures to support multiple windows. See appendix B for details. Low-level device-dependent routines for the color frame-buffer have been replaced by pixrect operations. See the ***Sun Window System Programmer's Reference Manual*** for details of pixrects. SunCore now supports an interface from Pascal programs. See appendix E for details of the Pascal interface. A higher performance Core library is now available for use on machines with the hardware floating-point option. See appendix F for details.
F	15 May 1985	Added ***set_pick*** function. Added additional raster (STRING precision) fonts. **SunCore** now runs on the ***/dev/cgtwo*** display surface. Added new appendix C — alphabetical list of C functions. Added new appendix G — list of error messages. Various bug fixes.

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Chapter 1

Introduction

Welcome to the **SunCore** graphics package and its Programmer's Reference Manual. **Sun** Microsystems offers a comprehensive package of engineering graphics software providing the underlying support for interactive graphics applications programs. The **SunCore** software is an implementation of the ACM Core graphics specification[1], plus extensions. **SunCore** is implemented to level 3C of the ACM Core specification for output primitives, and to level 2 of the ACM Core specification for input primitives.

Extensions to the Core include textured polygon fill algorithms, raster primitives, ***rasterop*** attributes, shaded surface polygon rendering, and hidden surface elimination.

This graphics package supports both the high resolution monochrome bitmap displays and the Sun color displays. Device-dependent routines support all these displays under **SunCore**.

NOTE that this manual is a ***reference manual*** for the **SunCore** graphics package. It is not a tutorial for the programmer without knowledge of graphics principles. It assumes that the reader is familiar with the concepts of graphics, and has some familiarity with the ACM Core specification. Those who are new to graphics should consult one of the publications listed in ***further reading*** at the end of this chapter.

Where to Start

If you are an applications programmer who is familiar with the ACM Core specification, but are new to **SunCore**, it is recommended that you read appendix **A** in order to become familiar with the areas where **SunCore** deviates from and provides extensions to the ACM Core specification.

Note that **SunCore** supports the ACM Core output level 3C, that is, dynamic output is supported, including two and three-dimensional translation, scaling, and rotation. **SunCore** supports the ACM Core input level 2, that is, synchronous input, including the PICK device. **SunCore** supports dimension level 2, that is, three-dimensional operations.

1.1. Overview and Terminology

The objective of a graphics application program is drawing pictures and text on some display device, be it an ephemeral display device such as TV monitor or terminal, or a hard copy device such as a plotter or printer.

[1] As defined in Computer Graphics, the ACM SIGGRAPH Quarterly, Volume 13, #3, August 1979.

There is a need for a device-independent way of representing graphics images in the computer, and having a collection of software routines map the device-independent representations into the physical representations that the output device can handle. **SunCore** is an implementation of one of the "standard" packages of graphics software that have appeared recently. This section introduces some of the terminology of **SunCore**. This terminology is used throughout this manual. It is somewhat easier to describe the terminology from the point of view of the physical device working backwards to the application program, rather than starting at the software and working out to the device.

There are two quite distinct points of view for looking at a system running a graphics application:

- The physical device (monitor, printer, and so on) on which the final pictures appear, and
- The internal world which the programmer uses to describe the pictures, and which (because of **SunCore**) is independent of the physical device.

A ***view surface*** is a physical surface on which the final picture appears.

There are two interdependent sets of coordinate systems in use in the graphics package:

World Coordinates
: is a coordinate system which is device-independent. The applications programmer constructs all graphical objects in terms of world coordinates.

Normalized Device Coordinates
: (often abbreviated to NDC) is a fixed coordinate system which is independent of physical output devices. World coordinates are transformed to normalized device coordinates for clipping and other operations. Each physical output device driver then transforms from normalized device coordinates to the physical device coordinates for each view surface.

A ***viewport*** is a region of NDC space which the programmer selects and on which the pictures will appear.

It is the job of the viewing transformations to perform the correct mapping between world coordinates and normalized device coordinates.

A ***window*** is a region defined in world coordinates within which the images that the application program defines appear. The selection of the coordinates for the window are arbitrary — the graphics package maps the window into the viewport.

In two dimensions, the transformation from the window to the viewport is a relatively straightforward process. In three dimensions, another level of complexity is introduced with the notion of a ***view plane*** which is positioned arbitrarily in world coordinates.

An ***output primitive***, or often just a ***primitive***, is a part of a picture (such as a line or a character string). The appearance of primitives (such as solid or dotted lines) is determined by ***primitive attributes***. A ***primitive attribute*** is a general characteristic of an output primitive, and affects the appearance of that primitive. Examples of primitive attributes are color, linestyle, and linewidth.

Each output primitive may be assigned a name, called the ***pick-id***, which is used to identify that primitive when an input operation (such as pointing at the primitive with the mouse) is applied.

The *Current Position* is a **SunCore** system value that defines the current location for drawing. At startup time, the Current Position is set to the origin of the world coordinate system. Functions that create output primitives (move, line, and so on) can alter the Current Position.

Output primitives are collected together in ***segments***. A segment defines an ***image*** which is a part of the picture on a view surface.

Segments are divided into two classes, namely: ***temporary*** and ***retained***. A retained segment has a name, and can have segment attributes associated with it. A temporary segment is nameless, and furthermore, the image that a temporary segment defines only remains visible as long as information is only being added to the view surface. As soon as a new frame action (one which repaints view surface) occurs, the temporary segment's image disappears from the view surface.

Each retained segment has one static attribute, its image transformation type. The value of this attribute can be ***none***, ***translatable***, or ***transformable***. Translatable and transformable retained segments can be translated or transformed in either two or three dimensions.

Segments also have ***dynamic attributes***. The ***visibility*** and ***highlighting*** attributes control the appearance of the image. The ***detectability*** attribute determines if the segment can be detected by the pick device. Dynamic attributes for translatable and transformable segments include the segment's image transformation. Depending on the image transformation type, the image transformation may contain translation, rotation, and scaling components.

A ***viewing operation*** is an operation that maps positions in world coordinates to positions in normalized device coordinates. The viewing operation also determines the portion of the world coordinate space that is visible if window clipping or depth clipping is enabled.

The applications program can obtain user interaction by means of ***input primitives***, which provide facilities for pointing at objects, entering data from the keyboard, and causing events.

1.1.1. Basics of Drawing Pictures

The general sequence of actions that an application program goes through to create a picture on a device is this:

1. ***Initialize*** **SunCore**.
2. ***Initialize a view surface*** upon which the picture will be drawn.
3. ***Select a view surface*** upon which the picture will be drawn.
4. ***Specify the viewing operation parameters*** (sizes of windows in world coordinates, size of viewport, and so on).
5. ***Set*** an image transformation type.
6. ***Create a segment.*** The created segment becomes the currently open segment until it is closed.
7. ***Set attributes*** for the segment, if required.
8. ***Draw objects*** in the segment using output primitives.
9. ***Close the segment.***
10. Repeat steps 4 through 9 as often as required, for as many segments as needed to build the picture.
11. ***Apply image transformations*** (translation, scaling, and rotation) to a given segment, to achieve the required picture on the display device.
12. ***Deselect the view surface.***

13. *Terminate* **SunCore**.

In providing the application programmer with the capabilities needed to draw pictures, **SunCore** breaks the interface into six functional areas:

Control
directs the major actions of **SunCore**, such as startup, shutdown, selection and deselection of view surfaces, and so on.

Segments
control the creation, closing, and removal of segments. Segments are then used to collect sets of:

Output Functions
also known as output primitives, which describe the drawing of lines and line sequences, shaded regions, text, and markers.

Attributes
control the way in which output primitives actually appear in the final image (solid or dotted lines, for instance).

Transformations
control the major appearances of pictures, such as orientation (rotation), scaling, and translation. Transformations also control projection type and clipping.

Input Functions
handle the interaction with the user via the keyboard and the mouse.

1.2. Getting Started With SunCore

This section provides a very simple example of a **SunCore** application program. The program draws a martini glass on the screen. This program demonstrates the use of:

- Creating a temporary segment (see *Segmentation and Naming*),
- Moving to an absolute position (see *Output Primitives*),
- Using the polyline drawing routines (see *Output Primitives*),
- Using the absolute line drawing routines (see *Output Primitives*),

The annotated code of *glass.c* is shown below, followed by the *cc* compiler call used to create the executable program.

The first thing in the program is an include statement to get the definitions of constants:

```
#include <usercore.h>
```

Then there are the definitions of the relative points for the polyline function to draw the glass:

```
static float glassdx[] = {-10.0,9.0,0.0,-14.0,30.0,-14.0,0.0,9.0,-10.0};
static float glassdy[] = {0.0,1.0,19.0,15.0,0.0,-15.0,-19.0,-1.0,0.0};
int  bw1dd();          /*  Device driver name for Sun-1 Monochrome    */
                            /*  display — see appendix B for details    */
struct  vwsurf  vwsurf = DEFAULT_VWSURF(bw1dd);
```

Then comes the main program with some initialization code:

```
main()
{
                                /*  First initialize the SunCore Package  */
    if (initialize_core(BASIC, NOINPUT, TWOD))
        exit(1);
                                /*  Elements of vwsurf may be set up here  */
                                /*  See Appendix B for details  */

                                /*  Then initialize the monochrome display  */
    if (initialize_view_surface(&vwsurf, FALSE))
        exit(2);
                                /*  Then we must select that view surface  */
    if (select_view_surface(&vwsurf))
        exit(3);
                                /*  Then define the limits of the viewport  */
    set_viewport_2(0.125, 0.875, 0.125, 0.75);
                                /*  Then set a convenient window  */
    set_window(-50.0, 50.0, -10.0, 80.0);
                                /*  Create a temporary segment  */
    create_temporary_segment();
```

Here is the actual code that draws the picture:

```
                                /*  Now move to our origin point  */
    move_abs_2(0.0, 0.0);
                                /*  And draw the outline of the glass  */
    polyline_rel_2(glassdx, glassdy, 9);
                                /*  Then move to draw the liquid surface  */
    move_rel_2(-12.0, 33.0);
                                /*  Draw the liquid surface  */
    line_rel_2(24.0, 0.0);
```

Finally, we close things and exit the program:

```
                                /*  Now close the segment  */
    close_temporary_segment();
                                /*  Wait for 10 seconds ....  */
    sleep(10);
                                /*  Before closing the view surface .....  */
    deselect_view_surface(&vwsurf);
                                /*  and closing down SunCore  */
    terminate_core();
}
```

Now we compile this program using the **C** compiler:

```
tutorial% cc glass.c -lcore -lsunwindow -lpixrect -lm
```

In the above example, the options:

−lcore selects the **SunCore** run-time library from */usr/lib/libcore.a,*

−lsunwindow selects the window system library,

−lpixrect selects the pixrect library,

−lm selects the correct math library.

When the compilation is complete, the final program is in the file ***a.out*** and may be run by typing its name.

This is a very simple example, using the bare minimum of **SunCore**'s capabilities. There are many improvements that could be made, such as adding an olive on a cocktail stick and so on. The *Programming Examples* section of this manual will cover other areas of the graphics package.

1.3. The SunCore Lint Library

SunCore provides a ***lint*** library which provides type checking beyond the capabilities of the C compiler. For example, you could use the **SunCore** ***lint*** library to check the martini-glass drawing program with command like this:

```
tutorial% lint  glass.c  -lsuncore
```

but note that the error messages that ***lint*** generates are mostly warnings, and may not necessarily have any effect on the operation of the program. For a detailed explanation of ***lint***, see the ***lint*** manual in the *Programming Tools* manual.

1.4. The Coordinate Systems

Applications programs which draw pictures using **SunCore** communicate in ***world coordinates.*** World coordinates are a device-independent, two or three-dimensional, Cartesian coordinate system for describing objects. Output primitives are given to **SunCore** routines in World Coordinates (WC). However, if the ***world_coordinate*** matrix is used, **SunCore** concatenates this matrix with the view transform so that output primitives are first transformed by this matrix from 'model' or 'object' coordinates to world coordinates. This means that the user can supply primitives in 'model' coordinates, each model or object being moved into world coordinates according to the current ***world_coordinate_matrix.***

In three dimensions, the user may choose to use right-handed or left-handed world coordinates. In a right-handed system, if (for example) the x coordinate increases to the right and the y coordinate increases upwards, then the z coordinate increases towards the viewer. In the corresponding left-handed system, the x coordinate increases to the right, the y coordinate increases upwards, and the z coordinate increases away from the viewer.

The composite viewing transform is formed from the ***world_coordinate_matrix*** and the viewing parameters. **SunCore** routines transform the output primitives from world (or model) coordinates to Normalized Device Coordinates (NDC), which are a left-hand coordinate system bounded such that: $0.0 \leq x,y,z \leq 1.0$

Since current Sun view surfaces have four-to-three aspect ratios, the default normalized device coordinate space has the y extent bounded to $0.0 \leq y \leq 0.75$. Primitives are stored in the Display List (also called the Pseudo Display File or PDF), in Normalized Device Coordinates. The user-specified window in world coordinates is mapped (and optionally clipped) to the user-specified viewport within normalized device coordinate space. The entire normalized device coordinate space is then mapped to the selected physical view surfaces.

1.5. Details of Using SunCore

This section describes the details of creating applications programs to run with **SunCore**.

1.5.1. Classification of Functional Capabilities

The ACM Core specification defines levels of functional capability for a graphics package which implements the specification. The table below shows the classification. Terms such as BUFFERED and DYNAMICA are defined as constants in the file ***usercore.h***, discussed below.

Table 1-1: Output Capabilities

	Output Capabilities				
Functional Capability	BASIC	BUFFERED	DYNAMICA	DYNAMICB	DYNAMICC
Output Primitives and Primitive Attributes.	yes	yes	yes	yes	yes
Viewing	yes	yes	yes	yes	yes
Control	yes	yes	yes	yes	yes
Temporary Segments	yes	yes	yes	yes	yes
Retained Segments	no	yes	yes	yes	yes
Highlighting Segment Attribute	no	yes	yes	yes	yes
Visibility Segment Attribute	no	yes	yes	yes	yes
Image Transformation Segment Attribute	no	no	yes	yes	yes
Detectability Segment Attribute	no	yes*	yes*	yes*	yes*

* This feature is only available if input levels SYNCHRONOUS or COMPLETE are supported. Note that **SunCore** supports all output levels up to DYNAMICC.

Table 1-2: Input Capabilities

	Input Capabilities		
Functional Capability	NOINPUT	SYNCHRONOUS	COMPLETE
Device Initialization and Termination	no	yes	yes
Synchronous Interaction Functions	no	yes	yes
Echo Control	no	yes	yes
Explicit Enable or Disable	no	no	yes
Event Queue Management	no	no	yes
Sampled Device Functions	no	no	yes
Associations	no	no	yes

Note that **SunCore** supports up to the SYNCHRONOUS input level.

Table 1-3: Dimension Levels Supported

	Dimension Levels Supported	
Functional Capability	TWOD	THREED
Two Dimensional Primitives, Attributes, and Viewing.	yes	yes
Three Dimensional Primitives, Attributes, and Viewing.	no	yes

Note that **SunCore** supports the THREED dimension level.

1.5.2. Error Reporting

SunCore performs consistency checks on arguments passed to its various routines. Any time an error is detected, the name of the routine which raised the error condition and the text of the error message are printed on the standard error (stderr).

All **SunCore** interfaces are ***functions*** that return a value. If a function completes successfully, it returns the value zero. If the function raises any error conditions, it returns a non-zero value. **SunCore** always identifies the name of the routine which raised the error condition. The ACM Core specification defines specific error numbers. These do not correspond to SunCore's error numbers in the current release.

1.5.3. Useful Constants in the usercore.h Include File

The file ***usercore.h*** defines a collection of constants which the application programmer should use in lieu of hardwired constants in code. The constants are described here (but their values are not stated).

Useful Constants:

TRUE A universal value denoting the truth value.

FALSE A universal value denoting the false value.

MAXVSURF The maximum number of view surfaces which may be initialized at any one time.

Initialization Constants. These constants describe the levels of the **SunCore** facilities which the application program will use. These constants should be used when calling the ***initialize_core*** function.

BASIC Denotes the basic output level. See the tables above for the classifications.

BUFFERED Denotes the buffered output level. See the tables above for the classifications.

DYNAMICA Indicates that the application package wishes to use two-dimensional translation facilities. See the tables above for the classifications.

DYNAMICB Indicates that the application package wishes to use two-dimensional scaling, rotation, and translation facilities. See the tables above for the classifications.

DYNAMICC Indicates that the application package wishes to use three-dimensional scaling, rotation, and translation facilities. See the tables above for the classifications.

NOINPUT Indicates that this application package will not use any input facilities. See the tables above for the classifications.

SYNCHRONOUS
Indicates that this application program will use synchronous input facilities. See the tables above for the classifications.

COMPLETE **SunCore** does not support this input level. See the tables above for the classifications.

TWOD Indicates that the application package will only use two-dimensional functions. See the tables above for the classifications.

THREED Indicates that the application package will use both two-dimensional and three-dimensional functions. See the tables above for the classifications.

Character Quality Constants. These constants should be used when calling the ***set_charprecision*** function.

STRING Denotes low quality text.

CHARACTER
Denotes medium quality text.

Transform Constants. These constants should be used when calling the ***set_projection*** and ***set_coordinate_system_type*** functions.

PARALLEL Value to indicate ***parallel*** projection.

PERSPECTIVE
Value to indicate ***perspective*** projection.

RIGHT Value to indicate right-handed world coordinate system.

LEFT Value to indicate left-handed world coordinate system.

Image Transformation Type Constants. These constants are used when calling the ***set_image_transformation_type*** and ***set_segment_image_transformation_type*** functions.

NONE Indicates a retained segment which cannot be transformed.

XLATE2 Indicates a retained segment which may be translated in two dimensions.

XFORM2 Indicates a retained segment which may be fully translated, scaled, and rotated, in two dimensions.

XLATE3 Indicates a retained segment which may be translated in three dimensions.

XFORM3 Indicates a retained segment which may be fully translated, scaled, and rotated, in three dimensions.

Line Style Constants. These constants should be used when calling the ***set_linestyle*** attribute for output primitives.

SOLID Solid line.

DOTTED Dotted line.

DASHED Dashed line.

DOTDASHED
Dashed and dotted line.

Text Font Selection Constants. These constants should be used when calling ***set_font.***

ROMAN For ***character*** precision, a Roman font; for ***string*** precision, a raster font.

GREEK For ***character*** precision, a Greek font; for ***string*** precision, the default raster font.

SCRIPT For ***character*** precision, a Script font; for ***string*** precision, a small raster font.

OLDENGLISH
For ***character*** precision, an Old English font; for ***string*** precision, equivalent to ROMAN.

STICK For ***character*** precision, a stick font; for ***string*** precision, equivalent to GREEK.

SYMBOLS For ***character*** precision, a set of symbols; for ***string*** precision, equivalent to SCRIPT.

Input Device Constants. These constants should be used when calling the ***initialize_device*** and ***terminate_device*** functions and other input functions.

PICK The ***Pick*** device. The mouse in **SunCore.**

KEYBOARD The ***Keyboard*** device.

STROKE The freehand stroke device. The mouse in **SunCore**.

LOCATOR The *Locator* device. The mouse in **SunCore**.

VALUATOR The *Valuator* device. The mouse in **SunCore**.

BUTTON The *Button* device. The mouse in **SunCore**.

RasterOp Constants. These constants should be used when calling the ***set_rasterop*** function.

NORMAL Indicates normal copy mode.

XORROP Indicates bitwise exclusive or of source and destination.

ORROP Indicates bitwise or of source and destination.

Polygon Rendering Style Constants. These constants should be used when calling the ***set_polygon_interior_style*** and ***set_shading_parameters*** functions.

PLAIN Indicates area fill with the color indicated by the ***fill index*** primitive attribute.

SHADED Indicates shading according to the current shading parameters (for 3-D polygons only).

CONSTANT Indicates constant user-specified shade.

GOURAUD Indicates Gouraud shading.

PHONG Indicates Phong shading.

1.6. Further Reading

J. D. Foley and A. Van Dam:
Fundamentals of Interactive Computer Graphics, Addison-Wesley, 1982.

W. M. Newman and R. F. Sproull:
Principles of Interactive Computer Graphics (2nd edition), McGraw-Hill, 1979.

ACM SIGGRAPH:
Conference Proceedings.

IEEE *Computer Graphics and Applications* Magazine

Computer Graphics ACM SIGGRAPH *Quarterly*, Vol 13, #3, August 1979
Status Report of the Graphics Standards Planning Committee.

ACM Computing Surveys, Vol 10, #4, Dec 1978
Special Issue on Graphic Standards.

Computer Graphics World, Vol 5, #8, August 1982
The SIGGRAPH Core System Today.

Chapter 2

Control

The **SunCore** graphics package provides several functions for controlling the system. These functions are discussed here, and the sections and subsections which follow describe the individual functions in detail.

Initialization and *termination*
of **SunCore** provide for the initialization of the package to a specific and predetermined state, and for closing it down when the applications program has finished using the graphics package.

View surface control
provides for the initialization, termination, and selection of view surfaces. A view surface must be initialized before it can be used. A view surface should be terminated when the applications package has finished with it. Functions are provided to add view surfaces to the set of selected view surfaces, and to remove view surfaces from that set. View surface names in **SunCore** are structures. The `vwsurf` structure is declared in ***usercore.h*** and is described in appendix B. **SunCore** supports several view surfaces to date; see appendix B for details of view surfaces.

Picture change control
provides for the "batching" of changes to dynamic segment attributes so that the application program may force the simultaneous occurrence of a group of changes.

Frame control
denotes the function called `new_frame`, which clears the view surface and redraws all segments except temporary segments.

Error handling
is that part of **SunCore** concerned with reporting errors to the application program.

2.1. Initialization and Termination

There are two functions provided for initializing and terminating **SunCore**. The application program should call `initialize_core` before making any other calls upon the graphics system. `terminate_core` should be the last call to **SunCore** before the application program itself is finished.

2.1.1. `initialize_core` — *Initialize the SunCore System*

`initialize_core` initializes the Core graphics package to a known state.

```
initialize_core(output_level, input_level, dimension)
    int  output_level;      /*  SunCore Level for Output          */
                            /*  BASIC, BUFFERED, DYNAMICA         */
                            /*  DYNAMICB, DYNAMICC                */
    int  input_level;       /*  SunCore Level for Input           */
                            /*  NOINPUT, SYNCHRONOUS, COMPLETE    */
    int  dimension;         /*  Number of Dimensions Required     */
                            /*  TWOD, THREED                      */
```

SunCore supports up to output level DYNAMICC of the ACM Core specification, up to input level SYNCHRONOUS of the ACM Core, and dimension level THREED of the ACM Core.

Errors returned from `initialize_core`:

- The **SunCore** system is already initialized.
- The specified output level cannot be supported.
- The specified input level cannot be supported.
- The specified dimension cannot be supported.

2.1.2. `terminate_core` — *Close Down the SunCore System*

`terminate_core` closes down the Core graphics package.

```
terminate_core()
```

2.2. Initializing and Selecting View Surfaces

`View surface control` provides for the initialization, termination, and selection of view surfaces. A view surface must be initialized before it can be used. A view surface should be terminated when the applications package has finished with it. Examples of view surfaces are the Sun color display and the Sun monochrome bitmap display. Functions provided in this category are:

`initialize_view_surface`
: performs the functions required to gain access to a specified view surface.

`terminate_view_surface`
: terminates access to the specified view surface.

`select_view_surface`
: adds the specified view surface to the set of selected view surfaces for output.

`deselect_view_surface`
: removes the specified view surface from the set of selected view surfaces.

`inquire_selected_surfaces`
determines which view surfaces are currently selected (not yet implemented).

2.2.1. `initialize_view_surface` — *Initialize a View Surface*

`initialize_view_surface` initializes the Core package for a specific view surface.

```
initialize_view_surface(surface_name, type)
    struct  vwsurf  *surface_name;          /*  See appendix B  */
    int  type;          /*  TRUE for hidden surface removal  */
                        /*  FALSE otherwise */
```

The `surface_name` argument to the function specifies a physical view surface. View surface names in SunCore are structures. The ***vwsurf*** structure is defined in the ***usercore.h*** header file. Only color devices support hidden-surface removal.

Errors returned from `initialize_view_surface`:

- The view surface specified by `surface_name` is already initialized.
- The view surface specified by `surface_name` does not have any output device associated with it.
- No other view surfaces can be initialized at this time.
- The specified view surface does not support hidden surface removal.

2.2.2. `terminate_view_surface` — *Close Down a View Surface*

`terminate_view_surface` closes down the specified view surface.

```
terminate_view_surface(surface_name)
    struct  vwsurf  *surface_name;          /*  See appendix B  */
```

Errors returned from `terminate_view_surface`:

- The view surface specified by `surface_name` is not initialized.

2.2.3. `select_view_surface` — *Add View Surface to Selected Set*

`select_view_surface` adds a specified view surface to the list of selected view surfaces.

```
select_view_surface(surface_name)
    struct  vwsurf  *surface_name;          /*  See appendix B  */
```

A segment is only drawn on those view surfaces marked as "selected" at the time that the segment is created.

Errors returned from `select_view_surface`:

- A segment is open.
- The view surface specified by `surface_name` is not initialized.
- The view surface specified by `surface_name` is already selected.
- The view surface specified by `surface_name` cannot be selected.

2.2.4. `deselect_view_surface` — *Remove View Surface from Selected Set*

`deselect_view_surface` removes a specified view surface from the list of selected view surfaces.

```
deselect_view_surface(surface_name)
    struct  vwsurf  *surface_name;          /*  See appendix B  */
```

Segments created after `deselect_view_surface` is called will not be drawn on the deselected view surface.

Errors returned from `deselect_view_surface`:

- A segment is open.
- The view surface specified by `surface_name` is not selected.

2.3. Batching of Updates

SunCore provides the facility for the application program to indicate that a sequence of updates is being started, and the graphics package stacks up these picture changes until an `end_batch_of_updates` function call indicates that the end of the sequence of updates has occurred. Picture changes or 'updates' include dynamic segment attributes such as visibility, detectability, translate, rotate, and scale.

2.3.1. `begin_batch_of_updates` — *Indicate Start of a Batch of Updates*

`begin_batch_of_updates` indicates the beginning of a batch of updates to the picture. All modifications to dynamic attributes of segments between calls to `begin_batch_of_updates` and `end_batch_of_updates` are saved up and executed simultaneously.

```
begin_batch_of_updates()
```

Errors returned from `begin_batch_of_updates`:

- There has been no `end_batch_of_updates` function call since the last `begin_batch_of_updates` function call.

2.3.2. end_batch_of_updates — *Indicate End of a Batch of Updates*

end_batch_of_updates indicates the end of a batch of updates. The batch of changes to dynamic attributes of segments is executed,

```
end_batch_of_updates()
```

Errors returned from **end_batch_of_updates**:

- There has been no corresponding **begin_batch_of_updates** function call.

2.4. Frame Control

2.4.1. new_frame — *Start New Frame Action for Selected View Surfaces*

new_frame starts new frame action for currently selected view surfaces. The view surface is cleared, and all visible retained segments are redrawn.

```
new_frame()
```

Errors returned from **new_frame**:

- The set of currently selected view surfaces is empty.

2.5. Error Control

2.5.1. report_most_recent_error

report_most_recent_error obtains a copy of the most recently detected error number.

```
report_most_recent_error(error_number)
    int  *error_number;
```

A value of zero returned to **error_number** indicates that there has been no error since the last call on **report_most_recent_error**.

2.5.2. print_error

To print the message associated with this **error_number** on the standard error file (stderr), use the function call:

```
print_error("Your message", error_number);
    int  error_number;
```

where "Your message" is any character string that the user wants printed. The error message is printed on the line following "Your message".

2.6. Drag Control (SunCore Extension)

2.6.1. set_drag

An additional function, **set_drag**, writes all output to the bitmap or color framebuffer with exclusive or'ing.

```
set_drag(mode)
    int  mode;      /*  FALSE = uses the rasterop  */
                    /*  set by set_rasterop */
                    /*  TRUE = enable XOR'ing  */
```

If dragging is enabled, all output to the device drivers is done with exclusive OR's to the data in the displays. This feature makes dragging more convenient. For example, if you want to drag segment A across segment B, leaving segment B's image unaffected, do the following sequence of operations:

- Set A visibility *off*,
- Set dragging *on*,
- Set A visibility *on*,
- Drag segment A to the desired location,
- Set A visibility *off*,
- Set dragging *off*,
- Set A visibility *on*.

See also: **set_rasterop**.

Chapter 3

Viewing Operations and Coordinate Transforms

Specifying a viewing operation may be thought of as specifying the arbitrary orientation of a synthetic camera. The resulting view of the object (the snapshot) can appear on one or more view surfaces. The viewing operations are provided for two reasons:

1. To specify how much of the world coordinate space should be visible, and
2. To specify a mathematical transformation between the world coordinate system and the normalized device coordinate system.

A viewing operation is specified by a view volume that defines the portion of world coordinate space which is to be projected onto a view plane (also called a projection plane), and a rectangular viewport in normalized device coordinate space to which the projected image will be mapped. The viewing operation is sufficiently general as to support both parallel and perspective projections. The parallel projection includes the orthographic, axonometric, isometric, cavalier, and cabinet projections, as special cases.

Once the camera model is specified via calls to `set_view_reference_point`, `set_view_plane_normal`, and so on, a 4 X 4 view transform matrix is constructed. Then the process of generating an image on a view surface is:

1. View-transforming the output primitives (using the view transform preceded by any modelling transform the user has specified) to normalized device coordinates.
2. Optional clipping to the window.
3. Scale the output to map the window to the viewport.
4. Optional image transformation as specified by dynamic segment attributes.
5. Optional clipping to the viewport.
6. Convert to device coordinates and draw the picture.

3.1. Windows, View Volumes, and Clipping

The ***window*** is the bounded portion of the view plane containing projected objects which will appear within the viewport on the ***view surface.*** The view surface corresponds to the physical device on which the picture is drawn. The window is the logical region, specified in world coordinates, in which the image appears.

Specifying a window involves defining a coordinate system for the ***view plane.*** The coordinate system for the view plane is called the *UVW* coordinate system, to distinguish it from the world

coordinate system and the normalized device coordinate system, both of which are *XYZ* coordinate systems.

The origin of the *UVW* coordinate system is at the point where the line through the view reference point parallel to the view plane normal vector intersects the view plane. In the default case, the view plane distance is zero, and so the view reference point lies in the view plane and is the origin of the *UVW* coordinate system.

The direction of the *V* axis is determined from the ***view up vector***. The view up vector is specified in world coordinates relative to the view reference point.

The positive *U* axis of the *UVW* coordinate system is 90 degrees clockwise from the positive *V* axis, as viewed in the direction of the view plane normal vector. The positive *U* and *V* axes, together with the view plane normal vector, form a left handed coordinate system. The window is specified in terms of maximum and minimum ***u*** and ***v*** values (see the `set_window` function).

The diagram below shows the various components of the viewing system.

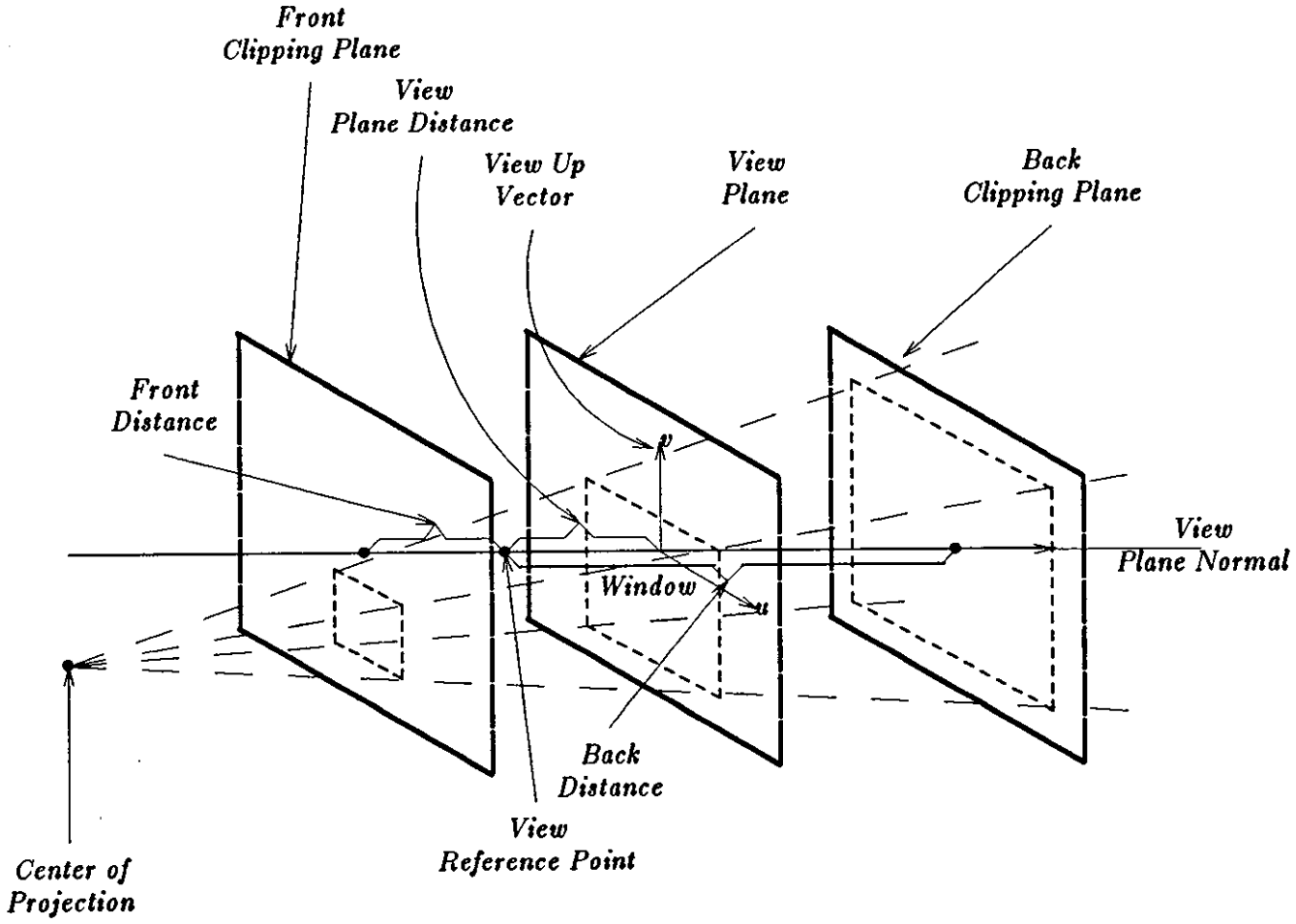

Figure 3-1: Components of Viewing System

3.2. Default Values of Viewing Operation Parameters

Table 3-1: Default Values of Viewing Operation Parameters

Viewing Operation Parameters	
Parameter	***Default Value***
View Reference Point	(0, 0, 0)
View Plane Normal	(0, 0, −1)
View Distance	0
Front Distance	0
Back Distance	1
Type of Projection	***Parallel*** (0, 0, 1) (perpendicular to the UV plane)
Window	(0, 1, 0, 0.75)
View Up Vector	(0, 1, 0)
Normalized Device Coordinate Space	$0.0 \leq x, z \leq 1.0$ $0.0 \leq y \leq 0.75$
Viewport	(0.0, 1.0, 0.0, 0.75, 0.0, 1.0)

Table 3-2: Default Values of Viewing Control Parameters

Viewing Control Parameters	
Parameter	***Default Value***
Window Clipping	*On*
Output Clipping	*Off*
Front Plane Clipping	*Off*
Back Plane Clipping	*Off*
World Coordinate System	***Right handed***

Table 3-3: World Coordinate Matrix Parameters

World Coordinate Matrix Parameters (Modelling Transform)		
Parameter	*Default Value*	
World Coordinate Matrix	1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1	(identity)

Table 3-4: Image Transformation Parameters

Image Transformation Parameters	
Parameter	*Default Value*
SX, SY, SZ	1, 1, 1 (no scaling)
AX, AY, AZ	0, 0, 0 (no rotation)
TX, TY, TZ	0, 0, 0 (no translation)

3.3. Setting 3D Viewing Operation Parameters

SunCore provides a number of functions for setting parameters of the viewing operations. There are a number of separate calls available for setting individual parameters, then there is a composite `set_viewing_parameters` function which sets all the viewing parameters in one fell swoop. The individual calls provided are summarized here and described in detail in the subsections following.

Table 3-5: Summary of Functions for Setting Viewing Control Parameters

Function	*Description*
`set_view_reference_point`	Sets the view reference point in world coordinates.
`set_view_plane_normal`	Defines a vector which determines the view plane, relative to the view reference point.
`set_view_plane_distance`	Defines the view plane distance from the view reference point along the view plane normal vector.
`set_view_depth`	Defines the distance from the view reference point to the 'front' clipping plane (also known as the 'hither' or 'near' clipping plane) and the distance from the view reference point to the 'back' clipping plane (also known as the 'yon' or 'far' clipping plane).
`set_projection`	Selects perspective or parallel projection, and defines the center of projection (for PERSPECTIVE projection) or direction of projection (for PARALLEL projection).
`set_view_up_2, set_view_up_3`	Establish the view up direction in the view plane for two or three-dimensional viewing.
`set_window`	Establishes the window boundaries in the view plane.
`set_viewport_2, set_viewport_3`	Establish the viewport boundaries in normalized device coordinates for two or three-dimensional viewing.
`set_ndc_space_2, set_ndc_space_3`	Establish the size of Normalized Device Coordinate space for two or three-dimensional viewing.
`set_viewing_parameters`	is a composite function which does all of the above functions at one time.

None of the above calls have any effect until the next call upon the `create_retained_segment` or `create_temporary_segment` functions.

3.3.1. `set_view_reference_point` — *Establish Reference Point for Viewing*

`set_view_reference_point` sets the view reference point in world coordinates.

```
set_view_reference_point(x, y, z)
    float  x, y, z;      /*  x, y, and z coordinates  */
```

x, *y*, and *z* are the coordinates of the view reference point. In the absence of a specified reference point, the default view reference point is (0, 0, 0). The new reference point does not take effect until a new segment is created.

3.3.2. `set_view_plane_normal` — *Establish View Plane Normal Vector*

`set_view_plane_normal` defines a vector relative to the view reference point, in world coordinates.

```
set_view_plane_normal(dx_norm, dy_norm, dz_norm)
    float  dx_norm, dy_norm, dz_norm;
```

The view plane is perpendicular to the view plane normal vector. In the absence of any information to the contrary, **SunCore** establishes the view plane normal vector as (0, 0, −1). The new vector does not take effect until a new segment is created.

Errors returned from `set_view_plane_normal`:

- No view plane normal direction can be established because ***dx_norm***, ***dy_norm***, and ***dz_norm*** are all zero.

3.3.3. `set_view_plane_distance` — *Establish View Plane Distance*

`set_view_plane_distance` establishes the view plane distance.

```
set_view_plane_distance(distance)
    float  distance;
```

`set_view_plane_distance` establishes the view, or projection, plane. The view plane is perpendicular to the view plane normal vector, and is ***distance*** from the view reference point along the view plane normal vector. Distances are measured in world coordinate units from the view reference point. Positive values of ***distance*** correspond to the direction of the view plane normal vector, and negative values correspond to the opposite direction. In the absence of any information to the contrary, ***distance*** is set to zero, which means that the viewing plane is located at the view reference point.

3.3.4. `set_projection` — *Select Projection Type*

`set_projection` selects the projection system for displaying.

```
set_projection(projection, dx_proj, dy_proj, dz_proj)
    int  projection;  /*  Projection type  */
                      /*  PARALLEL;  PERSPECTIVE  */
    float  dx_proj, dy_proj, dz_proj;
                      /*  x, y, and z Deltas of Projection Point  */
```

The arguments ***dx_proj***, ***dy_proj***, and ***dz_proj*** specify a world coordinate point relative to the view reference point. If projection is PARALLEL, objects project onto the view plane along lines parallel to the vector specified by ***dx_proj***, ***dy_proj***, and ***dz_proj***. If projection is PERSPECTIVE, (***dx_proj***, ***dy_proj***, ***dz_proj***) specify a point in world coordinates called the center of projection (often abbreviated to COP). Objects project onto the view plane along lines travelling towards this point. Thus the center of projection is the apex of a pyramid whose edges pass through the four corners of the view window.

Errors returned from `set_projection`:

- The direction of projection cannot be established because ***dx***, ***dy***, and ***dz*** are all zero. Note that this error is only applicable if parallel projection was selected.

3.3.5. `set_view_up_2` — *Establish 2D View Up Vector*

`set_view_up_2` establishes a view up vector in two dimensions. This vector defines the direction of 'up' for the window in world coordinates.

```
set_view_up_2(dx, dy)
    float  dx, dy;      /*  dx and dy coordinates  */
```

Errors returned from `set_view_up_2`:

- The view up vector cannot be established because ***dx***, and ***dy*** are both zero.

3.3.6. `set_view_up_3` — *Establish 3D View Up Vector*

`set_view_up_3` establishes a view up vector in three dimensions.

```
set_view_up_3(dx_up, dy_up, dz_up)
    float  dx_up, dy_up, dz_up;
                /*  x, y, and z Deltas of View Up Vector  */
```

The three arguments ***dx_up***, ***dy_up***, and ***dz_up*** establish a view up vector relative to the view reference point. The view up vector, when projected onto the view plane in the direction of the view plane normal vector, specifies the positive V-axis of the UVW coordinate system in the view plane. The U-axis is also in the view plane, such that the U-axis, the V-axis, and the view plane normal vector form a left handed coordinate system. The V-axis is vertical and the U-axis increases to the right when the view plane is mapped onto the view surface.

SunCore establishes the default view up vector as (0, 1, 0), which means that the Y-axis is ***up***.

If the view plane normal vector is parallel to the Y-axis, this does not work and so **SunCore** checks the view transforms for validity when creating a segment. **SunCore** may generate the error message:

```
`The current viewing specification is inconsistent'
```

Errors returned from `set_view_up_3`:

- No view plane normal direction can be established because ***dx_up***, ***dy_up***, and ***dz_up*** are all zero.

3.3.7. `set_ndc_space_2` — *Establish Size of NDC Space*

`set_ndc_space_2` defines the size of the Normalized Device Coordinate space which can be addressed on the view surface of all display devices available to the applications program and within which viewports may be established.

```
set_ndc_space_2(width, height)
    float  width, height;
```

Both ***width*** and ***height*** must be in the range of 0.0 to 1.0, and at least one of the parameters must have a value of 1.0. Normalized Device Coordinates range from 0.0 to ***width*** in the horizontal direction and from 0.0 to ***height*** in the vertical direction. The rectangle defined by this function is mapped to the viewable area of any display device available to the application program so that the entire rectangle is visible. Only uniform scaling of the rectangle is allowed; no changes can be made to the viewport aspect ratio. **SunCore** maximizes the usable area of the dislay and centers NDC space on each view surface.

The default Normalized Device Coordinate specification is ***width***=1.0 and ***height***=0.75. Either of the `set_ndc_space_2` or `set_ndc_space_3` (see below) functions may be used at most once per initialization of **SunCore**, and the Normalized Device Coordinate space established applies to all view surfaces which the application program might use.

Ten **SunCore** functions require that Normalized Device Coordinate space be established before they complete execution. If Normalized Device Coordinate space has not been explicitly defined before any of these functions are executed, they implicitly define the Normalized Device Coordinate space using default values. Functions which implicitly define Normalized Device Coordinate space are:

- `initialize_device`
- `initialize_group`

- `create_retained_segment`
- `create_temporary_segment`

- `set_viewport_2`
- `set_viewport_3`
- `set_viewing_parameters`

- `inquire_viewport_2`
- `inquire_viewport_3`
- `inquire_viewing_parameters`

The ***depth*** of Normalized Device Coordinate space is set to 0.0 if `set_ndc_space_2` is used in a three-dimensional implementation.

Errors returned from `set_ndc_space_2`:

- `set_ndc_space_2` or `set_ndc_space_3` has already been called since the system was initialized.
- `set_ndc_space_2` or `set_ndc_space_3` has been called too late — the default values have already been defined implicitly.
- A parameter is outside the range 0.0 to 1.0.
- One of ***width*** or ***height*** must have a value of 1.0.
- ***width*** or ***height*** has a value of 0.0.

3.3.8. `set_ndc_space_3` — *Establish Size of NDC Space*

`set_ndc_space_3` defines the size of the Normalized Device Coordinate space which can be addressed on the view surface of all display devices available to the applications program and within which viewports may be established. Three-dimensional Normalized Device Coordinate space is a rectangular parallelepiped lying within the Normalized Device Coordinate system. This coordinate system is always left-handed, with the *x*-axis increasing to the right, the *y*-axis increasing upwards, and the *z*-axis increasing away from the viewer.

```
set_ndc_space_3(width, height, depth)
    float  width, height, depth;
```

All of the parameters ***width***, ***height***, and ***depth*** must be in the range of 0.0 to 1.0, and at least one of ***width*** or ***height*** must have a value of 1.0. Normalized Device Coordinates range from 0.0 to ***width*** in the horizontal direction, from 0.0 to ***height*** in the vertical direction, and from 0.0 to ***depth*** in the direction away from the viewer. The rectangle of size ***width*** by ***height*** in the z=0 plane of Normalized Device Coordinate space is mapped to the viewable area of any display device available to the application program so that the entire rectangle is visible. Only uniform scaling of the rectangle is allowed — no changes can be made to the viewport aspect ratio. **SunCore** maximizes the usable area of the display and centers NDC space on each view surface.

The default Normalized Device Coordinate specification is ***width***=1.0, ***height***=0.75, and ***depth***=1.0. Either of the `set_ndc_space_3` or `set_ndc_space_2` (see above) functions may be used at most once per initialization of **SunCore**, and the Normalized Device Coordinate space established applies to all view surfaces which the application program might use.

Ten **SunCore** functions require that Normalized Device Coordinate space be established before they complete execution. If Normalized Device Coordinate space has not been explicitly defined before any of these functions are executed, they implicitly define the Normalized Device Coordinate space using default values. Functions which implicitly define Normalized Device Coordinate space are:

- `initialize_device`
- `initialize_group`

- `create_retained_segment`
- `create_temporary_segment`

- `set_viewport_2`
- `set_viewport_3`
- `set_viewing_parameters`

- `inquire_viewport_2`
- `inquire_viewport_3`
- `inquire_viewing_parameters`

Errors returned from `set_ndc_space_3`:

- `set_ndc_space_2` or `set_ndc_space_3` has already been called since the system was initialized.
- `set_ndc_space_2` or `set_ndc_space_3` has been called too late — the default values have already been defined implicitly.

- A parameter is outside the range 0.0 to 1.0.
- One of ***width*** or ***height*** must have a value of 1.0.
- ***width*** or ***height*** has a value of 0.0.

3.3.9. `set_window` — *Establish a Window in the View Plane*

`set_window` establishes a window, defined by four coordinates in the UV coordinate system, in the view plane.

```
set_window(umin, umax, vmin, vmax)
    float  umin, umax;      /*  Left and Right sides of window  */
    float  vmin, vmax;      /*  Bottom and Top of window  */
```

SunCore establishes the default window as (0.0, 1.0, 0.0, 0.75).

Errors returned from `set_window`:

- ***umin*** is greater than or equal to ***umax***, which means that the left side of the window is congruent with or to the right of the right side of the window.
- ***vmin*** is greater than or equal to ***vmax***, which means that the top of the window is congruent with or below the bottom of the window.

3.3.10. `set_view_depth` — *Specify Planes for Depth Clipping*

`set_view_depth` defines the front and back planes for depth clipping.

```
set_view_depth(front_distance, back_distance)
    float  front_distance, back_distance;
                            /*  Distances to Front and Back Planes  */
```

Clipping to these depth bounds is controlled by `set_front_plane_clipping` and `set_back_plane_clipping`. The front and back planes determine the 3-D view volume which is mapped to the 3-D viewport.

SunCore initializes the front distance to 0.0 and the back distance to 1.0.

Errors returned from `set_view_depth`:

- ***front_distance*** is greater than ***back_distance***, so that the back clipping plane is in front of the front clipping plane.

3.3.11. `set_viewport_2` — *Establish Limits of Two-Dimensional Viewport*

`set_viewport_2` establishes the limits of the viewport in two-dimensional normalized device coordinate space. The limits must lie in the range: $0 \leq x \leq NDCwidth$ and $0 \leq y < NDCheight$

```
set_viewport_2(xmin, xmax, ymin, ymax)
    float  xmin, xmax;      /*  Left and Right sides of Viewport  */
    float  ymin, ymax;      /*  Bottom and Top of Viewport  */
```

SunCore establishes the viewport to (0.0, 1.0, 0.0, 0.75) at initialization time.

Errors returned from `set_viewport_2`:

- ***xmin*** is greater than or equal to ***xmax***, which means that the left side of the viewport is congruent with or to the right of the right side of the viewport.
- ***ymin*** is greater than or equal to ***ymax***, which means that the top of the viewport is congruent with or below the bottom of the viewport.
- Viewport exceeds Normalized Deviced Coordinate space.

3.3.12. `set_viewport_3` — *Establish Limits of Three-Dimensional Viewport*

`set_viewport_3` establishes the limits of the viewport in three-dimensional normalized device coordinate space. The limits must lie in the range: $0 \leq x \leq NDCwidth, 0 \leq y < NDCheight$, and $0 \leq z < NDCdepth$

```
set_viewport_3(xmin, xmax, ymin, ymax, zmin, zmax)
    float  xmin, xmax;     /*  Left and Right sides of Viewport  */
    float  ymin, ymax;     /*  Bottom and Top of Viewport  */
    float  zmin, zmax;     /*  Front and Back of Viewport  */
```

SunCore establishes the viewport to (0.0, 1.0, 0.0, 0.75, 0.0, 1.0) at initialization time.

Errors returned from `set_viewport_3`:

- ***xmin*** is greater than or equal to ***xmax***, which means that the left side of the viewport is congruent with or to the right of the right side of the viewport.
- ***ymin*** is greater than or equal to ***ymax***, which means that the top of the viewport is congruent with or below the bottom of the viewport.
- ***zmin*** is greater than or equal to ***zmax***, which means that the front of the viewport is congruent with or behind the back of the viewport.
- Viewport exceeds Normalized Deviced Coordinate space.

3.3.13. `set_viewing_parameters`

`set_viewing_parameters` specifies all the viewing parameters with a single function call.

```
set_viewing_parameters(view_parameters)
    struct  {
        float  vwrefpt[3];  /*  x, y, z                                  */
        float  vwplnorm[3]; /*  dx, dy, dz                               */
        float  viewdis;     /*  View Reference Point to View Plane       */
        float  frontdis;    /*  View Reference Point to Front Clip Plane */
        float  backdis;     /*  View Reference Point to Back Clip Plane  */
        int  projtype;      /*  PARALLEL or PERSPECTIVE  */
        float  projdir[3];  /*  Meaning depends on projection type       */
        float  window[4];   /*  umin, umax, vmin, vmax                   */
        float  vwupdir[3];  /*  dx, dy, dz                               */
        float  viewport[6]; /*  xmin, xmax, ymin, ymax, zmin, zmax       */
    } *view_parameters;
```

The *view_parameters* argument is a pointer to a structure as defined above. `set_viewing_parameters` fills in the associated structure with the current values of the viewing parameters. The parameters are:

vwrefpt An array of three `floats` describing the coordinates of the view reference point.

vwplnorm An array of three `floats` describing the direction of the view plane normal vector.

viewdis A float describing the distance of the view plane from the view reference point.

frontdis A float describing the front clipping distance.

backdis A float describing the back clipping distance.

projtype A `int` describing the projection type.

projdir An array of three `floats` describing the direction of projection. The meaning of *projdir* is dependent on the projection type:

PARALLEL *projdir* specifies the direction of projection.

PERSPECTIVE
projdir specifies the center of projection.

window An array of four `floats` describing the boundaries of the viewing window.

vwupdir An array of three `floats` describing the view up direction.

viewport An array of six `floats` describing the boundaries of the viewport.

3.4. Viewing Control

3.4.1. `set_window_clipping` — *Enable Clipping in the View Plane*

`set_window_clipping` enables or disables clipping against the window in the view plane.

```
set_window_clipping(on_off)
    int  on_off;      /*  TRUE = turn clipping on  */
                      /*  FALSE = turn clipping off  */
```

The *on_off* argument specifies whether window clipping is enabled or not. A value of FALSE *disables* window clipping, whereas a value of TRUE *enables* window clipping.

When window clipping is *off*, objects described to **SunCore** are not checked to insure that they lie within the window when projected onto the view plane. When window clipping is *on*, objects described to **SunCore** are clipped to the window.

SunCore initializes window clipping to TRUE.

Note that window clipping is done before segment primitives are written to the pseudo display file. This means that subsequent image transformations may extend images beyond the bounds of the viewport. **SunCore** has optional output clipping (an extension to the ACM Core specification) to correct for this. See the `set_output_clipping` function described below.

3.4.2. `set_front_plane_clipping` — *Enable Depth Clipping*

`set_front_plane_clipping` enables or disables clipping against the front clipping plane.

```
set_front_plane_clipping(front_on_off)
    int  front_on_off;
```

The *front_on_off* argument specifies clipping enabled or disabled for the front clipping plane. A value of FALSE means *disable* the clipping, and a value of TRUE *enables* the clipping. Clipping is disabled by default.

3.4.3. `set_back_plane_clipping` — *Enable Depth Clipping*

`set_back_plane_clipping` enables or disables clipping against the back clipping plane.

```
set_back_plane_clipping(back_on_off)
    int  back_on_off;
```

The *back_on_off* argument specifies clipping enabled or disabled for the back clipping plane. A value of FALSE means *disable* the clipping, and a value of TRUE *enables* the clipping. Clipping is disabled by default.

3.4.4. `set_output_clipping` *(SunCore extension)*

SunCore supports output clipping, which is done after image transformations on segments, as an option in addition to window clipping. The `set_output_clipping` function enables or disables output clipping.

```
set_output_clipping(on_off)
    int  on_off;      /*  TRUE = turn on clipping  */
                      /*  FALSE = turn off clipping  */
```

If output clipping is enabled, it places a clipping process after the image transformation specified by the dynamic segment attribute. This ensures that everything is correctly clipped to the viewport.

3.4.5. set_coordinate_system_type

set_coordinate_system_type selects a left-handed or right-handed world coordinate system.

```
set_coordinate_system_type(type)
    int  type;      /*  RIGHT = right handed coordinates  */
                    /*  LEFT = left handed coordinates  */
```

3.4.6. set_world_coordinate_matrix_2 — *Specify World or Modelling Transform*

set_world_coordinate_matrix_2 specifies a 3 X 3 matrix containing the 'world transform' or modelling transform. This matrix is concatenated with the 'viewing transform' to give the 'composite viewing transform'. The composite viewing transform is the transform that is actually used for all **SunCore** viewing transform operations. The default world coordinate matrix is the identity matrix. Currently, this function does not modify column 2 of the matrix. This function may be called at any time, even in the midst of putting output primitives into a segment.

```
set_world_coordinate_matrix_2(array)
    float  array[3][3];          /*  [row] [column]  */
```

Note that the matrix order is such that:

$$xnew = x*array_{0,0} + y*array_{1,0} + array_{2,0}$$

$$ynew = x*array_{0,1} + y*array_{1,1} + array_{2,1}$$

3.4.7. set_world_coordinate_matrix_3 — *Specify World or Modelling Transform*

set_world_coordinate_matrix_3 specifies a 4 X 4 matrix containing the 'world transform' or modelling transform. This matrix is concatenated with the 'viewing transform' to give the 'composite viewing transform'. The composite viewing transform is the transform that is actually used for all **SunCore** viewing transform operations. The default world coordinate matrix is the identity matrix. Currently, this function does not modify column 3 of the matrix. This function may be called at any time, even in the midst of putting output primitives into a segment.

```
set_world_coordinate_matrix_3(array)
    float  array[4][4];          /*  [row] [column]  */
```

Note that the matrix order is such that:

$$xnew = x*array_{0,0} + y*array_{1,0} + z*array_{2,0} + array_{3,0}$$

$$ynew = x*array_{0,1} + y*array_{1,1} + z*array_{2,1} + array_{3,1}$$

$$znew = x*array_{0,2} + y*array_{1,2} + z*array_{2,2} + array_{3,2}$$

3.4.8. map_ndc_to_world_2 — *Convert NDC to World Coordinates*

map_ndc_to_world_2 maps a point in normalized device coordinate (NDC) space to its world coordinates.

```
map_ndc_to_world_2(ndcx, ndcy, wldx, wldy)
    float  ndcx, ndcy;
    float  *wldx, *wldy;
```

3.4.9. map_ndc_to_world_3 — *Convert NDC to World Coordinates*

map_ndc_to_world_3 maps a point in normalized device coordinate (NDC) space to its world coordinates.

```
map_ndc_to_world_3(ndcx, ndcy, ndcz, wldx, wldy, wldz)
    float  ndcx, ndcy, ndcz;
    float  *wldx, *wldy, *wldz;
```

3.4.10. map_world_to_ndc_2 — *Convert World to NDC Coordinates*

map_world_to_ndc_2 maps a point in world coordinates to its normalized device coordinates (NDC).

```
map_world_to_ndc_2(wldx, wldy, ndcx, ndcy)
    float  wldx, wldy;
    float  *ndcx, *ndcy;
```

3.4.11. map_world_to_ndc_3 — *Convert World to NDC Coordinates*

map_world_to_ndc_3 maps a point in world coordinates to its normalized device coordinates (NDC).

```
map_world_to_ndc_3(wldx, wldy, wldz, ndcx, ndcy, ndcz)
    float  wldx, wldy, wldz;
    float  *ndcx, *ndcy, *ndcz;
```

3.5. Inquiring Viewing Characteristics

SunCore provides a number of functions for inquiring about parameters of the viewing operations. There are a number of separate calls available for inquiring about individual parameters, then there is a composite **inquire_viewing_parameters** function which obtains all the viewing parameters in one fell swoop. The individual calls provided are summarized here and

described in detail in the subsections following.

Table 3-6: Summary of Functions for Inquiring Viewing Parameters

Function	*Description*
`inquire_view_reference_point`	Obtains the view reference point in world coordinates.
`inquire_view_plane_normal`	Obtains a vector which determines the view plane, relative to the view reference point.
`inquire_view_plane_distance`	Obtains the distance from the view reference point to the view plane.
`inquire_view_depth`	Obtains the distance from the view reference point to the 'front' clipping plane (also known as the 'hither' or 'near' clipping plane), and the distance from the view reference point to the 'back' clipping plane (also known as the 'yon' or 'far' clipping plane).
`inquire_projection`	Determines which projection type is in use, and returns either the center of projection (for PERSPECTIVE projection) or direction of projection (for PARALLEL projection).
`inquire_view_up_2`	Determines the view up direction in two dimensions.
`inquire_view_up_3`	Determines the view up direction in three dimensions.
`inquire_viewport_2`	Obtains the coordinates of the two-dimensional viewport.
`inquire_viewport_3`	Obtains the coordinates of the three-dimensional viewport.
`inquire_window`	Obtain the boundaries of the viewing window.
`inquire_viewing_parameters`	is a composite function which does all of the above functions at one time.
`inquire_ndc_space_2`	Determine the size of the normalized device coordinate space in two dimensions.
`inquire_ndc_space_3`	Determine the size of the normalized device coordinate space in three dimensions.

3.5.1. `inquire_view_reference_point`

`inquire_view_reference_point` obtains the coordinates of the view reference point.

```
inquire_view_reference_point(x, y, z)
    float  *x, *y, *z;      /*  x, y, and z Coordinates  */
```

3.5.2. `inquire_view_plane_normal`

`inquire_view_plane_normal` obtains the coordinates of the view plane normal vector.

```
inquire_view_plane_normal(dx, dy, dz)
    float  *dx, *dy, *dz;      /*  x, y, and z deltas  */
```

3.5.3. inquire_view_plane_distance

inquire_view_plane_distance obtains the distance of the view plane from the view reference point.

```
inquire_view_plane_distance(view_distance)
    float  *view_distance;
```

3.5.4. inquire_view_depth

inquire_view_depth obtains the distances of the front and back clipping planes from the view reference point.

```
inquire_view_depth(front_distance, back_distance)
    float  *front_distance, *back_distance;
```

3.5.5. inquire_projection

inquire_projection obtains the current projection type and the coordinates of the center of projection (for PERSPECTIVE projections) or the direction of projection (for PARALLEL projections).

```
inquire_projection(projection_type, dx, dy, dz)
    int    *projection_type;
    float  *dx, *dy, *dz;      /*  x, y, and z deltas  */
```

3.5.6. inquire_view_up_2

inquire_view_up_2 obtains the view up direction in two dimensions.

```
inquire_view_up_2(dx, dy)
    float  *dx, *dy;      /*  x and y directions  */
```

3.5.7. inquire_view_up_3

inquire_view_up_3 obtains the view up direction in three dimensions.

```
inquire_view_up_3(dx, dy, dz)
    float  *dx, *dy, *dz;      /*  x, y, and z directions  */
```

3.5.8. inquire_ndc_space_2

inquire_ndc_space_2 obtains the dimensions of the Normalized Device Coordinate space in two dimensions.

```
inquire_ndc_space_2(width, height)
    float  *width, *height;
```

3.5.9. inquire_ndc_space_3

inquire_ndc_space_3 obtains the dimensions of the Normalized Device Coordinate space in three dimensions.

```
inquire_ndc_space_3(width, height, depth)
    float  *width, *height, *depth;
```

3.5.10. inquire_viewport_2

inquire_viewport_2 obtains the coordinates of the two-dimensional viewport.

```
inquire_viewport_2(xmin, xmax, ymin, ymax)
    float  *xmin, *xmax;
    float  *ymin, *ymax;
```

3.5.11. inquire_viewport_3

inquire_viewport_3 obtains the coordinates of the three-dimensional viewport.

```
inquire_viewport_3(xmin, xmax, ymin, ymax, zmin, zmax)
    float  *xmin, *xmax;
    float  *ymin, *ymax;
    float  *zmin, *zmax;
```

3.5.12. inquire_window

inquire_window obtains the boundaries of the viewing window.

```
inquire_window(umin, umax, vmin, vmax)
    float  *umin, *umax;
    float  *vmin, *vmax;
```

3.5.13. inquire_viewing_parameters

`inquire_viewing_parameters` returns a collection of information pertaining to the current parameters of the viewing system.

```
inquire_viewing_parameters(view_parameters)
    struct  {
        float  vwrefpt[3];  /*  x, y, z  */
        float  vwplnorm[3];  /*  dx, dy, dz  */
        float  viewdis;    /*  View Reference Point to View Plane */
        float  frontdis;    /*  View Reference Point to Front Clip Plane */
        float  backdis;    /*  View Reference Point to Back Clip Plane */
        int  projtype;    /*  PARALLEL or PERSPECTIVE */
        float  projdir[3];  /*  Meaning depends on projection type */
        float  window[4];  /*  umin, umax, vmin, vmax  */
        float  vwupdir[3];  /*  dx, dy, dz  */
        float  viewport[6];  /*  xmin, xmax, ymin, ymax, zmin, zmax  */
    } *view_parameters;
```

The *view_parameters* argument is a pointer to a structure as defined above. `inquire_viewing_parameters` fills in the associated structure with the current values of the viewing parameters. The parameters are:

vwrefpt An array of three `floats` describing the coordinates of the view reference point.

vwplnorm An array of three `floats` describing the direction of the view plane normal vector.

viewdis A `float` describing the distance of the view plane from the view reference point.

frontdis A `float` describing the front clipping distance.

backdis A `float` describing the back clipping distance.

projtype A `int` describing the projection type.

projdir An array of three `floats` describing the direction of projection. The meaning of *projdir* is dependent on the projection type:

PARALLEL
projdir specifies the direction of projection.

PERSPECTIVE
projdir specifies the center of projection.

window An array of four `floats` describing the boundaries of the viewing window.

vwupdir An array of three `floats` describing the view up direction.

viewport An array of six `floats` describing the boundaries of the viewport.

3.5.14. inquire_world_coordinate_matrix_2

`inquire_world_coordinate_matrix_2` returns a 3 by 3 matrix containing the 'world transform' or modelling transform. This matrix is concatenated with the 'viewing transform' to give the 'composite viewing transform'. The composite viewing transform is the transform that is actually used for all **SunCore** viewing transform operations. The default world coordinate matrix is the identity matrix.

```
inquire_world_coordinate_matrix_2(array)
    float  array[3][3];     /*  array[row][col]  */
```

3.5.15. inquire_world_coordinate_matrix_3

`inquire_world_coordinate_matrix_3` returns a 4 by 4 matrix containing the 'world transform' or modelling transform. This matrix is concatenated with the 'viewing transform' to give the 'composite viewing transform'. The composite viewing transform is the transform that is actually used for all **SunCore** viewing transform operations. The default world coordinate matrix is the identity matrix.

```
inquire_world_coordinate_matrix_3(array)
    float  array[4][4];     /*  array[row][col]  */
```

3.5.16. inquire_inverse_composite_matrix *(SunCore Extension)*

SunCore uses the matrix inverse of the composite viewing transform internally for operations such as ***map_ndc_to_world.*** This matrix may at times be useful to the applications program.

```
inquire_inverse_composite_matrix(array)
    float  array[4][4];     /*  array[row][col]  */
```

3.5.17. inquire_viewing_control_parameters

`inquire_viewing_control_parameters` obtains the enabled status of clipping, and the type of world coordinates in use.

```
inquire_viewing_control_parameters(windowclip, frontclip, backclip, type)
    int  *windowclip;     /*  TRUE if window clipping enabled  */
    int  *frontclip;      /*  TRUE if front plane clipping enabled  */
    int  *backclip;       /*  TRUE if back plane clipping enabled  */
    int  *type;      /*  RIGHT or LEFT world coordinate system type */
```

Chapter 4

Segmentation and Naming

All output primitives for a graphical object are placed in a ***segment*** by **SunCore** on request from the application program. Each segment defines an ***image*** which is a view of the object and which is part of the picture displayed on the view surface. An application program describes an object by creating a segment, calling output primitive functions (the results of which are placed in the segment), and then closing the segment.

There are two kinds of segments, namely: ***temporary*** segments and ***retained*** segments. Retained segments have an `image_transformation_type` which specifies how they can be transformed. Retained segments can be made visible or invisible, detectable (via the ***pick*** input function) or undetectable, highlighted, and may be transformed, depending on their type.

Retained segments have names (actually numeric identifiers) so that by placing output primitives in such segments, the application programmer can selectively modify parts of the picture by deleting and recreating segments (which effectively replaces them) so that their images change. Retained segments are stored in the display list for later dynamic modification.

Temporary segments are not saved in the display list, are only drawn once, and may not be modified dynamically. A `new_frame` action deletes all portions of any temporary segments which have already been drawn.

4.1. Retained Segment Attributes

In the same way that primitive attributes affect the output primitives, ***retained segment dynamic attributes*** affect the characteristics of retained segments. From now on, the term ***dynamic attributes*** means the dynamic attributes of retained segments.

As well as being identified by the name of the retained segment into which they have been placed, output primitives may also be assigned a primitive attribute known as a ***pick identifier*** or ***pick-id***. This means that within the single level of segmentation, another level of naming is provided. An example of the use of pick-id might be that all the character strings for (say) a menu could appear in a single segment, where each character string is assigned a different pick-id. Then when the user is using the mouse to select a specific item from the menu, the application program uses the PICK input function to find out which menu item was selected.

Retained segments have one ***static*** attribute and four ***dynamic*** attributes. Attributes, and the means of setting them and enquiring their values, are described in detail in chapter 6.

The only ***static*** attribute of retained segments is the `image_transformation_type`. This attribute can have one of five values:

None
The segment is a retained segment on which no transformations may be applied.

Translatable 2-D
The segment is a retained segment which may be translated in two dimensions.

Transformable 2-D
The segment is a retained segment which may be fully translated, scaled, and rotated, in two dimensions.

Translatable 3-D
The segment is a retained segment which may be translated in two or three dimensions.

Transformable 3-D
The segment is a retained segment which may be fully translated, scaled, and rotated, in two or three dimensions.

SunCore sets `image_transformation_type` to the default value of NONE at initialization time.

The four ***dynamic*** attributes of retained segments are defined here.

Visibility indicates whether the segment should have a visible image. There are only two values of this attribute, namely: TRUE and FALSE.

SunCore sets the default value of ***visibility*** to TRUE at initialization time.

Highlighting indicates whether the segment's image should be highlighted. In **SunCore**, highlighting is done by blinking. There are only two values of the ***highlighting*** attribute, namely: TRUE and FALSE. When highlighting is turned on, the segment is blinked once.

SunCore sets the default value of ***highlighting*** to FALSE at initialization time.

Detectability indicates whether the retained segment can be detected by the pick device (mouse pointing device). See the `await_pick` function. The values for the ***detectability*** attribute, are: 0 through 2,147,483,647. **SunCore** sets the default value of ***detectability*** to 0 at initialization time.

Image_transformation
indicates how the image of a retained segment, in normalized device coordinates, is scaled, rotated, or translated. A segment's static ***image_transformation_type*** attribute limits the values which its ***image_transformation*** attribute may have. See the set of functions called `set_segment_image_`***xxx*** in chapter 6.

SunCore sets the default value of `image_transformation` to the identity transformation at initialization time.

4.2. Retained Segment Operations

4.2.1. create_retained_segment — *Create a New Segment*

`create_retained_segment` creates a new, empty, open segment.

```
create_retained_segment(segment_name)
    int  segment_name;          /*  Segment Identifier  */
```

The `segment_name` argument defines a segment number in the range 1 through 2,147,483,647.

The image transformation type for the newly created segment is obtained from the current attribute value for `image_transformation_type`. The dynamic attribute values for the newly created segment are obtained from the default values of the dynamic attributes for retained segments.

Use the `set_image_transformation_type` function, before calling `create_retained_segment`, to specify whether the created segment is translatable or transformable. After calling `create_retained_segment`, the specified segment is said to be "open". This means that output primitives can now be called upon to add graphics primitives (lines, text, polygons, and so on) to this segment.

Only one segment can be open at a time.

Errors returned from `create_retained_segment`:

- The set of currently selected view surfaces is empty.
- The current viewing specification is inconsistent.
- There is already an open segment.
- A retained segment named `segment_name` already exists.
- The default value of `image_transformation` is invalid for the current `image_transformation_type`.

4.2.2. close_retained_segment — *Close a Segment*

`close_retained_segment` closes the currently open segment. Dynamic segment attributes may be changed both before and after closing the segment.

```
close_retained_segment()
```

Errors returned from `close_segment`:

- There is no open retained segment.

4.2.3. delete_retained_segment — *Delete a Retained Segment*

`delete_retained_segment` deletes a specifically named segment.

```
delete_retained_segment(segment_name)
    int  segment_name;          /*  Segment Identifier  */
```

The segment specified by the **segment_name** argument is deleted. If the segment being deleted is the currently open segment, it is closed before it is deleted. The deleted segment is erased from all view surfaces.

Errors returned from **delete_retained_segment**:

- There is no retained segment with the name **segment_name**.

4.2.4. rename_retained_segment — *Rename a Retained Segment*

rename_retained_segment changes the name of a retained segment.

```
rename_retained_segment(segment_name, newname)
    int  segment_name;          /*  Old Segment Identifier  */
    int  newname;          /*  New Segment Identifier  */
```

The segment whose identity is **segment_name** is renamed as ***newname***, and this name must be used in any future references to that segment. The segment **segment_name** is no longer accessible.

Errors from **rename_retained_segment**:

- There is no retained segment with the name **segment_name**.
- There is an existing retained segment named **new_name**.

4.2.5. delete_all_retained_segments

delete_all_retained_segments deletes all retained segments.

```
delete_all_retained_segments()
```

All retained segments are deleted. If there is a currently open retained segment, it is closed before it is deleted.

4.2.6. inquire_retained_segment_surfaces

inquire_retained_segment_surfaces obtains the number and names of the view surfaces upon which this segment gets drawn. These view surfaces were 'selected' when the segment was created.

```
inquire_retained_segment_surfaces(segment_name, array_size,
                        view_surface_array, number_of_surfaces)
    int  segment_name;        /*  Name of Segment */
    int  array_size;          /*  Size of View Surface Array */
    struct  vwsurf  view_surface_array[];     /*  Array of view surface names  */
    int  *number_of_surfaces;      /*  Returned number of surfaces */
```

The number of view surfaces selected at the time the retained segment name given by **segment_name** was created is copied into **number_of_surfaces**. The names of those surfaces are copied into **view_surface_array**, where the array is an array of view surface

names. `array_size` is specified by the caller, and is the size of `view_surface_array`. The view surface structure is defined in the ***usercore.h*** header file.

If `number_of_surfaces` is greater than ***array_size***, only `array_size` view surface names are copied into ***view_surface_array***. If `array_size` is less than or equal to zero, no names are returned.

Errors from `inquire_retained_segment_surfaces`:

- There is no retained segment with the name `segment_name`.

4.2.7. `inquire_retained_segment_names`

`inquire_retained_segment_names` obtains a list of the retained segments names.

```
inquire_retained_segment_names(array_size, name_array, number_of_segments)
    int  array_size;            /*  Size of Array  */
    int  name_array[];          /*  Segment Identifiers  */
    int  *number_of_segments;    /*  Number of Segments */
```

The `name_array` argument is an array which is to receive a list of the existing retained segments. `array_size` specifies the number of elements in `name_array`. The ***number_of_segments*** argument is returned to the caller, and is the number of existing retained segments. If the number of existing retained segments is greater than the size of the array, only `array_size` segment names are copied into the array. If `array_size` is less than or equal to zero, no segment identifiers are returned.

4.2.8. `inquire_open_retained_segment`

`inquire_open_retained_segment` obtains the name of the currently open retained segment.

```
inquire_open_retained_segment(segment_name)
    int  *segment_name;          /*  Segment Name  */
```

The name of the currently open retained segment (if there is one) is copied into the `segment_name` variable. If there is no currently open retained segment, `segment_name` is set to zero.

4.3. Temporary or Non-Retained Segments

Temporary segments are used for transient images. Temporary segments cannot be modified dynamically, and all portions of temporary segments which have already been drawn are deleted upon any new frame action. Primitives placed in temporary segments are not stored in the display list.

4.3.1. create_temporary_segment

create_temporary_segment creates a new, empty, nonretained or temporary, segment.

```
create_temporary_segment()
```

4.3.2. close_temporary_segment

close_temporary_segment closes the currently open temporary segment.

```
close_temporary_segment()
```

4.3.3. inquire_open_temporary_segment — *Get Temporary Segment Status*

inquire_open_temporary_segment determines whether there is a currently open temporary segment.

```
inquire_open_temporary_segment(open)
    int  *open;     /*  Receives status of temporary segment  */
```

The *open* argument receives the status of whether there is a currently open temporary segment:

FALSE There is no currently open temporary segment.

TRUE There is a currently open temporary segment.

4.4. Saving and Restoring Segments on Disk (SunCore Extension)

The two functions described in this section provide for saving segments on disk files and restoring segments from disk files. Only one segment is saved in a given file.

4.4.1. save_segment — *Save Segment on Disk File (SunCore Extension)*

save_segment saves the named retained segment on a specified disk file.

```
save_segment(segment_name, filename)
    int  segment_name;      /*  Name of segment to save  */
    char  *filename;        /*  Pointer to a UNIX filename  */
```

Saved primitives are in normalized device coordinates. Dynamic segment attributes are also saved.

4.4.2. `restore_segment` — *Restore Segment from Disk File (SunCore Extension)*

`restore_segment` restores the named retained segment from a specified disk file. A new segment is created and the segment from the disk file is copied into it. The segment is then closed.

```
restore_segment(segment_name, filename)
    int  segment_name;        /*  Name of segment to create  */
    char  *filename;          /*  Pointer to a UNIX filename  */
```

Chapter 5

Output Primitives

Output Primitives serve to describe objects in the world coordinate system. When the output primitive functions are called, ***primitives*** are placed in the currently open segment via drawing commands which eventually produce line and character output.

SunCore supports six kinds of output primitives, namely ***moves***, ***lines*** and ***polylines***, ***polygons***, ***text***, ***markers*** and ***polymarkers***, and ***rasters***. The table below summarizes these types of functions:

Table 5-1: Summary of Output Primitive Functions

Primitive	*Description*
Move	primitives alter the value of the Current Position (described below).
Line	primitives describe lines in world coordinates.
Polyline	primitives describe sequences of connected lines in world coordinates.
Polygon	primitives describe a closed polygon which will be filled with a color. The polygon primitives are a **SunCore** extension to the ACM Core specification.
Text	primitives describe character strings on the display.
Marker	primitives describe markers which are written on the display in a constant orientation, independent of any transformations which may be in effect.
Polymarker	primitives describe a sequence of markers which are written on the display in a constant orientation, independent of any transformations which may be in effect.
Rasters	primitive describes an array of one-bit or eight-bit pixels.

All primitive operations use world coordinates. Some of these operations affect the value known as the *Current Position*. The Current Position defines the current drawing location in the world coordinate system. **SunCore** maintains the value of the Current Position at all times. At initialization time, the Current Position is initialized to the origin of the world coordinate system.

In both two dimensions and three dimensions, coordinate positions can be specified in terms of absolute world coordinates, or coordinates can be specified relative to the Current Position.

A segment must be open (see the `create_`***`xxxxx`***`_segment` functions) before any output primitives may be used. A segment contains a set of output primitives which can subsequently be manipulated as a unit.

An output primitive is processed as follows:

1. The primitive is transformed to clipping coordinates using the ***composite viewing transform.*** This places the window boundaries at *umin*=−32767, *umax*=+32767, *vmin*=−32767, and *vmax*=+32767. The front clipping plane is at *z*=0 and the back clipping plane is at *z*=+32767.
2. The primitive is then clipped to the boundaries just mentioned if ***window clipping*** is enabled.
3. The output primitive is then ***output scaled*** to the viewport which is specified in normalized device coordinate space.
4. The resulting primitive is then copied to the ***display list*** or ***pseudo display file*** (PDF) if the open segment is a retained segment.
5. Next, the primitive is transformed using the ***image transform*** which is an attribute of retained translatable or retained transformable segments.
6. The output primitive is then clipped again to the viewport boundaries if ***output clipping*** is enabled.
7. For each view surface which was selected when the segment was created, the primitive is then converted to physical device coordinates and drawn on the view surface.

If a change is made to certain dynamic segment attributes of a retained segment, the primitives in that segment are recovered from the PDF and used to erase the segment (if necessary) and redraw the segment following steps 5 through 7 above. The diagram below shows the above process in a graphical form.

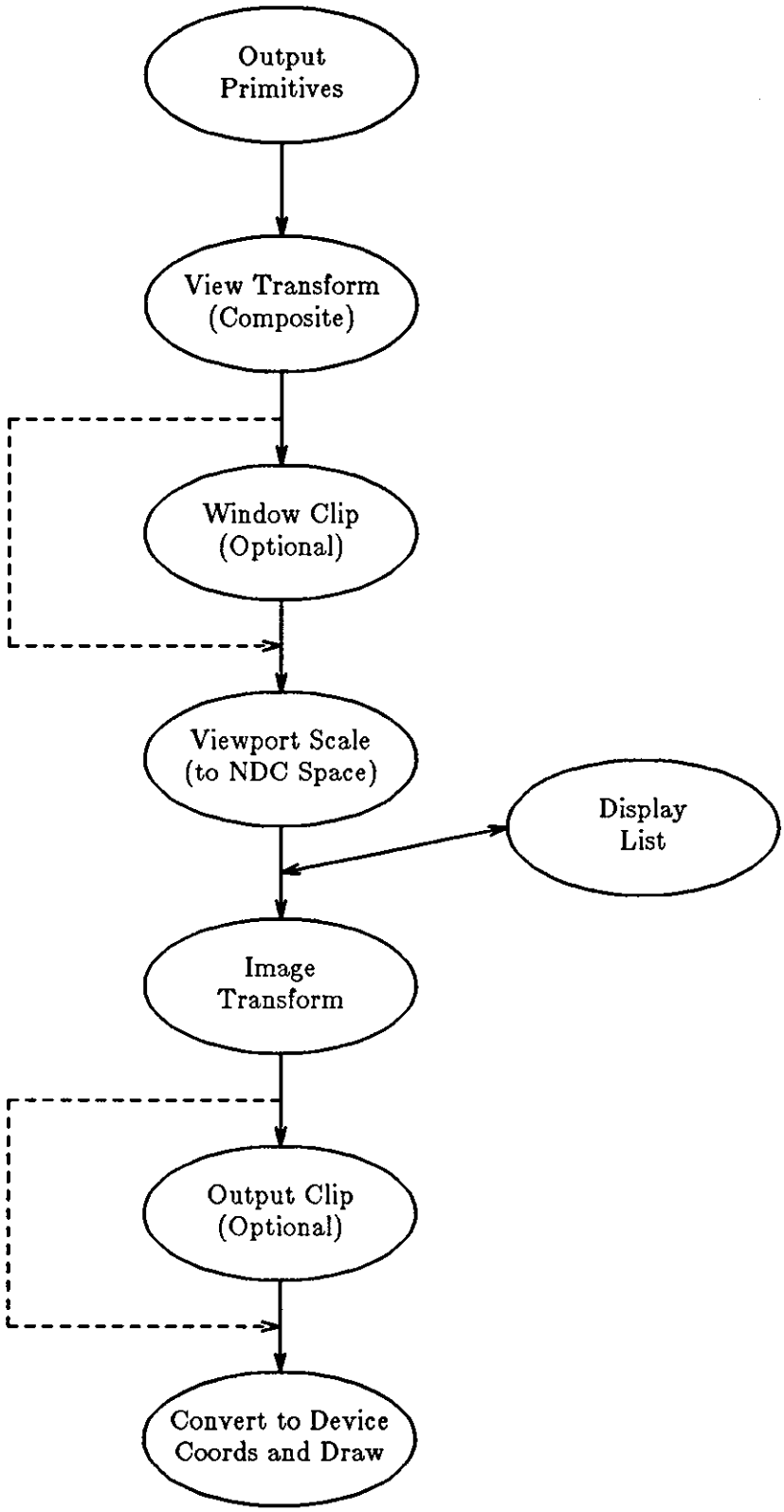

Figure 5-1: Flow Diagram of Output Primitive Processing

Output primitives are drawn with the static primitive attributes set by the primitive attribute functions (see chapter 6).

5.1. Moving the Current Position

There are four functions for moving the Current Position. `move_abs_2` and `move_abs_3` change the Current Position to an absolute position in world coordinates, whereas `move_rel_2` and `move_rel_3` change the Current Position by a delta relative to the Current Position.

Note that `move_abs_2` and `move_rel_2` are simply short forms of the corresponding three-dimensional functions. The *z* coordinate of `move_abs_2` is the *z* coordinate of the Current Position. The *z* delta of `move_rel_2` is taken as zero.

5.1.1. `move_abs_2` — *Move to Absolute 2D Position*

`move_abs_2` moves the Current Position to an absolute position.

```
move_abs_2(x, y)
    float  x, y;          /*  x and y coordinates to move to  */
```

The Current Position is set to the values of ***x*** and ***y*** in two-dimensional world coordinates. `move_abs_2` only sets the Current Position; no drawing commands are output.

5.1.2. `move_abs_3` — *Move to Absolute 3D Position*

`move_abs_3` moves the Current Position to an absolute position.

```
move_abs_3(x, y, z)
    float  x, y, z;          /*  x, y, and z coordinates to move to  */
```

The Current Position is set to the values of ***x***, ***y***, and *z* in three-dimensional world coordinates. `move_abs_3` only sets the Current Position; no drawing commands are output.

5.1.3. `move_rel_2` — *Move to Relative 2D Position*

`move_rel_2` increments the Current Position by the values given.

```
move_rel_2(dx, dy)
    float  dx, dy;          /*  x and y coordinate deltas  */
```

The Current Position is set to the value of Current Position plus ***dx*** and ***dy*** in two-dimensional world coordinates. `move_rel_2` only sets the Current Position; no drawing commands are output.

5.1.4. `move_rel_3` — *Move to Relative 3D Position*

`move_rel_3` increments the Current Position by the values given.

```
move_rel_3(dx, dy, dz)
    float  dx, dy, dz;          /*  x, y, and z coordinate deltas  */
```

The Current Position is set to the value of Current Position plus ***dx***, ***dy***, and ***dz*** in three-dimensional world coordinates. `move_rel_3` only sets the Current Position; no drawing commands are output.

5.2. Position Enquiry Functions

The position enquiry functions return the coordinates of the Current Position to the caller.

5.2.1. `inquire_current_position_2` — *Enquire 2D Position*

`inquire_current_position_2` returns the two-dimensional world coordinates of the Current Position to the caller.

```
inquire_current_position_2(x, y)
    float  *x, *y;
```

5.2.2. `inquire_current_position_3` — *Enquire 3D Position*

`inquire_current_position_3` returns the three-dimensional world coordinates of the Current Position to the caller.

```
inquire_current_position_3(x, y, z)
    float  *x, *y, *z;
```

5.3. Line Routines

The line routines draw lines on the currently selected **SunCore** view surfaces. Attributes of the line can be specified with additional calls to primitive attribute setting routines.

The primitive attributes of ***line index***, ***linestyle***, ***linewidth***, and ***pick_id*** are applicable for lines.

Error Codes from the Line Functions:

- There is no open segment.

5.3.1. `line_abs_2` — *Describe Line in Absolute 2D Coordinates*

`line_abs_2` describes a line in two-dimensional world coordinates.

```
line_abs_2(x, y)
    float  x, y;
```

The line that `line_abs_2` describes extends from the Current Position to the position specified by the *x* and *y* coordinates.

The Current Position is updated to the coordinates specified by *x* and *y*.

5.3.2. `line_abs_3` — *Describe Line in Absolute 3D Coordinates*

`line_abs_3` describes a line in three-dimensional world coordinates.

```
line_abs_3(x, y, z)
    float  x, y, z;
```

The line that `line_abs_3` describes extends from the Current Position to the position specified by the *x*, *y*, and *z* coordinates.

The Current Position is updated to the coordinates specified by *x*, *y*, and *z*.

5.3.3. `line_rel_2` — *Describe Line in Relative 2D Coordinates*

`line_rel_2` describes a line in two-dimensional world coordinates.

```
line_rel_2(dx, dy)
    float  dx, dy;
```

The line that `line_rel_2` describes extends from the Current Position to the position specified by the Current Position plus the *dx* and *dy* coordinates.

The Current Position is updated by the deltas specified by *dx* and *dy*.

5.3.4. `line_rel_3` — *Describe Line in Relative 3D Coordinates*

`line_rel_3` describes a line in three-dimensional world coordinates.

```
line_rel_3(dx, dy, dz)
    float  dx, dy, dz;
```

The line that `line_rel_3` describes extends from the Current Position to the position specified by the Current Position plus the *dx*, *dy*, and *dz* coordinates.

The Current Position is updated by the deltas specified by *dx*, *dy*, and *dz*.

5.4. Polyline Routines

The polyline functions describe connected sequences of lines. The first two or three arguments to a polyline function are arrays of the appropriate coordinates. Consider the polyline function:

```
polyline_abs_3(x_array, y_array, z_array, n)
    float  x_array[], y_array[], z_array[]; /*  x, y, and z arrays  */
    int  n;                                 /*  Number of coordinates */
```

The sequence of lines that these arrays of coordinates describe starts at the current position, then draws to: (*x_array*[0], *y_array*[0], *z_array*[0]), then runs through the intermediate array values and ends at (*x_array*[*n*−1], *y_array*[*n*−1], *z_array*[*n*−1]), where *n* is the number of elements in each of the coordinate arrays. There are thus *n* lines in the figure described.

Error Codes from the Polyline Functions:

- The number of coordinates, *n*, is less than or equal to zero.
- There is no open segment.

5.4.1. polyline_abs_2 — *Describe Line Sequence in Absolute 2D Coordinates*

polyline_abs_2 describes a line sequence in absolute two-dimensional world coordinates.

```
polyline_abs_2(x_array, y_array, n)
    float  x_array[], y_array[];          /*  x and y coordinates  */
    int  n;                 /* number of array elements */
```

The Current Position is updated to the end of the last line drawn.

5.4.2. polyline_abs_3 — *Describe Line Sequence in Absolute 3D Coordinates*

polyline_abs_3 describes a line sequence in absolute three-dimensional world coordinates.

```
polyline_abs_3(x_array, y_array, z_array, n)
    float  x_array[], y_array[], z_array[]; /*  x, y, and z arrays  */
    int  n;                                 /* number of elements */
```

The Current Position is updated to the end of the last line drawn.

5.4.3. polyline_rel_2 — *Describe Line Sequence in Relative 2D Coordinates*

polyline_rel_2 describes a line sequence in relative two-dimensional world coordinates.

```
polyline_rel_2(dx_array, dy_array, n)
    float  dx_array[], dy_array[];  /*  x and y delta arrays  */
    int  n;                         /* number of array elements */
```

The sequence of lines that this function describe starts at the current position, moves to: current position + (*dx_array*[0], *dy_array*[0]) then draws to: current position + (*dx_array*[0], *dy_array*[0]) + (*dx_array*[1], *dy_array*[1]) and so on. The Current Position is updated to the end of the last line drawn.

5.4.4. `polyline_rel_3` — *Describe Line Sequence in Relative 3D Coordinates*

`polyline_rel_3` describes a line sequence in relative three-dimensional world coordinates.

```
polyline_rel_3(dx_array, dy_array, dz_array, n)
    float  dx_array[], dy_array[], dz_array[];  /*  x, y, and z delta arrays  */
    int  n;                                     /* number of elements */
```

The sequence of lines that this function describe starts at the current position, moves to: current position + (***dx_array***[0], ***dy_array***[0], ***dz_array***[0]) then draws to: current position + (***dx_array***[0], ***dy_array***[0], ***dz_array***[0]) + (***dx_array***[1], ***dy_array***[1], ***dz_array***[1]) and so on. The Current Position is updated to the end of the last line drawn.

5.5. Text Routines

5.5.1. `text` — *Draw Character String In World Coordinates*

text draws a character string in world coordinates.

```
text(string);
    char *string;
```

The character string specified by ***string*** is drawn from the Current Position. The Current Position is unchanged. The font, size, orientation, and so on, are set by calls to the set primitive attribute functions.

Error Codes from the Text Function:

- There is no open segment.
- The character string contains one or more characters which cannot be drawn.
- The vectors that the current ***charpath*** and ***charup*** attributes describe are parallel.

5.6. Text Enquiry Functions

Text enquiry functions obtain the length that a character string would extend, in world coordinates, if the character string were actually drawn according to the current text primitive attributes.

Error Codes from the Text Enquiry Functions:

- `inquire_text_extent_2` was used to obtain the Current Position when `inquire_text_extent_3` should have been used in order to avoid loss of information.
- The character string contains one or more characters which cannot be drawn.
- The vectors that the current ***charpath*** and ***charup*** attributes describe are parallel.

5.6.1. inquire_text_extent_2

`inquire_text_extent_2` obtains the two-dimensional extent, in world coordinates, of the specified character string.

```
inquire_text_extent_2(string, dx, dy)
    char  *string;
    float  *dx, *dy;
```

`inquire_text_extent_2` returns the extent of the character string specified by ***string***, if the character string were drawn, unjustified, from the Current Position. The extent is returned in ***dx*** and ***dy*** in world coordinates relative to the Current Position.

The specified character string, and the values of the primitive attributes ***font***, ***charup***, ***charsize***, ***charpath***, ***charspace***, and ***charprecision*** are used to calculate the vector which represents the extent of the character string.

In the current implementation of SunCore, this function only returns meaningful values if ***charprecision*** is CHARACTER.

5.6.2. inquire_text_extent_3

`inquire_text_extent_3` obtains the three-dimensional extent, in world coordinates, of the specified character string.

```
inquire_text_extent_3(string, dx, dy, dz)
    char  *string;
    float  *dx, *dy, *dz;
```

`inquire_text_extent_3` returns the extent of the character string specified by ***string***, if the character string were drawn, unjustified, from the Current Position. The extent is returned in ***dx***, ***dy***, and ***dz*** in world coordinates relative to the Current Position.

The specified character string, and the values of the primitive attributes ***font***, ***charup***, ***charsize***, ***charpath***, ***charspace***, and ***charprecision*** are used to calculate the vector which represents the extent of the character string.

In the current implementation of SunCore, this function only returns meaningful values if ***charprecision*** is CHARACTER.

5.7. Marker Functions

The ***marker*** functions place a character at a specific location on the display. The ***polymarker*** functions place a character at a sequence of locations on the display.

The marker character is any printable ASCII character, and is the value of the `marker_symbol` primitive attribute. The `marker_symbol` primitive attribute is set by the `set_marker_symbol` function described in chapter 6.

The markers are placed on the display without any of the rotations, translations, or scaling which is applied to text strings. Markers use the default orientation attributes.

Error Codes from the Marker Functions:

- There is no open segment.

5.7.1. marker_abs_2 — *Plot Marker at Absolute 2D Coordinates*

marker_abs_2 plots a marker at specified absolute two-dimensional world coordinates.

```
marker_abs_2(x, y)
    float  x, y;          /*  Absolute x and y Coordinates  */
```

marker_abs_2 plots the marker at the absolute two-dimensional coordinates specified by the ***x*** and ***y*** arguments. The Current Position is updated to be this point.

5.7.2. marker_abs_3 — *Plot Marker at Absolute 3D Coordinates*

marker_abs_3 plots a marker at specified absolute three-dimensional world coordinates.

```
marker_abs_3(x, y, z)
    float  x, y, z;          /*  Absolute x, y, and z Coordinates  */
```

marker_abs_3 plots the marker at the absolute three-dimensional coordinates specified by the ***x***, ***y***, and ***z*** arguments. The Current Position is updated to be this point.

5.7.3. marker_rel_2 — *Plot Marker at Relative 2D Coordinates*

marker_rel_2 plots a marker at a specified relative two-dimensional position.

```
marker_rel_2(dx, dy)
    float  dx, dy;          /*  x and y Coordinate Deltas  */
```

marker_rel_2 plots the marker at the position relative to the Current Position, specified by the deltas ***dx*** and ***dy***. The Current Position is updated to be this point.

5.7.4. marker_rel_3 — *Plot Marker at Relative 3D Coordinates*

marker_rel_3 plots a marker at a specified relative three-dimensional position.

```
marker_rel_3(dx, dy, dz)
    float  dx, dy, dz;          /*  x, y, and z Coordinate Deltas  */
```

marker_rel_3 plots the marker at the position relative to the Current Position, specified by the deltas ***dx***, ***dy***, and ***dz***. The Current Position is updated to be this point.

5.7.5. polymarker_abs_2 — *Plot Marker Sequence at Absolute 2D Coordinates*

`polymarker_abs_2` plots a sequence of markers at specified absolute two-dimensional positions.

```
polymarker_abs_2(x_array, y_array, n)
    float  x_array[], y_array[];  /*  Absolute x and y */
    int  n;                       /*  Number of Coordinates  */
```

`polymarker_abs_2` plots a sequence of markers at the absolute positions specified by the ***x_array*** and ***y_array*** arguments. ***n*** specifies the number of coordinates in the arrays. The Current Position is updated to be the last point.

5.7.6. polymarker_abs_3 — *Plot Marker Sequence at Absolute 3D Coordinates*

`polymarker_abs_3` plots a sequence of markers at specified absolute three-dimensional positions.

```
polymarker_abs_3(x_array, y_array, z_array, n)
    float  x_array[], y_array[], z_array[];  /*  Absolute x, y, and z */
    int  n;                                  /*  Number of Coordinates  */
```

`polymarker_abs_3` plots a sequence of markers at the absolute positions specified by the ***x_array***, ***y_array***, and ***z_array*** arguments. The number of coordinates in the array is given by the ***n*** argument. The Current Position is updated to be the last point.

5.7.7. polymarker_rel_2 — *Plot Marker Sequence at Relative 2D Coordinates*

`polymarker_rel_2` plots a sequence of markers at specified relative two-dimensional positions.

```
polymarker_rel_2(dx_array, dy_array, n)
    float  dx_array[], dy_array[];          /*  x and y Deltas  */
    int  n;                  /*  Number of Coordinates  */
```

`polymarker_rel_2` plots a sequence of markers at the positions relative to the Current Position, specified by the deltas ***dx_array*** and ***dy_array***. The number of deltas in the arrays is specified by ***n***. The Current Position is updated to be the last point.

5.7.8. polymarker_rel_3 — *Plot Marker Sequence at Relative 3D Coordinates*

`polymarker_rel_3` plots a sequence of markers at specified relative three-dimensional positions.

```
polymarker_rel_3(dx_array, dy_array, dz_array, n)
    float  dx_array[], dy_array[], dz_array[];   /*  x, y, and z Deltas  */
    int  n;                  /*  Number of Coordinates  */
```

`polymarker_rel_3` plots a sequence of markers at the positions relative to the Current Position, specified by the deltas ***dx_array***, ***dy_array***, and ***dz_array***. The number of deltas in the

arrays is specified by ***n***. The Current Position is updated to be the last point.

5.8. Three-Dimensional Polygon Shading Parameters (SunCore Extension)

When drawing three-dimensional polygons on the Sun color displays, several shading options are available. The routines described in this section provide shading control. These shading parameters may be changed at any time and are not stored in the display list. Therefore a segment may be drawn with fast shading at one time, and then drawn again later with smooth shading.

5.8.1. `set_shading_parameters`

`set_shading_parameters` specifies the parameters for rendering three-dimensional polygons on the color display.

```
set_shading_parameters(ambient, diffuse, specular, flood, bump, hue, style)
    float  ambient;     /*  percent background light  */
    float  diffuse;     /*  percent diffuse reflection  */
    float  specular;     /*  percent specular reflection */
    float  flood;     /*  percent flood lighting  */
    float  bump;     /*  specular power 2 .. 9  */
    int  hue;     /*  color index range to generate  */
                        /*  0 = 1 .. 255,  1 = 1 .. 63  */
                        /*  2 = 64 .. 127,  3 = 128 .. 191  */
                        /*  4 = 192 .. 255  */
    int  style;     /*  Type of surface shading to do  */
                        /*  CONSTANT, GOURAUD, PHONG  */
```

See `set_polygon_interior_style` for the ways in which these shading parameters are used. CONSTANT style shading gives constant intensity over the polygon using the color set by `set_fill_index`. GOURAUD style shading linearly interpolates between vertices (use only convex polygons) where the intensity at each vertex is set by the `set_vertex_indices` function. PHONG style shading produces smooth shading using the other parameters (only with convex polygons).

The shading equation with PHONG is:

$$pixelshade = ambient + diffuse(L \bullet N) + specular(H \bullet N)^{bump} - (flood * z)$$

where L is the direction vector of the light source, N is the surface normal vector, H is a vector which is the average of L and E (the eye direction vector), and z is depth in NDC.

Here are some useful sets of PHONG parameters:

Table 5-2: Useful PHONG Parameters

ambient	0.05	0.05
diffuse	0.94	0.74
specular	0.0	0.20
flood	0.0	0.0
bump	0.0	7.0
hue	0	0
style	PHONG	PHONG

5.8.2. `set_light_direction` — *Specify Direction of Light Source*

`set_light_direction` specifies the direction of the light source from the object.

```
set_light_direction(dx, dy, dz)
    float  dx, dy, dz;
```

This assumes normalized device coordinate space where the direction from object to viewer is always (0.0, 0.0, −1.0). Hence, to place the light source at the viewer, the light direction is (0.0, 0.0, −1.0). The light direction vector is only used if the shading style is GOURAUD or PHONG. A useful light direction is (−0.2, 0.2, −1.0).

5.8.3. `set_vertex_normals`

`set_vertex_normals` sets the surface normal vectors for each vertex of the subsequent three-dimensional polygon primitives (`polygonabs_3` or `polygonrel_3`). These normals are used for PHONG style shading. For GOURAUD style shading, use `set_vertex_indices`.

```
set_vertex_normals(xlist, ylist, zlist, n)
    float  xlist[], ylist[], zlist[];
    int  n;
```

The number of elements in the list, *n*, must be equal to the number of vertices in the subsequent call to `polygon`*xxx*`_3`.

5.8.4. `set_vertex_indices`

`set_vertex_indices` specifies a color index for each vertex of the next `polygon`*xxx*`_3` primitive. GOURAUD shading linearly interpolates these color indices for smooth shading in the interior of the polygon.

```
set_vertex_indices(color_index_list, n)
    int  color_index_list[];
    int  n;
```

The number of elements in the list, ***n***, must be equal to the number of vertices in the subsequent call to `polygonxxx_3`.

5.8.5. `set_zbuffer_cut`

`set_zbuffer_cut` specifies a cutaway view of 3-D polygon objects when hidden surfaces are being removed. `set_zbuffer_cut` specifies an array of depths in Normalized Device Coordinate space. Any parts of objects which are closer to the viewer than this piecewise-linear function are clipped away.

```
set_zbuffer_cut(surface_name, xlist, zlist, n)
    struct  vwsurf  *surface_name;     /*  See appendix B  */
    float  xlist[], zlist[];
    int  n;
```

xlist is assumed to be monotonically increasing. This function specifies a piecewise-linear cutaway threshold in the z coordinate, which, given any x coordinate, is constant in y. The default cutaway depth is 0 for all values of x. Values of x less than ***xlist***[0] or greater than ***xlist***[***n*** - 1] will have the default depth. The view surface must have been initialized with the ***hidden*** flag on.

5.9. Polygon Functions (SunCore Extension)

The polygon functions are a **SunCore** extension to the ACM Core specification. The polygon functions describe connected sequences of lines which form closed figures. The polygons are filled in with color as specified by the `set_fill_index` primitive attribute, or are shaded according to the current shading parameters, depending on the `polygoninterior_style` primitive attribute. Only polygons created by the three-dimensional polygon functions may be shaded.

The first two or three arguments to a polygon function are arrays of the appropriate coordinates. Consider the polygon function:

```
polygon_abs_3(x_array, y_array, z_array, n)
    float  x_array[], y_array[], z_array[]; /*  x, y, and z coordinates  */
    int  n;                                 /*  Number of coordinates */
```

The bounding sequence of edges that these arrays of coordinates describe pass from the first point (***x_array***[0], ***y_array***[0], ***z_array***[0]), then runs through the intermediate array values to (***x_array***[***n***−1], ***y_array***[***n***−1], ***z_array***[***n***−1]), and then back to the first point. ***n*** is the number of elements in each of the coordinate arrays. There are thus ***n*** sides in the figure described.

Note that the polygon functions describe a closed figure. The last coordinate in the array of points is connected to the first point.

Error Codes from the Polygon Functions:

- The number of coordinates, *n*, is less than or equal to two.
- There is no open segment.

5.9.1. polygon_abs_2 — *Describe Polygon in Absolute 2D Coordinates*

polygonabs_2 describes a polygon in absolute two-dimensional world coordinates.

```
polygon_abs_2(x_array, y_array, n)
    float  x_array[], y_array[];          /*  x and y coordinates  */
    int  n;                 /* number of array elements */
```

The Current Position is set to the first point.

5.9.2. polygon_abs_3 — *Describe Polygon in Absolute 3D Coordinates*

polygonabs_3 describes a polygon in absolute three-dimensional world coordinates.

```
polygon_abs_3(x_array, y_array, z_array, n)
    float  x_array[], y_array[], z_array[];  /*  x, y, and z coordinates  */
    int  n;                 /* number of array elements */
```

The Current Position is set to the first point.

5.9.3. polygon_rel_2 — *Describe Polygon in Relative 2D Coordinates*

polygonrel_2 describes a polygon in relative two-dimensional world coordinates. The first array value specifies a displacement from the Current Position; remaining array values specify displacements from the preceding point.

```
polygon_rel_2(dx_array, dy_array, n)
    float  dx_array[], dy_array[];          /*  x and y deltas  */
    int  n;                 /* number of array elements */
```

The Current Position is set to the first point.

5.9.4. polygon_rel_3 — *Describe Polygon in Relative 3D Coordinates*

polygonrel_3 describes a polygon in relative three-dimensional world coordinates. The first array value specifies a displacement from the Current Position; remaining array values specify displacements from the preceding point.

```
polygon_rel_3(dx_array, dy_array, dz_array, n)
    float  dx_array[], dy_array[], dz_array[];  /*  x, y, and z deltas  */
    int  n;                 /* number of array elements */
```

The Current Position is set to the first point.

5.10. Raster Primitive Functions (SunCore Extension)

5.10.1. `put_raster` — *Raster Output Primitive*

`put_raster` draws a rectangular 1-bit or 8-bit deep raster and enters it into the current segment. The raster may not be used in transformable segments, because rasters cannot be scaled or rotated in the current release of **SunCore**. A raster primitive may, however, be picked or dragged if it is entered in a translatable segment. The Current Position is at the lower left-hand corner of the raster.

Note that `put_raster` is ***device dependent*** in that it is written to the right and upward from the Current Position a specified number of PIXELS in height and width. The Current Position is unchanged.

```
put_raster(raster)
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
```

The ***depth*** parameter can be 1 or 8 bits per pixel.

The bits of the raster are stored in the following order for ***depth*** = 1: The first word is the upper left 16 horizontal bits, with the high order bit being the leftmost bit. The first (***width***+15)/16 words comprise the top row of the rectangle. The number of words of storage that ***bits*** points to is:

```
((width+15) / 16) * height
```

for ***depth*** = 1.

Rasters of ***depth*** = 8 are stored as successive bytes in row order. The number of bytes that ***bits*** points to is:

```
width * height
```

for ***depth*** = 8.

If a 1-bit deep raster is written to a color view surface, '0' bits select the background color and '1' bits select the color specified by the ***fill index*** primitive attribute.

Note that output clipping is always done on raster primitives.

5.10.2. `get_raster` — *Read Raster from Black/White or Color Frame Buffer*

`get_raster` reads a specified region of the black and white or color frame buffer into a storage area.

```
get_raster(surface_name, xmin, xmax, ymin, ymax, x, y, raster)
    struct  vwsurf  *surface_name;          /*  See appendix B  */
    float  xmin, ymin, xmax, ymax;      /*  Region of NDC space to get  */
    int  x, y;  /* starting point pixel offsets in raster relative top left */
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;      /*  Returned Raster  */
```

`get_raster` requires an area of memory large enough to hold the raster region that it returns. It is the user's responsibility to allocate this storage area before calling `get_raster`. The `size_raster` and `allocate_raster` functions may be used to do this:

```
size_raster(surface_name, xmin, xmax, ymin, ymax, &raster);
allocate_raster(&raster);
if (raster.bits == NULL)
        error case — the raster could not be allocated
else
        continue with the processing
```

To free the area when finished with the raster, call the `free_raster` function:

```
free_raster(&raster);
```

Hence, a large raster may be allocated and then portions of it filled with data using `get_raster` with various *x*, *y* offsets, in pixel coordinates from the top left hand corner of the raster.

5.10.3. `size_raster` — *Set Size of Raster in NDC*

`size_raster` returns the raster with the pixel coordinates ***width***, ***height***, and ***depth***, for a specified region of Normalized Device Coordinate space and a specified view surface.

```
size_raster(surface_name, xmin, xmax, ymin, ymax, raster)
    struct  vwsurf  *surface_name;
    float  xmin, xmax, ymin, ymax;
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
```

On return, ***raster.bits*** is set to NULL.

5.10.4. `allocate_raster` — *Allocate Space for a Raster*

Given a raster whose ***width***, ***height***, and ***depth*** fields were filled by the `size_raster` function (described above), `allocate_raster` allocates the memory required for that raster and sets the ***raster.bits*** pointer.

```
allocate_raster(raster)
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
```

`allocate_raster` returns a NULL pointer value in ***raster.bits*** if it is unable to obtain enough memory for the raster structure.

5.10.5. `free_raster` — *Free Space of a Raster*

`free_raster` frees the memory used by a specified raster, if ***raster.bits*** is not NULL.

```
free_raster(raster)
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
```

5.10.6. `raster_to_file` — *Copy a Raster to a Disk Raster File*

`raster_to_file` copies a raster to a disk file in Sun's standard raster file format.

```
raster_to_file(raster, map, fd, replicate)
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
    struct  {
        int  type;      /*  1 for RGB color table  */
        int  nbytes;    /*  3 times number of color table elements  */
        char  *data;    /*  ptr to nbytes/3 red, blue, and green bytes */
    }  *map;
    int  fd;            /*  standard UNIX file descriptor for C programs  */
                        /*  FORTRAN logical unit number for FORTRAN programs  */
                        /*  Pascal file variable for Pascal programs  */
    int  replicate;     /*  magnification factor  */
```

If ***map.nbytes*** = 0, no color map data will be written. This would normally be the case for rasters copied from the bitmap display.

The ***replicate*** parameter specifies whether the raster should be magnified on transmission to the file. The raster is transmitted without magnification if ***replicate*** = 1, and is transmitted with pixel-replication zoom for a factor of 2 magnification if ***replicate*** = 2.

The format of the generated disk file can be found in the include file in ***/usr/include/rasterfile.h***. Disk raster files can be printed on a Versatec_like ploter device by using the ***lpr***(1) command with the **−v** option.

5.10.7. `file_to_raster` — *Get a Raster from a Disk File*

`file_to_raster` allocates enough memory for a raster stored on a disk file, then fills in all fields of the raster and map structures.

```
file_to_raster(fd, raster, map)
    int  fd;  /*  standard UNIX file descriptor for C programs  */
              /*  Fortran logical unit number for Fortran programs  */
              /*  Pascal file variable for Pascal programs  */
    struct  {
        int  width, height, depth;
        short  *bits;
    }  *raster;
    struct  {
        int  type;   /*  1 for RGB color table  */
        int  nbytes; /*  3 times number of color table elements  */
        char  *data; /*  ptr to nbytes/3 red, blue, and green bytes */
    }  *map;
```

Note that this function frees ***map.data,*** unless ***data*** is NULL, and allocates ***map.data*** each time it is called — therefore ***map.data*** is only valid in the last call to this function. The ***raster.bits*** field is set to NULL if there is not enough room to allocate the raster.

The format of the disk file can be found in the include file in ***/usr/include/rasterfile.h.***

Chapter 6

Attributes

Attributes in **SunCore** specify general characteristics for segments and for output primitives.

There are two major divisions of attributes. One set of attributes is called ***segment attributes*** and applies only to retained segments. The other set is called ***primitive attributes*** and applies only to output primitives. There are no attributes which apply to both retained segments and to output primitives.

Attributes are further subdivided into ***static*** and ***dynamic***. Static attributes specify characteristics of retained segments or output primitives which apply for the entire lifetime of those objects. Dynamic attributes specify characteristics of segments which can change during the lifetime of those segments. Static primitive attributes are stored in the display list so that subsequent manipulation of a segment is performed with the appropriate attributes.

6.1. Primitive Static Attributes

The list below defines the primitive static attribute values.

line index
: is an index into three `float` arrays which determine the red, green, and blue components of the color displayed for line and polyline output primitives. Index value 0 corresponds to the background color. For lines and polylines on monochrome displays, a non-zero ***line index*** gives black lines on a white background. **SunCore** initializes ***line index*** to 1. The range of possible values is 0 to 255.

fill index
: is an index into three `float` arrays which determine the red, green, and blue components of the color displayed for polygon and raster output primitives. Index value 0 corresponds to the background color. For monochrome displays, the values form a set of definitions for texture, described later. **SunCore** initializes ***fill index*** to 1. The range of possible values is 0 to 255.

text index
: is an index into three `float` arrays which determine the red, green, and blue components of the color displayed for markers and text. Index value 0 corresponds to the background color. For text and markers on monochrome displays, a non-zero ***text index*** gives black on a white background. **SunCore** initializes ***text index*** to 1. The range of possible values is 0 to 255.

linestyle
is an `int` value which controls the appearance of lines drawn. ***Linestyle*** can assume the values:

SOLID Solid lines,

DOTTED Dotted lines,

DASHED Dashed lines,

DOTDASHED
Dotdashed lines.

The definitions of these constants can be found in ***usercore.h***. **SunCore** sets ***linestyle*** to SOLID at initialization time.

polygon interior style
is an `int` value which controls the interior filling style for polygons. ***polygon interior style*** can have the values:

PLAIN Solid color polygon

SHADED Shading style is set dynamically by `set_shading_parameters`. Only 3-D polygons may be shaded.

SunCore sets ***polygon interior style*** to PLAIN at initialization time.

polygon edge style
is not implemented in the current release of **SunCore**.

linewidth is a `float` value which describes, in world coordinates, the width of drawn lines. **SunCore** sets ***linewidth*** to 0.0 (the minimum) at initialization time.

pen is an `int` value which is passed to the device driver to select a particular device dependent pen. **SunCore** initializes ***pen*** to 0.

font is an `int` value which determines the character font in which text will be written. ***Font*** can assume the following values (for ***charprecision***=CHARACTER):

ROMAN If ***charprecision***=STRING, this gives a large raster font.

GREEK If ***charprecision***=STRING, this gives the default raster font.

SCRIPT If ***charprecision***=STRING, this gives a small raster font.

OLDENGLISH If ***charprecision***=STRING, this is equivalent to a bold version of GREEK.

STICK If ***charprecision***=STRING, this is equivalent to a medium sized ROMAN raster font.

SYMBOLS Currently holds some electronics symbols (character values 32 through 47). If ***charprecision***=STRING, this is equivalent to a bold version of STICK.

SunCore sets ***font*** to STICK at initialization time.

charsize is a pair of `float` values which determine the size of characters, in world coordinates. **SunCore** sets the default character width to 11.0 and the default character height to 11.0 at initialization time.

charup attribute consists of three `float` values which represent a vector giving the direction of 'up' for characters:

(*dx_charup, dy_charup, dz_charup*)

in world coordinates. Usually, ***charup*** is normal to ***charpath***. **SunCore** establishes the default as a vector in the positive ***y*** direction (0.0, 1.0, 0.0) at initialization time.

charpath
consists of three `float` values which represent a vector:

(*dx_charpath, dy_charpath, dz_charpath*)

that determines the direction, in world coordinates, in which character strings will extend. **SunCore** sets the ***charpath*** attribute to (1.0, 0.0, 0.0) at initialization time.

charspace
is a single `float` value specifying the space, in world coordinates, which should be inserted between characters in a text string. **SunCore** establishes ***charspace*** with the value 0.0 at initialization time.

charjust
is not implemented in the current release of **SunCore**.

charprecision
is an `int` value which controls the quality of the text drawing operation. ***Charprecision*** can have the values:

STRING Fast raster fonts, fixed size, and fixed orientation.

CHARACTER Hershey vector fonts.

marker_symbol
determines the character which is plotted on the displays by the marker and polymarker functions described in the chapter on ***Output Primitives***. Any printable ASCII character can be used as the marker character.

Note: The ACM Core specifies that the integer values 1 through 5 represent specific characters. **SunCore** does ***not*** implement this feature.

pick_id
is an `int` value identifying the next output primitive. The input primitives use this number for user interaction with segments and primitives within segments.

rasterop
specifies the rasterop used when writing to the display. It can be one of:

NORMAL Source value is written to the display.

XORROP Source value is exclusive or'ed with the value already in the display before being written to the display.

ORROP Source value is or'ed with the value already in the display before being written to the display.

This attribute is ignored if `set_drag` was specified as TRUE.

The functions listed in the subsections below each set the specified attribute value for the indicated primitive attribute.

Errors returned from the primitive attribute setting functions:

- One or more of the attribute values is incorrect.
- No character orientation can be established because ***dx_charpath***, ***dy_charpath***, and ***dz_charpath*** are all zero.
- No character up direction can be established because ***dx_charup***, ***dy_charup***, and ***dz_charup*** are all zero.

6.1.1. Using Texture for Color Attributes on the Monochrome Display

When a monochrome display is used, the ***fill index*** attribute is used to determine how a region of the screen is textured when using the polygon output primitives. Texturing is done in terms of 16 × 16 pixel regions of the screen. There are 16 rows of 16 pixels each. The ***fill index*** attribute selects an entry from each of three arrays of `float` values in the range 0.0 through 1.0, representing red, green, and blue. In the case of the monochrome display, each of these three `float` numbers is converted to an integer between 0 and 255. Each of the 8-bit numbers is divided into two four-bit quantities, which we can call A and B.

Table 6-1: Structure of a Fill-Index Value

Red		Green		Blue	
Select B	Select A	Length B	Length A	Rotate B	Rotate A

Select A and *Select B* are four-bit values which are used to select an *A* ***pattern*** and a *B* ***pattern*** out of the table of numbers shown below.

Table 6-2: Texture Selection Values

Four-Bit Value	Hexadecimal Pattern	Binary Pattern															
0	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8080	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
3	8410	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
4	8888	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
5	9124	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0
6	9494	1	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0
7	A552	1	0	1	0	0	1	0	1	0	1	0	1	0	0	1	0
8	AAAA	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
9	EB6E	1	1	1	0	1	0	1	1	0	1	1	0	1	1	1	0
10	DDDD	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1
10	F7F7	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1
12	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	E3E3	1	1	1	0	0	0	1	1	1	1	1	0	0	0	1	1
14	FF00	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
15	00FF	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

The patterns are then laid down in the texture field, pixels, as described in the pseudo code below.

```
let x = y = Pattern A
for index = 0 to Length A - 1
    pixels[index] = x | y
    if Rotate A & 1 then rotate x one bit right
    if Rotate A & 2 then rotate x one bit left
    if Rotate A & 4 then rotate y one bit right
    if Rotate A & 8 then rotate y one bit left

let x = y = Pattern B
for index = Length A to Length A + Length B - 1
    pixels[index] = x | y
    if Rotate B & 1 then rotate x one bit right
    if Rotate B & 2 then rotate x one bit left
    if Rotate B & 4 then rotate y one bit right
    if Rotate B & 8 then rotate y one bit left
```

If the value of

length A + length B

is less than 16, the processes described above are repeated as many times as required to fill the 16 line region.

The above encoding provides for an enormous number of textures. Here are a few of the useful ones.

Table 6-3: Useful Texture Selection Values

Red Value	*Green Value*	*Blue Value*	*Resultant Texture*
0.1334	0.5020	0.3529	Hatched Left
0.1334	0.5020	0.6471	Hatched Right
0.4667	0.5334	0.2118	Wallpaper
0.0000	0.2667	0.3882	Black
0.8001	0.2667	0.4001	White
0.1334	0.3334	0.4001	Wavy Lines
0.5334	0.5334	0.4001	Grey Tone
0.1334	0.5334	0.4001	Cross Hatched

6.1.2. `define_color_indices` — *Assign Colors to Indices*

define_color_indices defines entries in the color lookup table of a view surface.

```
define_color_indices(surface_name, i1, i2, red_array, green_array, blue_array)
    struct  vwsurf  *surface_name;      /*  See appendix B  */
    int  i1, i2;                /*  indices range from 0 through 255 */
    float  red_array[], green_array[], blue_array[];
```

The three arrays provide the values for red, green, and blue respectively. The value of each element in the color arrays is in the range 0.0 through 1.0. The function defines all the indices in the color index table between *i1* and *i2* inclusive, using the first $i2-i1+1$ elements from each of the three arrays.

Subsequent calls to the **set_*zzz*_index** function selects a color from the lookup table to use as a color attribute.

Location 0 in the color tables is the background color for the view surface. For the monochrome displays, lines, text, and markers are drawn black for any color index other than 0.

SunCore initializes the lookup table for monochrome view surfaces such that for the *i*th entry, red[*i*] = *i*, green[*i*] = 255 − *i*, and blue[*i*] = *i*. **SunCore** initializes color view surfaces which have a full 256-element lookup table such that entry 0 is gray, entry 1 is black, entries 2 through 63 contain an intensity ramp in red, entries 64 through 127 contain an intensity ramp in green, entries 128 through 191 contain an intensity ramp in blue, and entries 192 through 255 contain an intensity ramp in yellow (red+green). See appendix B for details of color view surfaces with fewer than 256 entries in the lookup table.

6.1.3. set_line_index — *Select a Line Color Attribute*

set_line_index selects a color by providing an index into the tables defined by the ***define_color_indices*** function. This color attribute is applied to subsequent line and polyline output primitives.

```
set_line_index(index)
    int  index;             /*  range 0 through 255  */
```

6.1.4. set_fill_index — *Select a Polygon and Raster Color*

set_fill_index selects a color by providing an index into the tables defined by the ***define_color_indices*** function. This color attribute is applied to subsequent polygon and raster output primitives.

```
set_fill_index(index)
    int  index;             /*  range 0 through 255  */
```

6.1.5. `set_text_index` — *Select a Text and Marker Color*

`set_text_index` selects a color by providing an index into the tables defined by the *define_color_indices* function. This color attribute is applied to subsequent text and marker output primitives.

```
set_text_index(index)
    int  index;          /*  range 0 through 255  */
```

6.1.6. `set_linewidth`

`set_linewidth` specifies the ***linewidth*** attribute for the output primitives.

```
set_linewidth(linewidth)
    float  linewidth;    /*  unit of width is 1 percent of NDC space  */
```

SunCore initializes ***linewidth*** to 0.0, which results in a one pixel wide line.

If XOR'ing is enabled (via the `set_rasterop` or `set_drag` functions), lines whose pixel width is greater than one may partially overwrite themselves, resulting in poorly drawn wide lines. Redrawing the lines with XOR'ing off will draw the lines correctly (until this problem is fixed).

6.1.7. `set_linestyle`

`set_linestyle` specifies the ***linestyle*** attribute for output primitives.

```
set_linestyle(linestyle)
    int  linestyle;      /*  SOLID, DOTTED,  */
                                /*  DASHED, DOTDASHED  */
```

SunCore initializes ***linestyle*** to SOLID.

6.1.8. `set_polygon_interior_style` — *Select Plain or Shaded Polygons*

`set_polygon_interior_style` specifies the method of filling for polygons.

```
set_polygon_interior_style(style)
    int  style;      /*  PLAIN, SHADED  */
```

If the filling method is SHADED, polygons are shaded according to the parameters set by the `set_shading_parameters` function. Only 3-D polygons may be shaded.

6.1.9. set_polygon_edge_style (No Effect)

set_polygon_edge_style specifies the method of drawing the edges of a polygon.

```
set_polygon_edge_style(style)
    int  style;      /*  SOLID, INTERIOR  */
```

This function has no effect in the current release of **SunCore**.

6.1.10. set_font

set_font specifies the ***font*** attribute for the output primitives.

```
set_font(font)
    int  font;      /*  ROMAN, GREEK, SCRIPT  */
                    /*  OLDENGLISH, STICK, SYMBOLS  */
```

SunCore initializes ***font*** to STICK. If the ***charprecision*** attribute is set to STRING, ROMAN gives a small Roman font, GREEK gives a stick figure font, SCRIPT gives a tiny stick figure font, OLDENGLISH gives a bold version of GREEK, STICK gives a medium sized ROMAN raster font, and SYMBOLS gives a bold version of STICK. The STRING precision fonts are 'raster' fonts and are not scalable or rotatable, hence they are in pixel coordinates and are larger on the color surface than on the monochrome bitmap display.

6.1.11. set_pen — *Select a Device Dependent Pen*

This function has no effect on the standard **SunCore** view surfaces.

```
set_pen(pen)
    int  pen;
```

6.1.12. set_charsize

set_charsize specifies the ***charsize*** attribute for the text output primitive, in world coordinates.

```
set_charsize(charwidth, charheight)
    float  charwidth, charheight;
```

If the ***charprecision*** attribute is set to STRING, **set_charsize** has no effect, except to control the target extent of the text for the ***await_pick*** function. If the ***charprecision*** attribute is set to CHARACTER, **set_charsize** sets the average size of a character, given that each character has its own size.

6.1.13. set_charspace — *Define Character Spacing for Output Primitives*

set_charspace specifies the ***space*** attribute for the text output primitive, in world coordinates. It is used to insert additional space between characters in text strings.

```
set_charspace(charspace)
    float  charspace;
```

If the ***charprecision*** attribute is set to STRING, set_charspace has no effect.

6.1.14. set_charup_2

set_charup_2 specifies the ***charup*** attribute for the text output primitive, in world coordinates.

```
set_charup_2(dx, dy)
    float  dx, dy;
```

Note that the *dz* offset is set to 0.0 for this function. If the ***charprecision*** attribute is set to STRING, set_charup_2 has no effect; otherwise it specifies the ***upward*** direction for the characters. This provides for slanting, mirror imaging, and so on, for characters.

6.1.15. set_charup_3

set_charup_3 specifies the ***charup*** attribute for the text output primitive, in world coordinates.

```
set_charup_3(dx, dy, dz)
    float  dx, dy, dz;
```

If the ***charprecision*** attribute is set to STRING, set_charup_3 has no effect; otherwise it specifies the direction of ***upward*** for the characters. This provides for slanting, mirror imaging and such, for characters.

6.1.16. set_charpath_2

set_charpath_2 specifies the ***charpath*** attribute for the text output primitive, in world coordinates.

```
set_charpath_2(dx, dy)
    float  dx, dy;
```

Note that the *dz* offset is set to 0.0 for this function. If the ***charprecision*** attribute is set to STRING, set_charpath_2 has no effect; otherwise the character string is written in this direction.

6.1.17. set_charpath_3

set_charpath_3 specifies the ***charpath*** attribute for the text output primitive, in world coordinates.

```
set_charpath_3(dx, dy, dz)
    float  dx, dy, dz;
```

If the ***charprecision*** attribute is set to STRING, set_charpath_3 has no effect; otherwise the character string is written in this direction.

6.1.18. set_charjust — *Specify Text Justification (No Effect)*

set_charjust specifies how text strings should be justified.

```
set_charjust(just)
    int  just;
```

This function has no effect in the current release of **SunCore**.

6.1.19. set_charprecision

set_charprecision selects the method of drawing text.

```
set_charprecision(charprecision)
    int  charprecision;     /*  STRING, CHARACTER  */
```

STRING Specifies characters of fixed size and orientation, which are drawn rapidly using raster operations. This is the default.

CHARACTER Specifies Hershey vector fonts, which can be clipped and transformed.

6.1.20. set_marker_symbol

set_marker_symbol establishes the ***marker_symbol*** primitive attribute.

```
set_marker_symbol(marker)
    int  marker;            /*  Character to use as Marker — 32 .. 127  */
```

The character specified by the ***marker*** argument in the set_marker_symbol function call is subsequently used as the marker character by the marker and polymarker functions.

6.1.21. set_pick_id

set_pick_id specifies the ***pick_id*** attribute for output primitives.

```
set_pick_id(pick_id)
    int  pick_id;
```

The ***pick_id*** attribute is only used by the ***await_pick*** input function. Subsequent output primitives are identified by the specified ***pick_id*** when they are detected by the mouse pointing device, via the ***await_pick*** input function.

6.1.22. set_rasterop — *Select Rasterop to Display Memory (SunCore Extension)*

set_rasterop selects Xor'ing or or'ing of primitives to display memory.

```
set_rasterop(rop)
    int  rop;          /*  XORROP, ORROP, NORMAL  */
```

6.1.23. set_primitive_attributes — *Specify All Primitive Attributes*

set_primitive_attributes is a composite function which provides a means to set all the primitive attributes in a single function call.

```
set_primitive_attributes(attributes)
    struct  {
        int  lineindx, fillindx, textindx;
        int  linestyl, polylinestyl, polyedgestyl;
        float  linwidth;
        int  pen, font;
        float  charwidth, charheight;
        float  charupx, charupy, charupz, charupw;
        float  charpathx, charpathy, charpathz, charpathw;
        float  charspacex, charspacey, charspacez, charspacew;
        int  chjust, chquality;
        int  marker, pickid, rasterop;
    }  *attributes;
```

Note that the function call:

```
set_primitive_attributes(&PRIMATTS)
```

sets all the primitive attributes to their default values. PRIMATTS is defined in ***usercore.h***.

6.2. Inquiring Primitive Static Attribute Values

Errors returned from the primitive static attribute enquiry functions:

- A two dimensional inquiry function was used when a three dimensional inquiry function should have been used to avoid loss of information.

6.2.1. inquire_color_indices

`inquire_color_indices` obtains the color lookup table for the specified view surface.

```
inquire_color_indices(surface_name, i1, i2, red_array, green_array, blue_array)
    struct  vwsurf  *surface_name;      /*  See appendix B  */
    int  i1, i2;                /*  Start and end table indices  */
    float  red_array[];     /*  Range of each element is 0.0 thru 1.0  */
    float  green_array[];   /*  Range of each element is 0.0 thru 1.0  */
    float  blue_array[];    /*  Range of each element is 0.0 thru 1.0  */
```

surface_name is the name of the view surface for which the color lookup tables should be obtained.

`inquire_color_indices` takes entries from the color lookup tables, starting at index ***i1*** (relative to zero) and ending at index ***i2***. The color lookup tables for a given color are stored in

array`[0] through` *array*`[`*i2*`-`*i1*`]`

6.2.2. inquire_line_index

`inquire_line_index` obtains the current color index for coloring line and polyline output primitives.

```
inquire_line_index(index)
    int  *index;
```

6.2.3. inquire_fill_index

`inquire_fill_index` obtains the current color index for coloring polygon and raster output primitives.

```
inquire_fill_index(index)
    int  *index;
```

6.2.4. inquire_text_index

inquire_text_index obtains the current color index for coloring marker and text output primitives.

```
inquire_text_index(index)
    int  *index;
```

6.2.5. inquire_linewidth

inquire_linewidth obtains the ***linewidth*** attribute, in percent of normalized device coordinate space, for the output primitives.

```
inquire_linewidth(linewidth)
    float  *linewidth;
```

6.2.6. inquire_linestyle

inquire_linestyle obtains the ***linestyle*** attribute for the output primitives.

```
inquire_linestyle(linestyle)
    int  *linestyle;     /*  SOLID, DOTTED,  */
                             /*  DASHED, DOTDASHED  */
```

6.2.7. inquire_polygon_interior_style — *Obtain Polygon Shading Method*

inquire_polygon_interior_style obtains the method of filling for polygons.

```
inquire_polygon_interior_style(style)
    int  *style;     /*  PLAIN, SHADED  */
```

6.2.8. inquire_polygon_edge_style

inquire_polygon_edge_style obtains the current method of drawing polygon edges.

```
inquire_polygon_edge_style(style)
    int  *style;     /*  SOLID, INTERIOR  */
```

6.2.9. inquire_pen

```
inquire_pen(pen)
    int  *pen;        /*  Device dependent pen selector  */
```

6.2.10. inquire_font

`inquire_font` obtains the ***font*** attribute for the text output primitive.

```
inquire_font(font)
    int  *font;      /*  ROMAN, GREEK, SCRIPT, OLDENGLISH,  */
                          /*  STICK, SYMBOLS  */
```

6.2.11. inquire_charsize

`inquire_charsize` obtains the ***charsize*** attribute for the text output primitive.

```
inquire_charsize(charwidth, charheight)
    float  *charwidth, *charheight;
```

6.2.12. inquire_charspace

`inquire_charspace` obtains the ***charspace*** attribute for the text output primitive.

```
inquire_charspace(charspace)
    float  *charspace;
```

6.2.13. inquire_charup_2

`inquire_charup_2` obtains the ***charup*** attribute for the text output primitive.

```
inquire_charup_2(dx, dy)
    float  *dx, *dy;
```

6.2.14. inquire_charup_3

`inquire_charup_3` obtains the ***charup*** attribute for the text output primitive.

```
inquire_charup_3(dx, dy, dz)
    float  *dx, *dy, *dz;
```

6.2.15. inquire_charpath_2

inquire_charpath_2 obtains the ***charpath*** attribute for the text output primitive.

```
inquire_charpath_2(dx, dy)
    float  *dx, *dy;
```

6.2.16. inquire_charpath_3

inquire_charpath_3 obtains the ***charpath*** attribute for the text output primitive.

```
inquire_charpath_3(dx, dy, dz)
    float  *dx, *dy, *dz;
```

6.2.17. inquire_charjust — *Obtain Justification Attribute*

inquire_charjust obtains the justification attribute for text strings.

```
inquire_charjust(just)
    int  *just;
```

6.2.18. inquire_rasterop — *Obtain Current Rasterop (SunCore Extension)*

inquire_rasterop determines the current setting of the ***rasterop*** attribute.

```
inquire_rasterop(rop)
    int  *rop;          /*  XORROP, ORROP, NORMAL  */
```

6.2.19. inquire_charprecision

inquire_charprecision obtains the ***charprecision*** attribute for the text output primitive.

```
inquire_charprecision(charprecision)
    int  *charprecision;     /*  STRING, CHARACTER  */
```

6.2.20. inquire_pick_id

inquire_pick_id obtains the ***pick_id*** attribute for output primitives.

```
inquire_pick_id(pick_id)
    int  *pick_id;
```

6.2.21. inquire_marker_symbol

`inquire_marker_symbol` obtains the current value of the marker symbol.

```
inquire_marker_symbol(symbol)
    int  *symbol;      /*  32 .. 127  */
```

6.2.22. inquire_primitive_attributes — *Obtain All Primitive Attributes*

`inquire_primitive_attributes` is a composite function which provides a means to obtain all the primitive attributes in a single function call.

```
inquire_primitive_attributes(attributes)
    struct  {
        int  lineindx, fillindx, textindx;
        int  linestyl, polylinestyl, polyedgestyl;
        float  linwidth;
        int  pen, font;
        float  charwidth, charheight;
        float  charupx, charupy, charupz, charupw;
        float  charpathx, charpathy, charpathz, charpathw;
        float  charspacex, charspacey, charspacez, charspacew;
        int  chjust, chquality;
        int  marker, pickid, rasterop;
    }  *attributes;
```

6.3. Retained Segment Static Attributes

There is only one static attribute for segments. This is the ***image_transformation_type*** attribute. This attribute can take on one of five values:

NONE Retained segment on which no translation, scaling, or rotation can be performed.

XLATE2 Translatable retained segment. The segment can be moved (translated) in two dimensions (x and y of NDC space).

XFORM2 Fully transformable retained segment. The segment can be moved (translated), rotated, and scaled (have its size changed) in two dimensions (x and y of NDC space).

XLATE3 Translatable retained segment. The segment can be moved (translated) in three dimensions (x, y and z of NDC space).

XFORM3 Fully transformable retained segment. The segment can be moved (translated), rotated, and scaled (have its size changed) in three dimensions (x, y and z of NDC space).

The ***image_transformation_type*** attribute is set when a segment is created and cannot be changed at any time during the life of the segment. The default value of ***image_transformation_type*** is NONE.

The functions described below are used to set and enquire about the values of *image_transformation_type*.

6.3.1. set_image_transformation_type

set_image_transformation_type specifies the *image_transformation_type* attribute for subsequently created segments.

```
set_image_transformation_type(type)
    int  type;          /*  NONE, XLATE2, XFORM2, XLATE3, XFORM3   */
```

6.3.2. inquire_image_transformation_type

inquire_image_transformation_type obtains the current value of the *image_transformation_type* attribute.

```
inquire_image_transformation_type(type)
    int  *type;          /*  NONE, XLATE2, XFORM2, XLATE3, XFORM3   */
```

6.3.3. inquire_segment_image_transformation_type

inquire_segment_image_transformation_type obtains the *image_transformation_type* for a specified segment.

```
inquire_segment_image_transformation_type(segment_name, type)
    int  segment_name;      /*  Name of segment for inquiry  */
    int  *type;         /*  NONE, XLATE2, XFORM2, XLATE3, XFORM3   */
```

6.4. Setting Retained Segment Dynamic Attributes

In addition to the one static attribute described above, there are a number of dynamic attributes which apply to segments. Each retained segment has its own set of dynamic attributes, as listed below.

Visibility indicates whether the segment should have a visible image. There are only two values of this attribute, namely: TRUE and FALSE.

SunCore sets *visibility* to TRUE at initialization time.

Highlighting indicates whether the segment's image should be highlighted. In **SunCore**, highlighting is done by briefly blinking the segment. There are only two values of the *highlighting* attribute, namely, TRUE and FALSE.

SunCore sets *highlighted* to FALSE at initialization time.

Detectability indicates whether the retained segment can be detected by the *await_pick* input primitive. A value of 0 means that the segment is not pickable. If two segments

overlap, the one with the greatest value of ***detectability*** is the one that gets picked. **SunCore** sets ***detectability*** to the default value of 0 at initialization time.

Image_transformation

indicates how the image of a retained segment is scaled, rotated, or translated. Image transformations are done in NDC space, that is, after all viewing operations have been performed. Image transformations do not compose and do not cumulate. Whenever any function affecting a segment's image transformation is called, the transformation is reset to reflect only the values specified by the call. The ***image_transformation*** attribute of a segment must be consistent with its ***image_transformation_type*** attribute (for instance, if the ***image_transformation_type*** is XLATE2, it is an error to attempt to rotate the segment).

SunCore sets the default ***image_transformation*** to the identity transformation (that is, no translation, scaling, or rotation) at initialization.

There are two classes of functions for setting retained segment dynamic attributes. One class sets the default attributes for subsequently created segments; the other sets attributes on a named segment basis.

Errors which can be returned from the retained segment dynamic attribute setting routines are:

- There is no retained segment called ***segment_name***.
- One or more of the attributes is incorrect.
- The segment's ***image_transformation_type*** attribute value is incompatible with the requested function.

6.4.1. `set_visibility`

`set_visibility` specifies the default ***visibility*** attribute for subsequently created segments. This does not affect the visibility of existing segments or the currently open segment.

```
set_visibility(visibility)
    int  visibility;          /*  TRUE or FALSE  */
```

6.4.2. `set_highlighting`

`set_highlighting` specifies the default ***highlighting*** attribute for subsequently created segments.

```
set_highlighting(highlighting)
    int  highlighting;          /*  TRUE or FALSE  */
```

6.4.3. set_detectability

`set_detectability` specifies the default ***detectability*** attribute for subsequently created segments.

```
set_detectability(detectability)
    int  detectability;          /*  0 thru 2^31-1  */
```

6.4.4. set_image_translate_2

`set_image_translate_2` sets the default image transformation attribute for subsequently created segments.

```
set_image_translate_2(tx, ty)
    float  tx, ty;     /* x and y translation values in NDC  */
```

The default image transformation is set to a two-dimensional translate by ***tx*** and ***ty***.

6.4.5. set_image_transformation_2

`set_image_transformation_2` sets the default image transformation for subsequently created segments.

```
set_image_transformation_2(sx, sy, a, tx, ty)
    float  sx, sy; /* x and y scale factors */
    float  a;      /* rotation value in radians clockwise about z axis */
    float  tx, ty; /* x and y translation values in NDC */
```

The default transformation is set to a two-dimensional scale by ***sx*** and ***sy***, rotation by ***a***, and translation by ***tx*** and ***ty***. The order of transformation is:

1. *Scale* about the origin of NDC space.
2. *Rotate* about the origin of NDC space (about the z axis). A positive rotation of $\pi/2$ radians will rotate the x axis into the y axis.
3. *Translate.*

To scale and rotate about a point ***x***, ***y***, add ***dx*** to ***tx*** and add ***dy*** to ***ty***, where

```
dx = x - (x * sx * cos(a) - y * sy * sin(a))
dx = y - (x * sx * sin(a) + y * sy * cos(a))
```

6.4.6. set_image_translate_3

`set_image_translate_3` sets the default image transformation attribute, in normalized device coordinates, for subsequently created segments.

```
set_image_translate_3(tx, ty, tz)
    float  tx, ty, tz;      /* x, y, and z Translation Values in NDC */
```

The default image transformation is set to a three-dimensional translate by ***tx***, ***ty***, and ***tz***.

6.4.7. set_image_transformation_3

set_image_transformation_3 sets the default image transformation attribute for subsequently created segments.

```
set_image_transformation_3(sx, sy, sz, ax, ay, az, tx, ty, tz)
    float  sx, sy, sz;      /* x, y, and z Scale Factors */
    float  ax, ay, az;      /* Rotation Values in radians clockwise */
                          /* about the x, y, and z axes. */
    float  tx, ty, tz;      /* x, y, and z Translation Values in NDC */
```

The default image transformation is set to a three-dimensional scale by ***sx***, ***sy***, ***sz***, a three-dimensional rotation by ***ax***, ***ay***, ***az***, and a three-dimensional translation by ***tx***, ***ty***, ***tz***. The order of transformation is:

1. *Scale* about (0.0, 0.0, 0.0) in NDC space,
2. *Rotate* about (0.0, 0.0, 0.0) in NDC space, first about the *x*-axis, then about the *y*-axis, and then about the *z*-axis. Since NDC space is a left-handed coordinate system, rotations are computed using the left-hand rule. When the origin is viewed from the positive side of the axis of rotation, clockwise rotations correspond to positive rotations.
3. *Translate.*

6.4.8. set_segment_visibility

set_segment_visibility specifies the ***visibility*** attribute for the named segment.

```
set_segment_visibility(segment_name, visibility)
    int  segment_name;
    int  visibility;          /*  TRUE or FALSE  */
```

When ***visibility*** is set to FALSE, the segment is erased from the view surfaces. The segment is redrawn again when ***visibility*** is set to TRUE.

6.4.9. set_segment_highlighting

set_segment_highlighting specifies the ***highlighting*** attribute for the named segment.

```
set_segment_highlighting(segment_name, highlighting)
    int  segment_name;
    int  highlighting;          /*  TRUE or FALSE  */
```

When ***highlighting*** is set to TRUE, the segment is blinked once.

6.4.10. set_segment_detectability

set_segment_detectability specifies the ***detectability*** attribute for the named segment.

```
set_segment_detectability(segment_name, detectability)
    int  segment_name;
    int  detectability;          /*  0 thru 2^31-1  */
```

When ***detectability*** is set to 0, the segment cannot be picked by the ***await_pick*** input function. If two segments overlap, the segment with the greatest ***detectability*** is picked.

6.4.11. set_segment_image_translate_2

set_segment_image_translate_2 sets the image transformation attribute for the named segment.

```
set_segment_image_translate_2(segment_name, tx, ty)
    int  segment_name;
    float  tx;     /* x Translation Value in NDC */
    float  ty;     /* y Translation Value in NDC */
```

The image transformation is set to a two-dimensional translate by ***tx, ty***. The named segment is erased from the view surface and then redrawn after the new image transformation is applied. This may be done while the segment is open.

6.4.12. set_segment_image_transformation_2

set_segment_image_transformation_2 sets the image transformation attribute for the named segment.

```
set_segment_image_transformation_2(segment_name, sx, sy, a, tx, ty)
    int  segment_name;
    float  sx;     /* x Scale Factor */
    float  sy;     /* y Scale Factor */
    float  a;      /* Rotation Value in radians clockwise about z axis*/
    float  tx;     /* x Translation Value in NDC */
    float  ty;     /* y Translation Value in NDC */
```

The image transformation is set to a two-dimensional scale by ***sx*** and ***sy***, a two-dimensional rotation by ***a***, and a two-dimensional translation by ***tx*** and ***ty***. The order of transformation is:

1. ***Scale*** about the origin of NDC space.
2. ***Rotate*** about the origin of NDC space (about the z axis). A positive rotation of $\pi/2$ radians will rotate the x axis into the y axis.

3. *Translate.*

To scale and rotate about a point x, y, add dx to tx and add dy to ty, where

$$dx = x - (x * sx * \cos(a) - y * sy * \sin(a))$$

$$dx = y - (x * sx * \sin(a) + y * sy * \cos(a))$$

The named segment is erased from the view surface and then redrawn after the new image transformation is applied. This may be done while the segment is open.

6.4.13. set_segment_image_translate_3

`set_segment_image_translate_3` sets the image transformation attribute for the named segment.

```
set_segment_image_translate_3(segment_name, tx, ty, tz)
    int  segment_name;
    float  tx;      /* x Translation Value in NDC */
    float  ty;      /* y Translation Value in NDC */
    float  tz;      /* z Translation Value in NDC */
```

The image transformation is set to a three-dimensional translate by *tx, ty, tz*. The named segment is erased from the view surface and then redrawn after the new image transformation is applied. This may be done while the segment is open.

6.4.14. set_segment_image_transformation_3

`set_segment_image_transformation_3` sets the image transformation attribute for the named segment.

```
set_segment_image_transformation_3(segment_name, sx, sy, sz, ax, ay, az, tx, ty, tz
    int  segment_name;
    float  sx;      /* x Scale Factor */
    float  sy;      /* y Scale Factor */
    float  sz;      /* z Scale Factor */
    float  ax;      /* Rotation Value in radians clockwise about the x axis */
    float  ay;      /* Rotation Value in radians clockwise about the y axis */
    float  az;      /* Rotation Value in radians clockwise about the z axis */
    float  tx;      /* x Translation Value in NDC */
    float  ty;      /* y Translation Value in NDC */
    float  tz;      /* z Translation Value in NDC */
```

The image transformation is set to a three-dimensional scale by *sx, sy, sz*, a three-dimensional rotation by *ax, ay, az*, and a three-dimensional translation by *tx, ty, tz*. The order of transformation is:

1. *Scale* about (0.0, 0.0, 0.0) in NDC space.

2. *Rotate* about (0.0, 0.0, 0.0) in NDC space, first about the *x*-axis, then about the *y*-axis, and then about the *z*-axis. Since NDC space is a left-handed coordinate system, rotations are computed using the left-hand rule. When the origin is viewed from the positive side of the axis of rotation, clockwise rotations correspond to positive rotations.
3. *Translate.*

The named segment is erased from the view surface and then redrawn after the new image transformation is applied. This may be done while the segment is open.

6.5. Inquiring Retained Segment Dynamic Attributes

The functions described below are for inquiring the settings of the dynamic attributes for retained segments. There are two classes of functions for inquiring retained segment dynamic attributes. One class obtains the default attributes for subsequently created segments and the other obtains attributes on a named segment basis.

Errors which can be returned from these functions are:

- There is no segment called ***segment_name***.
- The default image transformation attribute value is of a more complex type than the inquiry function used.
- The segment's ***image_transformation_type*** attribute value is incompatible with the requested function.
- The segment's ***image_transformation_type*** attribute value is of a more complex type than the inquiry function used.

6.5.1. inquire_visibility

`inquire_visibility` obtains the default ***visibility*** attribute for subsequently created segments.

```
inquire_visibility(visibility)
    int  *visibility;          /*  TRUE or FALSE  */
```

6.5.2. inquire_highlighting

`inquire_highlighting` obtains the default ***highlighting*** attribute for the subsequently created segments.

```
inquire_highlighting(highlighting)
    int  *highlighting;          /*  TRUE or FALSE  */
```

6.5.3. inquire_detectability

inquire_detectability obtains the default ***detectability*** attribute for the subsequently created segments.

```
inquire_detectability(detectability)
    int  *detectability;          /*  0 thru 2^31-1  */
```

6.5.4. inquire_image_translate_2

inquire_image_translate_2 obtains the two-dimensional translation components of the default image transformation for subsequently created segments.

```
inquire_image_translate_2(tx, ty)
    float  *tx, *ty;     /* x and y Translation Values in NDC */
```

6.5.5. inquire_image_transformation_2

inquire_image_transformation_2 obtains the two-dimensional scale factor, rotation, and translation components of the default image transformation attribute for subsequently created segments.

```
inquire_image_transformation_2(sx, sy, a, tx, ty)
    float  *sx, *sy;     /* x and y Scale Factors */
    float  *a;      /* Rotation Value in radians clockwise about the z axis*/
    float  *tx, *ty;     /* x and y Translation Values in NDC */
```

6.5.6. inquire_image_translate_3

inquire_image_translate_3 obtains the three-dimensional translation components of the default image transformation attribute for subsequently created segments.

```
inquire_image_translate_3(tx, ty, tz)
    float  *tx, *ty, *tz;     /* x, y, and z Translation Values in NDC */
```

6.5.7. inquire_image_transformation_3

inquire_image_transformation_3 obtains the three-dimensional scale factor, rotation, and translation components of the default image transformation attribute for subsequently created segments.

```
inquire_image_transformation_3(sx, sy, sz, ax, ay, az, tx, ty, tz)
    float  *sx, *sy, *sz;     /* x, y, and z Scale Factors */
    float  *ax, *ay, *az;     /* Rotation Values in radians clockwise about the  */
                              /* x, y, and z axes */
    float  *tx, *ty, *tz;     /* x, y, and z Translation Values in NDC */
```

6.5.8. inquire_segment_visibility

`inquire_segment_visibility` obtains the ***visibility*** attribute for the named segment.

```
inquire_segment_visibility(segment_name, visibility)
    int  segment_name;
    int  *visibility;          /*  TRUE or FALSE  */
```

6.5.9. inquire_segment_highlighting

`inquire_segment_highlighting` obtains the ***highlighting*** attribute for the named segment.

```
inquire_segment_highlighting(segment_name, highlighting)
    int  segment_name;
    int  *highlighting;          /*  TRUE or FALSE  */
```

6.5.10. inquire_segment_detectability

`inquire_segment_detectability` obtains the ***detectability*** attribute for the named segment.

```
inquire_segment_detectability(segment_name, detectability)
    int  segment_name;
    int  *detectability;          /*  0 thru 2^31-1  */
```

6.5.11. inquire_segment_image_translate_2

`inquire_segment_image_translate_2` obtains the two-dimensional translation components of the named segment's image transformation attribute.

```
inquire_segment_image_translate_2(segment_name, tx, ty)
    int  segment_name;
    float  *tx;     /* x Translation Value in NDC */
    float  *ty;     /* y Translation Value in NDC */
```

6.5.12. inquire_segment_image_transformation_2

`inquire_segment_image_transformation_2` obtains the two-dimensional scale factor, rotation, and translation components of the named segment's image transformation attribute.

```
inquire_segment_image_transformation_2(segment_name, sx, sy, a, tx, ty)
    int  segment_name;
    float  *sx;      /* x Scale Factor */
    float  *sy;      /* y Scale Factor */
    float  *a;       /* Rotation Value in radians clockwise about the z axis*/
    float  *tx;      /* x Translation Value in NDC */
    float  *ty;      /* y Translation Value in NDC */
```

6.5.13. inquire_segment_image_translate_3

`inquire_segment_image_translate_3` obtains the three-dimensional translation components of the named segment's image transformation attribute.

```
inquire_segment_image_translate_3(segment_name, tx, ty, tz)
    int  segment_name;
    float  *tx;      /* x Translation Value in NDC */
    float  *ty;      /* y Translation Value in NDC */
    float  *tz;      /* z Translation Value in NDC */
```

6.5.14. inquire_segment_image_transformation_3

`inquire_segment_image_transformation_3` obtains the three-dimensional scale factor, rotation, and translation components of the named segment's image transformation attribute.

```
inquire_segment_image_transformation_3(segment_name, sx, sy, sz,
                                       ax, ay, az, tx, ty, tz)
    int  segment_name;
    float  *sx;      /* x Scale Factor */
    float  *sy;      /* y Scale Factor */
    float  *sz;      /* z Scale Factor */
    float  *ax;      /* Rotation Value in radians clockwise about the x axis */
    float  *ay;      /* Rotation Value in radians clockwise about the y axis */
    float  *az;      /* Rotation Value in radians clockwise about the z axis */
    float  *tx;      /* x Translation Value in NDC */
    float  *ty;      /* y Translation Value in NDC */
    float  *tz;      /* z Translation Value in NDC */
```

Chapter 7

Input Primitives

SunCore supports several ***logical input devices*** providing for interactive use of the graphics system. The physical input devices provided are the keyboard and the mouse. The mouse is versatile in that it can be used both as a pointer and a button device.

In the terminology of the ACM Core specification, input devices fall into two distinct classes, namely: devices that generate events, and devices that may only be sampled for position or numerical values. **SunCore** supports the ACM Core standard level 2 input (synchronous); hence no event generation or event queue is supported. The supported logical devices in **SunCore** are:

Table 7-1: Input Devices Supported By SunCore

Device	*Descruption*
Pick	identifies (picks out) a segment or a primitive within a segment. **SunCore** uses the mouse as a pick device.
Keyboard	provides alphanumeric information to the application program.
Button	provides a means of choosing among several alternatives. In **SunCore**, the three button devices are on the mouse.
Stroke	generates a sequence of positions in normalized device coordinates. In **SunCore**, the stroke device is the mouse.
Locator	provides a position in normalized device coordinates. **SunCore** uses the mouse as the locator device.
Valuator	provides a scalar value to the application program which samples it. **SunCore** uses the mouse as the valuator device.

A logical input device must be initialized before it can be used.

7.1. Initializing and Terminating Input Devices

7.1.1. `initialize_device` — *Initialize a Specific Device*

`initialize_device` initializes a specific logical device. This routine must be called before accessing any of the input devices.

```
initialize_device(device_class, device_number)
    int  device_class;      /*   PICK, KEYBOARD, STROKE */
                            /*   LOCATOR, VALUATOR, BUTTON  */

    int  device_number;     /*  There are:  */
                            /*   1 PICK device  */
                            /*   1 KEYBOARD device  */
                            /*   1 STROKE device  */
                            /*   3 BUTTON devices  */
                            /*   1 LOCATOR device  */
                            /*   1 VALUATOR device  */
```

An initialized input device which uses position information from the mouse must be associated with an initialized view surface (as an echo surface) before valid data can be read from the device. See appendix B for details.

Errors returned from `initialize_device`:

- The device specified by ***device_number*** is not initialized.
- The device specified by ***device_number*** is already initialized.

  Note: that if the KEYBOARD device is initialized and the program crashes before the KEYBOARD device is terminated, the tty will not echo and cbreak will be set. To recover from this condition, type 'reset' followed by a carriage return.

7.1.2. `terminate_device` — *Disable a Specific Device*

`terminate_device` disables a specific device.

```
terminate_device(device_class, device_number)
    int  device_class;     /*  PICK, KEYBOARD, STROKE */
                           /*  LOCATOR, VALUATOR, BUTTON  */

    int  device_number;     /*  There are:  */
                            /*   1 PICK device  */
                            /*   1 KEYBOARD device  */
                            /*   1 STROKE device  */
                            /*   3 BUTTON devices  */
                            /*   1 LOCATOR device  */
                            /*   1 VALUATOR device  */
```

Errors returned from `terminate_device`:

- The device specified by ***device_number*** is not enabled.

7.2. Device Echoing

Device echoing means that **SunCore** can provide a visible indication to the user that the system has seen the input from a specific input device.

SunCore provides the means whereby the application programmer can control the way in which input devices are echoed to the user of the graphics system.

Firstly, the types of echoing for each device are defined here. The tables below describe the types of echoing for specific devices.

Table 7-2: Echoing for Pick Device

Pick Device	
Echo Type	Actions Performed
0	No echo
1	**SunCore** blinks the picked segment briefly. A printer's fist (pointing finger) indicates the position of the pick device.
2	A printer's fist (pointing finger) indicates the position of the pick device. **SunCore** does not blink the picked segment.

Table 7-3: Echoing for Keyboard Device

Keyboard Device	
Echo Type	Actions Performed
0	No echo
1	The string which the user typed at the keyboard is echoed on the screen starting at the echo reference position.

Table 7-4: Echoing for Button Device

Button Device	
Echo Type	Actions Performed
0	No echo
1	No echo

Table 7-5: Echoing for Stroke Device

Stroke Device	
Echo Type	Actions Performed
0	No echo
1	a printers fist (pointing finger) sign is displayed at the cursor position.
2	A string of dots is drawn to follow the path of the cursor. (not implemented)
3	A solid line is drawn to follow the path of the cursor. (not implemented)
4	a printers fist sign is displayed at the final position of the cursor. (not implemented)

Table 7-6: Echoing for Locator Device

Locator Device	
Echo Type	Actions Performed
0	No echo
1	A printers fist (pointing finger) sign is displayed at the position of the locator.
2	A solid line is drawn connecting the echo reference point with the locator.
3	A solid line is drawn connecting the echo reference point with the *x* coordinate of the locator.
4	A solid line is drawn connecting the echo reference point with the *y* coordinate of the locator.
5	A solid line is drawn connecting the echo reference point with either the *x* coordinate, or the *y* coordinate, of the locator, whichever is farthest from the echo reference point.
6	A box is drawn with the position of the locator as one corner, and the echo reference point as the opposite corner.

Table 7-7: Echoing for Valuator Device

Valuator Device	
Echo Type	Actions Performed
0	No echo
1	The current value of the valuator is displayed on the screen starting at the echo reference point.
2 – 11	**SunCore** does not perform the actions as described in the ACM Core specification, which sets the values of the valuator into various parameters of the ***image_transformation_type*** attribute of retained segments. **SunCore** leaves this up to the application program.

7.2.1. set_echo — *Define Type of Echo for Device*

```
set_echo(device_class, device_number, echo_type)
    int  device_class;     /*  PICK, KEYBOARD, STROKE, */
                           /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    int  echo_type;
```

7.2.2. set_echo_group — *Define Type of Echo for a Group of Devices*

```
set_echo_group(device_class, device_number_array, n, echo_type)
    int  device_class;     /*  PICK, KEYBOARD, STROKE, */
                           /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number_array[];
    int  n;            /*  number of devices in array  */
    int  echo_type;
```

7.2.3. set_echo_position — *Define Echo Reference Point*

set_echo_position specifies the position, in normalized device coordinates, which will be used as the echo reference point. The coordinates must lie within the bounds of NDC space, or set_echo_position will set the echo reference point to be the point in NDC space closest to the specified point.

```
set_echo_position(device_class, device_number, echo_x, echo_y)
    int  device_class;     /*  PICK, KEYBOARD, STROKE, */
                           /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    float  echo_x;           /*  x Coordinate of Echo Point  */
    float  echo_y;           /*  y Coordinate of Echo Point  */
```

The echo reference point that this function defines is used for certain types of echo such as rubber band locator echo.

7.2.4. set_echo_surface — *Define View Surface for Echo*

set_echo_surface specifies the viewing surface on which echoing will be done.

```
set_echo_surface(device_class, device_number, surface_name)
    int  device_class;     /*  PICK, KEYBOARD, STROKE, */
                           /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    struct  vwsurf  *surface_name;     /*  See appendix B */
```

An initialized input device which uses position information from the mouse must be associated with an initialized view surface (as an echo surface) before valid data can be read from the device. See appendix B for details. If a NULL pointer is given for the ***surface_name*** argument, any association of the specified input device with an echo surface is ended.

7.3. Setting Input Device Parameters

7.3.1. set_locator_2 — *Initialize Locator Position*

`set_locator_2` sets the initial locator position in normalized device coordinates.

```
set_locator_2(locator_number, x, y)
    int  locator_number;
    float  x;
    float  y;
```

SunCore currently does not use this initial position of the locator.

7.3.2. set_valuator — *Initialize Value and Range for Valuator Device*

`set_valuator` sets the value and range for the valuator device.

```
set_valuator(valuator_number, initial_value, low, high)
    int  valuator_number;
    float  initial_value;
    float  low;
    float  high;
```

The default values are: ***initial_value*** = *0.0*, ***low*** = *0.0*, and ***high*** = *1.0*.

7.3.3. set_keyboard — *Initialize Keyboard Parameters*

`set_keyboard` sets the size of the character buffer for the keyboard, the initial character string, and the initial character cursor counting from the echo reference position.

```
set_keyboard(keyboard_number, buffer_size, initial_string, initial_cursor_position)
    int  keyboard_number;
    int  buffer_size;
    char  *initial_string;
    int  initial_cursor_position;
```

SunCore uses default values of ***buffer_size*** = *80*, ***initial_string*** = "enter:", and ***initial_cursor_position*** = 7. The maximum buffer_size and the maximum length of initial_string are 80 characters.

7.3.4. `set_stroke` — *Initialize Stroke Device*

`set_stroke` sets parameters for the stroke device.

```
set_stroke(stroke_number, buffer_size, distance, time)
    int  stroke_number; /*  Device Number  */
    int  buffer_size;   /*  Number of x, y points - not used */
    float  distance;    /*  Minimum distance to move  */
    int  time;          /*  Not used  */
```

The ***buffer_size*** argument is the maximum number of ***x, y*** points in a stroke. The ***distance*** argument is the minimum distance, in normalized device coordinates, which the mouse must move before a new point is added to the ***x, y*** list comprising the stroke. The default setting is ***distance=0.01***.

7.3.5. `set_pick` — *Initialize Pick Device*

`set_pick` sets the aperture for the pick device.

```
set_pick(pick-number, aperture)
    int  pick-number; /*  Device Number  */
    float  aperture;  /*  Device aperture  */
```

The ***aperture*** argument provides control over the 'sensitivity' of the ***pick*** device. A square is defined with its center at the cursor position and with sides of length 2 * ***aperture***. Segments that intersect this square can be picked. ***aperture*** is given in normalized device coordinates. An error is returned if the ***pick-number*** is incorrect or if the ***aperture*** ≤ 0.0. The default aperture square has two pixels per side.

7.4. Reading From Input Devices

7.4.1. `await_any_button` — *Wait for Mouse Button*

`await_any_button` waits for the user to click any of the mouse buttons.

```
await_any_button(time, button_number)
    int  time;              /*  Time in microseconds to wait  */
    int  *button_number;    /*  Button which was hit */
```

`await_any_button` waits for the user to click any initialized button on the mouse, or until the time specified by the ***time*** parameter expires. If the ***time*** argument is exactly zero, the buttons are checked once, then the function returns to the caller immediately.

If a button is clicked before ***time*** expires, the number of the button is returned in the ***button_number*** parameter. If the user does not click any mouse button before ***time*** expires, the function returns a button number of zero.

For the mouse, button numbers 1, 2, and 3 represent the left, middle, and right buttons, respectively, when the buttons are facing ***away*** from the user.

7.4.2. `await_pick` — *Wait for Pick Device*

`await_pick` waits for the user to pick an output primitive within a visible and detectable retained segment.

```
await_pick(time, pick_number, segment_name, pick_id)
    int  time;     /*  Time in microseconds to wait  */
    int  pick_number;
    int  *segment_name;
    int  *pick_id;
```

`await_pick` waits for the user to click the left hand button on the mouse, or until the time specified by the ***time*** parameter expires. If the ***time*** argument is exactly zero, the function tests the button once, and if the button has been clicked, performs the pick operation.

If the button is clicked before ***time*** expires, the function returns the ***segment_name*** of the segment that the pick device is pointing at, and the ***pick_id*** parameter is set to the value of the ***pick_id*** attribute of the primitive that was picked. If the user does not click any mouse button before ***time*** expires, or no segment is found where the user points, the function sets the ***segment_name*** and ***pick_id*** parameters to zero.

`await_pick` only searches those segments which are visible and detectable and appear on the echo surface of the specified PICK device. Primitives within a segment have bounded volume descriptors. The square pick aperture must intersect one of these 'extents' in order that the ***segment_name*** and ***pick_id*** be returned. If more than one segment is at the point, the segment with the highest value of the detectability attribute is returned. Detectability may be set to zero to prevent a segment from being picked.

Errors returned from `await_pick`:

- The specified pick device does not exist.

7.4.3. `await_keyboard` — *Wait for Input from the Keyboard*

`await_keyboard` waits for the user to type a line of input on the keyboard.

```
await_keyboard(time, keyboard_number, input_string, length)
    int  time;     /*  Time in microseconds to wait  */
    int  keyboard_number;
    char  *input_string;
    int  *length;
```

`await_keyboard` waits for the user to enter data at the keyboard, or until the time specified by the ***time*** parameter expires. If the ***time*** argument is exactly zero, the function tests once to see if a character has been typed, and then returns to the caller.

If any data is entered at the keyboard before ***time*** expires, the function returns the typed characters in an array pointed to by ***input_string***. The length of this character string is returned in ***length***. The string is null terminated. If the user does not enter any data before ***time*** expires, the function sets the ***length*** parameter to zero. If a carriage-return or newline character is typed, the function returns with the input string containing a newline character as the last non-null character.

Errors returned from `await_keyboard`:

- The specified keyboard does not exist.

7.4.4. `await_stroke_2` — *Wait for User to Draw a Line*

`await_stroke_2` waits for the user to draw a line, consisting of a list of points in normalized device coordinate space, using the mouse.

```
await_stroke_2(time, stroke_number, array_size, x_array, y_array, number_points)
    int  time;      /*  Time in microseconds to wait  */
    int  stroke_number;      /*  Stroke device to wait for  */
    int  array_size;        /*  Maximum size of x and y arrays  */
    float  x_array[];
    float  y_array[];
    int  *number_points;      /*  Number of x, y coordinates actually read  */
```

`await_stroke` waits for the user to draw a line using the mouse, or until the time specified by the ***time*** parameter expires. If the ***time*** argument is exactly zero, the function tests once to see if a line has been drawn, and then returns to the caller.

The line starts at the current position of the locator, and finishes when the user clicks button 3 on the mouse. When the function returns, the number of ***x, y*** coordinates actually read is returned in the ***number_points*** argument. When the number of points read equals ***array_size*** the function returns before time expires.

7.4.5. `await_any_button_get_locator_2` — *Read Locator When Button Clicked*

`await_any_button_get_locator_2` waits for the user to click any of the mouse buttons. When the button is clicked, the function returns the current normalized device coordinates of the locator.

```
await_any_button_get_locator_2(time, locator_number, button_number, x, y)
    int  time;      /*  Time in microseconds to wait  */
    int  locator_number;      /*  Locator device to wait for  */
    int  *button_number;      /*  Button which was clicked  */
    float  *x, *y;      /*  Returned point in NDC  */
```

`await_any_button_get_locator_2` waits for the user to click any mouse button, or until the time specified by the ***time*** argument expires. If the ***time*** argument is exactly zero, the function checks if any buttons have been clicked immediately and then returns.

If the time expires before the user has clicked any of the mouse buttons, the function returns a zero in the ***button_number*** argument.

7.4.6. `await_any_button_get_valuator` — *Read Valuator When Button Clicked*

`await_any_button_get_valuator` waits for the user to click any of the mouse buttons, or for a specified time. When the button is clicked, the function returns the current value of the valuator.

```
await_any_button_get_valuator(time, valuator_number, button_number, value)
    int  time;      /*  Time in microseconds to wait  */
    int  valuator_number;      /*  Valuator number to read from  */
    int  *button_number;      /*  Button which was clicked  */
    float  *value;      /*  Value of valuator  */
```

`await_any_button_get_valuator` waits for the user to click any mouse button, or until the time specified by the ***time*** argument expires. If the ***time*** argument is exactly zero, the function checks if any buttons have been clicked and then returns immediately.

If the user clicks one of the mouse buttons, the function returns with the value of the valuator, and the number of the button which was clicked. If the time expires before the user has clicked any of the mouse buttons, the function returns a zero in the ***button_number*** argument. Movement of the mouse left or right lowers or raises the value of the valuator.

7.4.7. `get_mouse_state` — *Low Level Mouse Support (SunCore extension)*

`get_mouse_state` reads the low level mouse ***x***, ***y***, and button information corresponding to a particular input device. The buttons are up-down encoded, and the location of the mouse is in normalized device coordinates.

```
get_mouse_state(device_class, device_number, x, y, buttons)
    int  device_class;    /*  PICK, STROKE, */
                                /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    float  *x, *y;
    int  *buttons;
```

Bit 0 of ***buttons*** is the right-hand mouse button.

Bit 1 of ***buttons*** is the middle mouse button.

Bit 2 of ***buttons*** is the left-hand mouse button.

A zero bit means that the button is ***up***, while a one bit means that the button is ***down***.

7.5. Inquiring Input Status Parameters

7.5.1. inquire_echo — *Obtain Type of Echo for Device*

inquire_echo obtains the echo_type for the specified device.

```
inquire_echo(device_class, device_number, echo_type)
    int  device_class;    /*  PICK, KEYBOARD, STROKE, */
                                /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    int  *echo_type;
```

7.5.2. inquire_echo_position — *Obtain Echo Reference Point*

inquire_echo_position obtains the position, in normalized device coordinates, of the echo reference point for the specified device.

```
inquire_echo_position(device_class, device_number, echo_x, echo_y)
    int  device_class;    /*  PICK, KEYBOARD, STROKE, */
                                /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    float  *echo_x;          /*  x Coordinate of Echo Point  */
    float  *echo_y;          /*  y Coordinate of Echo Point  */
```

7.5.3. inquire_echo_surface — *Obtain View Surface for Echo*

inquire_echo_surface obtains the viewing surface on which echoing is done for the specified device.

```
inquire_echo_surface(device_class, device_number, surface_name)
    int  device_class;    /*  PICK, KEYBOARD, STROKE, */
                                /*  LOCATOR, VALUATOR, BUTTON  */
    int  device_number;
    struct  vwsurf  *surface_name;
```

7.5.4. inquire_locator_2 — *Obtain Initial Locator Position*

inquire_locator_2 obtains the initial position of the specified locator in normalized device coordinates.

```
inquire_locator_2(locator_number, x, y)
    int  locator_number;
    float  *x;
    float  *y;
```

7.5.5. inquire_valuator — *Obtain Value and Range for Valuator Device*

`inquire_valuator` obtains the value and range for the specified valuator device.

```
inquire_valuator(valuator_number, initial_value, low, high)
    int  valuator_number;
    float  *initial_value;
    float  *low;
    float  *high;
```

7.5.6. inquire_keyboard — *Obtain Keyboard Parameters*

`inquire_keyboard` obtains the size of the character buffer, the initial character string, and the initial character cursor for the specified keyboard.

```
inquire_keyboard(keyboard_number, buffer_size, initial_string,
                 initial_cursor_position)
    int  keyboard_number;
    int  *buffer_size;
    char  *initial_string;
    int  *initial_cursor_position;
```

7.5.7. inquire_stroke — *Obtain Stroke Device Parameters*

`inquire_stroke` obtains the buffer size, distance, and time parameters for the specified stroke device.

```
inquire_stroke(stroke_number, buffer_size, distance, time)
    int  stroke_number;      /*  device number  */
    int  *buffer_size;       /*  number of x, y points in buffer - not used*/
    float  *distance;        /* minimum distance to move in NDC */
    int  *time;          /*  Not used  */
```

Chapter 8

Programming Examples

8.1. The Sun Workstation Factory

This example provides a relatively simple programming example that nevertheless uses a goodly number of **SunCore**'s facilities. The example is called *factory*. It has a factory building with a smokestack and a cloud of smoke puffing out. Silicon chips move in at one end of the building, and Sun Workstations come out of the other end.

Facilities displayed by this simple example include texturing, translation, scaling, and output clipping. The example is presented in pieces, with a narrative accompanying each of the pieces.

8.1.1. Declarations and the Main Program

First there is an include of the file usercore.h which contains the definitions required for using the graphics package:

```
#include  <usercore.h>
```

Then there are some definitions:

```
                              /*  Define segment numbers  */
#define FACTORY 10
#define CLOUD   9
#define WORKSTATION_1   1
#define WORKSTATION_2   2
#define WORKSTATION_3   3
#define CHIP_1  4
#define CHIP_2  5
#define CHIP_3  6
```

Then we define and initialize the variables that describe the outlines of the various objects in the picture:

```
static float delta[] = {0.0, 0.025, 2*0.025, 3*0.025, 4*0.025,
                        5*0.025, 6*0.025, 7*0.025, 8*0.025, 9*0.025,
                        10*0.025, 11*0.025, 12*0.025};

static float redtex[] = {0.9961, 0.1765, 0.1334, 0.1334, 0.4667,
                         0.1334, 0.1334, 0.1334, 0.8001, 0.2667,
                         0.5334, 0.0};
static float grntex[] = {0.5334, 0.2079, 0.5334, 0.5334, 0.5334,
                         0.5020, 0.5020, 0.3334, 0.2667, 0.5334,
                         0.5334, 0.2667};
static float blutex[] = {0.0, 0.0, 0.4001, 0.0, 0.2118, 0.3529,
                         0.6471, 0.4001, 0.4001, 0.4001, 0.4001, 0.3882};

int bw2dd();      /*  Device driver name for the Sun-2  */
                  /*  monochrome display — see appendix B  */
struct vwsurf  vsurf = DEFAULT_VWSURF(bw2dd);
                  /*  The DEFAULT_VWSURF macro is defined */
                  /*  in usercore.h */
```

Then we have the main program:

```
main()
{
    short i, p0, p1, p2, p3;
    int error;
    float scale;
    float clx, cly;
```

The first call in the program is to initialize **SunCore**, *with an appropriate exit if there is an error returned:*

```
    error = initialize_core(DYNAMICB, NOINPUT, TWOD);
    if (error)
        exit(0);
```

Then we initialize and select a view surface. Again, we exit if there was an error returned:

```
    error = initialize_view_surface(&vsurf, FALSE);
    error |= select_view_surface(&vsurf);
    if (error)
        exit(1);
```

Then we establish a viewport and a window. Note that we can set clipping on output — this is a **SunCore** *extension to the ACM Core.*

```
    set_viewport_2(0.05, 0.95, 0.05, 0.7);
    set_window(30.0, 225.0, 30.0, 225.0);
    set_output_clipping(TRUE);
    set_window_clipping(FALSE);
```

Set up the color lookup table.

```
define_color_indices(&vsurf, 1, 12, redtex, grntex, blutex);
```

Now make a temporary segment for a title and border.

```
create_temporary_segment();
move_abs_2(30., 30.);
line_rel_2(0., 195.);
line_rel_2(195., 0.);
line_rel_2(0., -195.);
line_rel_2(-195., 0.);
set_charprecision(CHARACTER);
set_charsize(14., 14.);
set_text_index(1);
move_abs_2(40., 200.);
text("SunCore");
close_temporary_segment();
```

Next we establish a segment for the factory. This segment is the simplest type, since we perform no transformations of any kind on it.

```
set_image_transformation_type(NONE);
create_retained_segment(FACTORY);
factory(110.0, 60.0);
close_retained_segment();
```

Next we establish a segment for the cloud above the factory. This segment is subject to scaling, so we must allow for transformations.

```
set_image_transformation_type(XFORM2);
create_retained_segment(CLOUD);
map_world_to_ndc_2(120., 100., &clx, &cly);
set_segment_image_transformation_2(CLOUD, 0.05, 0.1,
    0.0, clx, cly + 0.02);
cloud(0., 0.);
close_retained_segment();
```

Lastly, we establish segments for the chips and the workstations. The chips and workstations will be moving across the picture, so these segments must allow translation.

```
set_image_transformation_type(XLATE2);
                        /*  Do the Sun Workstation Segment  */
create_retained_segment(WORKSTATION_1);
sunws(160.0, 60.0);
close_retained_segment();
create_retained_segment(WORKSTATION_2);
sunws(160.0, 60.0);
close_retained_segment();
create_retained_segment(WORKSTATION_3);
sunws(160.0, 60.0);
close_retained_segment();
                        /*  Do the Chip Segment  */
create_retained_segment(CHIP_1);
chip(20.0, 70.0);
close_retained_segment();
create_retained_segment(CHIP_2);
chip(20.0, 70.0);
close_retained_segment();
create_retained_segment(CHIP_3);
chip(20.0, 70.0);
close_retained_segment();
```

Notice that we created the workstations all on top of each other, and also all the chips on top of each other. The actual spatial separation of the individual segments is handled in the main body of the animation code.

Now we get to the body of the code which animates the picture. The outer for loop is done 100 times. The calls on the translation routines make the chips and workstations move. The inner for loop makes the cloud grow.

```
p0 = 0; p1 = 4; p2 = 8;
for (i=0; i<100; i++) {
    set_segment_image_translate_2(WORKSTATION_1, delta[p0], 0.0);
    set_segment_image_translate_2(WORKSTATION_2, delta[p1], 0.0);
    set_segment_image_translate_2(WORKSTATION_3, delta[p2], 0.0);
    set_segment_image_translate_2(CHIP_3, delta[p2], 0.0);
    set_segment_image_translate_2(CHIP_2, delta[p1], 0.0);
    set_segment_image_translate_2(CHIP_1, delta[p0], 0.0);
    p0++;  p1++;  p2++;
    if (p0 > 11)
        p0 = 0;
    if (p1 > 11)
        p1 = 0;
    if (p2 > 11)
        p2 = 0;
    for (scale=0.1; scale<1.0; scale += 0.2)
        set_segment_image_transformation_2(CLOUD, 0.5 * scale, scale,
            0.0, clx, cly + scale * 0.2);
}
```

Finally, when everything is done, we deselect the view surface, and terminate **SunCore**:

```
    deselect_view_surface(&vsurf);
    terminate_core();
}       /*  End of the main program  */
```

The remainder of the demonstration program consists of the subroutines which fill in the details in the individual segments.

8.1.2. The factory Drawing Function

First, here are the coordinates for the outline of the factory itself:

```
static float factdx[] = {0.0, 0.0, 8.0, 2.0, 3.0, 2.0, 3.0,
                         1.0, 3.0, 1.0, 17.0, 0.0, -40.0};
static float factdy[] = {0.0, 20.0, 0.0, 20.0, 0.0, -20.0,
                         0.0, 15.0, 0.0, -15.0, 0.0, -20.0, 0.0};
```

The next set of declarations describe the outline of the windows in the factory:

```
static float winddx[] = {0.0, 0.0, 10.0, 0.0, −10.0};
static float winddy[] = {0.0, 5.0, 0.0, −5.0, 0.0};
static int black = 3;
static int brick = 1;
```

Now we have the actual code of the factory drawing routine itself:

```
factory(x0, y0)
float x0, y0;
{
```

The x0 and y0 arguments to the factory function describe the absolute position in world coordinates at which the factory should appear. The actual outline of the factory is described by the array of coordinates declared above.

```
    set_fill_index(brick);
    move_abs_2(x0, y0);     /*  Move to appropriate position  */
    polygon_rel_2(factdx, factdy, 12);     /*  Draw the factory outline  */
```

Now we draw the windows within the factory:

```
    set_fill_index(black);
    move_rel_2(5.0, 10.0);     /*  Move to position of first window  */
    polygon_rel_2(winddx, winddy, 4);     /*  and draw the window  */

    move_rel_2(15.0, 0.0);     /*  Move to position of second window  */
    polygon_rel_2(winddx, winddy, 4);     /*  and draw the window  */
    set_fill_index(1);          /* reset fill index */
}       /*  End of the factory drawing function  */
```

The next function is the one which draws the Sun Workstations within the workstation segment.

8.1.3. The Workstation Drawing Function

The declarations below describe the outline of the Sun Workstation. ***Tube*** describes the screen, ***Case*** describes the outer outline of the case, ***base*** describes the base of the Workstation, and ***keybd*** describes the appearance of the keyboard:

```
static float tubex[] = {0.0, 5.0, 0.0, -5.0};
static float tubey[] = {5.0, 0.0, -5.0, 0.0};

static float casex[] = {1.0, 7.0, 1.0, 1.0, -1.0, -7.0, -1.0};
static float casey[] = {7.0, 0.0, -7.0, 1.0, 7.0, 0.0, -1.0};

static float basex[] = {9.0, -1.0, -1.0, -5.0, -1.0};
static float basey[] = {0.0, 0.0, -2.0, 0.0, 2.0};

static float keybdx[] = {0.0, 10.0, 3.0, 0.0, -10.0, -3.0, 10.0, 3.0};
static float keybdy[] = {-1.0, 0.0, 2.0, 2.0, 0.0, -3.0, 0.0, 3.0};

sunws(x0, y0)
float x0, y0;
{
```

Then all we have to do is move to the coordinates that were supplied as function arguments, and draw the lines:

```
    move_abs_2(x0+5.0, y0+8.0);      /*  Move to the position given  */

    polyline_rel_2(tubex, tubey, 4);      /*  Draw the tube  */

    move_rel_2(-2.0, -1.0);
    polyline_rel_2(casex, casey, 7);      /*  Draw the case  */

    move_rel_2(-1.0, -7.0);
    polyline_rel_2(basex, basey, 5);      /*  Draw the base  */

    move_abs_2(x0, y0+1.0);
    polyline_rel_2(keybdx, keybdy, 8);      /*  Draw the keyboard  */
}          /*  End of the Workstation Drawing Function  */
```

8.1.4. The Chip Drawing Function

The declarations below describe the outline of the chips. ***Plasti*** describes the outline of the chip itself, while ***lead*** describes the outline of the leads on the chip:

```
static float plastix[] = {0.0, 16.0, 0.0, -16.0};
static float plastiy[] = {4.0, 0.0, -4.0, 0.0};

static float leadx[] =   {-1.0, 2.0, -1.0, 0.0};
static float leady[] =   {2.0, 0.0, -2.0, -4.0};

chip(x0, y0)
float x0, y0;
{
    short i;
```

Then all we have to do is move to the coordinates that were supplied as function arguments, and draw the lines:

```
    set_rasterop(XORROP);
    move_abs_2(x0, y0);     /*  Move to appropriate position  */

    polyline_rel_2(plastix, plastiy, 4);     /*  Draw the chip  */
    move_rel_2(2.0, 1.0);

    for (i=0; i<5; i++) {     /*  Draw the leads on the chip  */
        polyline_rel_2(leadx, leady, 4);
        move_rel_2(3.0, 4.0);
    }
    set_rasterop(NORMAL);                /* reset rasterop */
}         /*  End of the chip drawing function  */
```

8.1.5. The Cloud Drawing Function

The last function is the one that draws the cloud. The cloud function is easy: all we have to do is draw its outline. The actual scaling of the cloud is done in the main program.

The declarations below describe the outline of the cloud:

```
static float cloudx[] = {0.0, 8.0, -8.0, -4.0, 2.0, 14.0, 8.0, 0.0,
                         12.0, 8.0, 4.0, 0.0, -10.0, 10.0, 4.0, -2.0,
                         -6.0, -12.0, -6.0, -12.0, -10.0};
static float cloudy[] =   {12.0, 8.0, 2.0, 6.0, 6.0, 10.0, -4.0, -6.0,
                           10.0, 0.0, -4.0, -10.0, -10.0, -2.0, -6.0,
                           -8.0, -4.0, 0.0, 4.0, -8.0, 4.0};

cloud(x0, y0)
float x0, y0;
{
```

Then all we have to do is move to the coordinates that were supplied as function arguments, and draw the lines:

```
    move_abs_2(x0, y0);
    polyline_rel_2(cloudx, cloudy, 21);
}           /*  End of the cloud drawing function  */
```

Appendix A

Deviations from ACM SIGGRAPH Core

This appendix points out specific differences between the **SunCore** graphics package and the ACM SIGGRAPH Core Specification. In addition to differences noted here, **SunCore** has numerous extensions to the ACM Core which are documented in the main body of this manual.

A.1. Unimplemented Functions

Here is a list of those functions which **SunCore** does not implement:

Table A-1: Unimplemented Primitive Attribute Functions

Primitive Attribute Functions	
• *set_charjust*	• *inquire_charjust*

Table A-2: Unimplemented Synchronous Input Functions

Synchronous Input Functions	
• *initialize_group*	• *terminate_group*
• *await_stroke_3*	
• *set_echo_segment*	• *set_pick*
• *set_button*	• *set_all_buttons*
• *set_locator_3*	• *set_locport_2*
• *set_locport_3*	• *inquire_input_capabilities*
• *inquire_input_device_characteristics*	• *inquire_stroke_dimension*
• *inquire_locator_dimension*	• *inquire_pick*
• *inquire_button*	• *inquire_locator_3*
• *inquire_locport_2*	• *inquire_locport_3*
• *inquire_echo_segments*	

Table A-3: Unimplemented Asynchronous Input Functions

Asynchronous Input Functions	
• *enable_device*	• *enable_group*
• *disable_device*	• *disable_group*
• *disable_all*	• *read_locator_2*
• *read_locator_3*	• *read_valuator*
• *await_event*	• *flush_device_events*
• *flush_group_events*	• *flush_all_events*
• *associate*	• *disassociate*
• *disassociate_device*	• *disassociate_group*
• *disassociate_all*	• *get_pick_data*
• *get_keyboard_data*	• *get_stroke_data_2*
• *get_stroke_data_3*	• *get_locator_data_2*
• *get_locator_data_3*	• *get_valuator_data*
• *inquire_device_associations*	• *inquire_device_status*

Table A-4: Unimplemented Control Functions

Control Functions	
• *inquire_output_capabilities*	• *inquire_selected_surfaces*
• *set_immediate_visibility*	• *make_picture_current*
• *inquire_control_status*	• *set_visibilities*
• *log_error*	

Table A-5: Unimplemented Escape Functions

Escape Functions	
• *escape*	• *inquire_escape*

A.2. Other Differences

Text: **SunCore** does not have the charplane primitive attribute; instead, the charpath, charup, and charspace attributes are used to specify text orientation as described in the manual. The current release of **SunCore** has no STROKE precision text and no text justification. The *inquire_text_extent_2* and *inquire_text_extent_3* functions do not take a view surface name as an argument. The text enquiry functions only return meaningful values when the current *charprecision* attribute is CHARACTER.

Raster Extensions: **SunCore** contains several of the proposed raster extensions to the ACM Core and other raster functions. Thus there are no color or intensity primitive attributes. Instead a color lookup table model is used. There are several primitive attributes which are indices into lookup tables. In addition, hidden surfaces are supported on color view surfaces. This requires a second parameter to the ***initialize_view_surface*** function.

Miscellaneous: **SunCore** adds these functions:
set_image_translate_3,
inquire_image_translate_3,
set_segment_image_translate_3,
inquire_segment_image_translate_3.

The functions:
set_primitive_attributes_2,
set_primitive_attributes_3,
inquire_primitive_attributes_2, and
inquire_primitive_attributes_3
are replaced by the functions ***set_primitive_attributes*** and ***inquire_primitive_attributes***, which are equivalent to the 3-D functions.

Default values for many **SunCore** system parameters differ from those of the ACM Core.

There are restrictions on ***set_world_coordinate_matrix_2*** and ***set_world_coordinate_matrix_3*** as described in the manual.

As described in the manual, some of the echo types for input functions in the ACM Core are not implemented.

The marker symbol primitive attribute deviates from the ACM Core as described in the manual.

Batching of updates only applies to dynamic segment attributes as described in the manual.

View surfaces initialized for hidden-surface elimination do not support dynamic segment attributes of highlighting, transformation, or translation. ***initialize_view_surface*** can optionally suppress clearing the view surface when it is initialized.

Appendix B

SunCore View Surfaces

SunCore supports several types of view surfaces and multiple simultaneous instances of any type, subject to the hardware resources of the workstation on which a **SunCore** program is being run. The current release allows up to five view surfaces to be active at any time. This appendix gives implementation details of **SunCore** view surfaces and provides information on initializing them.

B.1. The vwsurf Structure

View surface names in **SunCore** are structures. The following declaration and definitions are contained in the header file */usr/include/usercore.h:*

```
#define DEVNAMESIZE 20

struct vwsurf   {
                char screenname[DEVNAMESIZE];
                char windowname[DEVNAMESIZE];
                int windowfd;
                int (*dd)();
                int instance;
                int cmapsize;
                char cmapname[DEVNAMESIZE];
                int flags;
                char **ptr;
                };

#define NULL_VWSURF {"", "", 0, 0, 0, 0, "", 0, 0}
#define DEFAULT_VWSURF(ddname) {"", "", 0, ddname, 0, 0, "", 0, 0}
#define VWSURF_NEWFLG   1
```

After initialization via the function *initialize_view_surface*, a *vwsurf* structure represents a specific instantiation of a particular type of view surface. The elements of the *vwsurf* structure completely characterize that instantiation and/or provide information used to initialize the view surface. This appendix refers to members of the *vwsurf* structure using the standard C notation, as if the declaration

```
struct vwsurf vwsurf;
```

had been given.

vwsurf.screenname
is a character string which is the name of the physical device on which the view surface appears (for example, */dev/cgone0*).

vwsurf.windowname
is a character string which is the name of a window device which has been opened for display of the output primitives directed to the view surface (for example, */dev/win10*).

vwsurf.windowfd
is the file descriptor corresponding to this device. Since, for all current **SunCore** view surface types, output display and input device echoing are accomplished through window system routines, these members of the structure are valid even for raw output devices.

vwsurf.dd
is the name of the device-independent/device-dependent interface routine through which graphics output to the view surface will pass. This routine defines the view surface type. The current **SunCore** view surface types are described below.

vwsurf.instance
identifies the instantiation of a view surface type. It should be set to 0 prior to calling *initialize_view_surface*. **SunCore** will set this value appropriately if the initialization is successful.

vwsurf.cmapsize
defines the size of the color lookup table for the view surface, and the character string *vwsurf.cmapname* gives its name, which can be used to share a color map between two or more view surfaces on the same physical device. These elements of the vwsurf structure are used only for view surfaces on color devices. Their use is described more fully below.

vwsurf.flags
is a field of one-bit flags. Currently, only one flag, VWSURF_NEWFLG, is defined; this flag is described below.

vwsurf.ptr
is a pointer to an array of character pointers. The array should be terminated by a null pointer. The strings pointed to by the array contain optional information which may be used to initialize the view surface. Details are provided below.

B.2. View Surface Types

A view surface type in **SunCore** is the name of the driver routine for the device-independent/device-dependent interface. The name of the routine corresponding to the desired view surface type should be put into *vwsurf.dd* prior to calling *initialize_view_surface* (see the programming examples in Chapters 1 and 8).

The current release of **SunCore** has six view surface types:

bw1dd The Sun-1 monochrome bitmap display used as a raw device.

bw2dd The Sun-2 monochrome bitmap display used as a raw device.

cg1dd The Sun-1 color graphics display used as a raw device.

cg2dd The Sun-2 color graphics display used as a raw device.

pixwindd A monochrome (one bit deep) graphics window within the Suntools window environment. This window may appear on either a color or monochrome display.

cgpixwindd A color graphics window within the Suntools window environment. This window must appear on a color display.

Only view surface types ***cg1dd***, ***cg2dd***, and ***cgpixwindd*** support hidden surface removal.

The term 'raw device' above implies that the physical device specified by ***vwsurf.screenname*** is used completely and only for display of graphics output directed to one view surface. This allows somewhat more efficient display of output primitives. It also implies that the user has not started up a Suntools window environment using the device as a desktop.

Low-level device-dependent routines are not part of **SunCore**. For the sake of efficiency, such routines are necessary for some applications. The Programmer's Reference Manual for the Sun Window System contains information on low-level routines corresponding to ***bw1dd***, ***bw2dd***, ***cg1dd***, and ***cg2dd*** (the 'pixrect' level) and ***pixwindd*** and ***cgpixwindd*** (the 'pixwin' level).

B.3. Choosing a View Surface Type within an Application Program

It may be desirable to write application programs which use different view surface types depending on the environment. The next two subsections provide examples of ways to do this. The next subsection illustrates using a Shell variable, and the subsection after that uses the `get_view_surface` function to do the job in a more general way.

B.3.1. Using Shell Variables to Determine the Environment

Examining a Shell environment variable is one way to determine which environment a program is running in. The following example illustrates using either a ***bw2dd*** (raw Sun-2 monochrome display) or a ***pixwindd*** (monochrome window) view surface depending on whether the user is currently in the Suntools window environment. The WINDOW_ME environment variable is normally defined in the user's environment if and only if the window system is being used.

```
/*
 * an example of selecting a view surface
 * depending on the current environment
 */

int bw2dd();
struct vwsurf rawsurface = DEFAULT_VWSURF(bw2dd);
int pixwindd();
struct vwsurf windowsurface = DEFAULT_VWSURF(pixwindd);

main()
        {
        struct vwsurf *surface, *get_surface();

        .
        .
        .
        surface = get_surface();
        initialize_view_surface(surface, FALSE);
        select_view_surface(surface);
        .
        .
        .
        }

struct vwsurf *get_surface()            /* function to return pointer */
        {                               /* to appropriate view surface */
        if (getenv("WINDOW_ME"))
                return(&windowsurface);
        else
                return(&rawsurface);
        }
```

B.3.2. The `get_view_surface` *Function*

The **SunCore** library includes the `get_view_surface` function which a programmer can use to set up a view surface structure using information from command-line arguments and the environment. A complete listing of `get_view_surface` appears at the end of this section. `get_view_surface` has the following declarations for C, FORTRAN, and Pascal:

Table B-1: Declarations of `get_view_surface` in C, FORTRAN, and Pascal

Language	*Declaration*

C	`get_view_surface(vsptr, argv)`
	`  struct vwsurf *vsptr;`
	`  char **argv;`

FORTRAN	`getviewsurface(vwsurf)` `  integer vwsurf(VWSURFSIZE)`
Pascal	`getviewsurface(var surfacename: vwsurf): integer; external;`

The elements of ***argv*** are pointers to null-terminated strings which are extracted from the command line that started the application program. The following fragment of C code illustrates the use of `get_view_surface` for C programs:

```
main(argc, argv)
    int argc;
    char **argv;
{
        struct  vwsurf  vwsurf;

                .
                .
                .
                code
                .
                .
                .
                if (get_view_surface(&vwsurf, argv))
                        exit(1);
                initialize_view_surface(&vwsurf, FALSE))
                .
                .
                .
                more code
                .
                .
                .
}
```

`get_view_surface` returns zero (0) if it succeeds and non-zero otherwise. The ***vwsurf*** structure will have ***vwsurf.dd*** and possibly ***vwsurf.screenname*** set to appropriate values. Other elements of the structure will be null — the programmer may modify them to suit the application, but it is not necessary.

The only command-line option that `get_view_surface` currently recognizes is the **−d** ***display_device*** option, where ***display_device*** is the name of the physical display device

(*/dev/fb* or */dev/cgone0* for example). The *vwsurf* structure will be set up to run on this device. `get_view_surface` also determines if the window system is running on the device, and chooses *vwsurf.dd* appropriately.

Using `get_view_surface` has a disadvantage in that since it refers to all six **SunCore** types of view surfaces, any program using it will get the code for all six device-independent/device-dependent driver routines linked in. For this reason, the code for `get_view_surface` is included here. **SunCore** programmers may wish to tailor a version of this code for particular machine configurations and applications.

The code of `get_view_surface` contains calls on several functions from *libsunwindow.a* — the window system library. Details of these routines can be found in the *Programmer's Reference Manual for the Sun Window System*.

```
/*
        get_view_surface  --  Determines from command-line arguments and
                              the environment a reasonable view surface
                              for a SunCore program to run on.
*/

#include <sys/file.h>
#include <sys/ioctl.h>
#include <sun/fbio.h>
#include <stdio.h>
#include <sunwindow/window_hs.h>
#include <usercore.h>

int bw1dd();            /* All six device-independent/device-dependent   */
int bw2dd();            /* routines are referenced in this function.     */
int cg1dd();            /* This means the linker will pull in all of them */
int cg2dd();
int pixwindd();
int cgpixwindd();

static struct vwsurf nullvs = NULL_VWSURF;

static char *devchk;
static int devhaswindows;

int get_view_surface(vsptr, argv)
struct vwsurf *vsptr;
char **argv;
        {
        int devfnd, fd, chkdevhaswindows();
        char *wptr, dev[DEVNAMESIZE], *getenv();
        struct screen screen;
        struct fbtype fbtype;

        *vsptr = nullvs;
        devfnd = FALSE;
        if (argv)
                /*
                If command-line arguments are passed, process them using
                win_initscreenfromargv (see the Programmer's Reference Manual
                for the Sun Window System).  The only option used by
                get_view_surface is the -d option, allowing the user to
                specify the display device on which to run.
                */
                {
                win_initscreenfromargv(&screen, argv);
                if (screen.scr_fbname[0] != '\0')
                        {
                        /* -d option was found */
                        devfnd = TRUE;
                        strncpy(dev, screen.scr_fbname, DEVNAMESIZE);
                        /*
                        Check to see if this device has a window system
                        running on it.  If so devhaswindows will be TRUE
```

```
                    following the call to win_enumall.  win_enumall is
                    a function in libsunwindow.a.  It takes a function
                    as its argument, and applies this function to every
                    window being displayed on any screen by the window
                    system.  To do this it opens each window and passes
                    the windowfd to the function.  The enumeration
                    continues until all windows have been tried or the
                    function returns TRUE.
                    */
                    devchk = dev;
                    devhaswindows = FALSE;
                    win_enumall(chkdevhaswindows);
                    }
            }
    if (!devfnd)
            /* No -d option was specified */
            if (wptr = getenv("WINDOW_ME"))
                    {
                    /*
                    Running in the window system.  Find the device from
                    which this program was started.
                    */
                    devhaswindows = TRUE;
                    if ((fd = open(wptr, O_RDWR, 0)) < 0)
                        {
                        fprintf(stderr, "get_view_surface: Can't open %s\n",
                            wptr);
                        return(1);
                        }
                    win_screenget(fd, &screen);
                    close(fd);
                    strncpy(dev, screen.scr_fbname, DEVNAMESIZE);
                    }
            else
                    {
                    /*
                    Not running in the window system.  Assume device is
                    /dev/fb.
                    */
                    devhaswindows = FALSE;
                    strncpy(dev, "/dev/fb", DEVNAMESIZE);
                    }
    /* Now have device name.  Find device type. */
    if ((fd = open(dev, O_RDWR, 0)) < 0)
            {
            fprintf(stderr, "get_view_surface: Can't open %s\n", dev);
            return(1);
            }
    if (ioctl(fd, FBIOGTYPE, &fbtype) == -1)
            {
            fprintf(stderr, "get_view_surface: ioctl FBIOGTYPE failed on %s\n",
                    dev);
            close(fd);
            return(1);
```

```
        }
    close(fd);
    /* Now have device type and know if window system is running on it. */
    if (devhaswindows)
        switch(fbtype.fb_type)
            {
        case FBTYPE_SUN1BW:
        case FBTYPE_SUN2BW:
            vsptr->dd = pixwindd;
            break;
        case FBTYPE_SUN1COLOR:
        case FBTYPE_SUN2COLOR:
            vsptr->dd = cgpixwindd;
            break;
        default:
            fprintf(stderr, "get_view_surface: %s is unknown fbtype\n",
                dev);
            return(1);
            }
    else
        switch(fbtype.fb_type)
            {
        case FBTYPE_SUN1BW:
            vsptr->dd = bw1dd;
            break;
        case FBTYPE_SUN2BW:
            vsptr->dd = bw2dd;
            break;
        case FBTYPE_SUN1COLOR:
            vsptr->dd = cg1dd;
            break;
        case FBTYPE_SUN2COLOR:
            vsptr->dd = cg2dd;
            break;
        default:
            fprintf(stderr, "get_view_surface: %s is unknown fbtype\n",
                dev);
            return(1);
            }
    /* Now SunCore device driver pointer is set up. */
    if (!devhaswindows || devfnd)
        /*
        If no window system on device or -d option was specified,
        tell SunCore which device.  Otherwise, let SunCore figure
        out the device itself from WINDOW_GFX so the default
        window will be used if desired.
        */
        strncpy(vsptr->screenname, dev, DEVNAMESIZE);
    return(0);
    }

static int chkdevhaswindows(windowfd)
int windowfd;
    {
```

```
struct screen windowscreen;

win_screenget(windowfd, &windowscreen);
if (strcmp(devchk, windowscreen.scr_fbname) == 0)
        {
        /*
        If this window is on the display device we are checking, set
        the flag TRUE.  Return TRUE to terminate the enumeration.
        */
        devhaswindows = TRUE;
        return(TRUE);
        }
return(FALSE);
}
```

B.4. Specifying a View Surface for Initialization

It is not necessary to specify every member of the ***vwsurf*** structure in order to initialize the view surface. If only ***vwsurf.dd*** is specified, **SunCore** will try to obtain a view surface of the specified type according to a default sequence. A statically allocated ***vwsurf*** structure may be set up to use this default by initializing the structure via the DEFAULT_VWSURF macro defined in ***usercore.h***. This is a compile-time initialization. The user may exercise finer control over view surfaces by setting other elements of the structure as described below. Any members which are not specified by the user should be set to zero (the integer 0, the NULL pointer, or an empty string, as appropriate).

B.4.1. View Surface Specification for Raw Devices

The default action for obtaining a new view surface of a raw device type is to try to open a sequence of devices until one is found which is of the right type and is not already being used. The sequence always starts with "/dev/fb". Then the following names are tried depending on the view surface type:

```
bw1dd  -  "/dev/bwone0", "/dev/bwone1", ..., "/dev/bwone9"
bw2dd  -  "/dev/bwtwo0", "/dev/bwtwo1", ..., "/dev/bwtwo9"
cg1dd  -  "/dev/cgone0", "/dev/cgone1", ..., "/dev/cgone9"
cg2dd  -  "/dev/cgtwo0", "/dev/cgtwo1", ..., "/dev/cgtwo9"
```

If none of the names in the sequence can be successfully opened and verified to be of the correct type and not already in use, ***initialize_view_surface*** fails.

If the user wishes to specify a particular physical device for a view surface, he may set ***vwsurf.screenname*** to be the device name of that device. The same steps will be taken to try to open the device as for each name in the default sequence. However, if these steps fail, no other names will be tried, and the initialization will fail.

vwsurf.cmapname and ***vwsurf.cmapsize*** are only used for color view surfaces. For ***cg1dd*** and ***cg2dd***, ***vwsurf.cmapsize*** is set to 256. If ***vwsurf.cmapname*** is specified, this name is used as the name of the color map; otherwise **SunCore** will provide a unique name.

No flags are currently defined for use with raw devices.

vwsurf.ptr provides a mechanism for passing optional initialization data to **SunCore**. In the case of raw devices, one such option is currently available — the passing of information about the adjacencies of physical screens. When the user creates a Suntools window environment on a screen, he is also responsible for specifying the relationship of that screen to other screens also running Suntools for purposes of tracking the mouse across multiple screens. The ***adjacentscreens*** command may be used to do this (see the User's Manual for the Sun UNIX System). However, when a **SunCore** program initializes a new view surface on a raw screen, the user will not previously have been able to inform the system of this adjacency because the new screen was previously not in use. ***vwsurf.ptr*** may be used to pass adjacency information for the new screen.

If ***vwsurf.ptr*** is not NULL, it should point to an array of character pointers. Only the first pointer in this array will be used. It should point to a string which is the pathname of a file containing information about the adjacencies of physical display devices. When the user sets up his display devices on his desk he may create a file describing the layout of these devices. For example, the following lines describe a system with two screens, the console frame buffer on the left (which might be either a Sun-1 or a Sun-2 monochrome bitmap display) and a Sun color graphics display on the right:

```
/dev/fb
R: /dev/cgone0
/dev/cgone0
L: /dev/fb
```

By convention, ***/dev/fb*** is the console frame buffer and ***/dev/cgone0*** is the first Sun color graphics display on a system. For each display device in the system, there should be one line giving its name, followed by several lines giving the directions and names of all adjacent screens. Thus all four lines above are necessary, not just the first two. Directions may be indicated as R, L, T, and B for right, left, top, and bottom, or as N, S, E, and W for north, south, east, and west.

B.4.2. View Surface Specification for Window Devices

The default action for obtaining a new view surface of type ***pixwindd*** or ***cgpixwindd*** is to first test whether the window referred to by the Shell environment variable WINDOW_GFX is already in use as a view surface. If not, a blanket window is inserted over the WINDOW_GFX window and this blanket window becomes the view surface. If WINDOW_GFX has already been used in this manner, the program /usr/suntool/coretool is invoked to create a new window on the same physical display device as WINDOW_GFX. This new window becomes the view surface. Thus, if a **SunCore** program is run from the tty subwindow of a Graphics Tool, the first default view surface will occupy the display space covered by the graphics subwindow of the tool. Subsequent default view surfaces will appear as graphics windows, each within a separate Core Tool on the same screen as the Graphics Tool.

This default action may be circumvented in two ways. If ***vwsurf.flags*** has the VWSURF_NEWFLG set, no attempt is made to take over WINDOW_GFX. A new window within a Core Tool is opened on the same screen as WINDOW_GFX. If ***vwsurf.screenname*** is non-empty, a new window within a Core Tool is opened on the screen specified by ***vwsurf.screenname***, provided this device exists and has a Suntools window environment running on it.

For view surfaces of type ***cgpixwindd***, ***vwsurf.cmapsize*** and ***vwsurf.cmapname*** provide a means of specifying and sharing color maps. The color map facilities of the Sun Window System are

used to control color maps for ***cgpizwindd*** view surfaces (see the Programmer's Reference Manual for the Sun Window System for details). The user may specify a color map size of 0, in which case a color map of length 2 will be used. Otherwise, ***vwsurf.cmapsize*** should be a power of 2 between 2 and 256. The user may specify a null color map name, in which case **SunCore** will provide a unique name. Otherwise, **SunCore** will check ***vwsurf.cmapname*** against the names of the color maps for all windows currently displayed on the physical device on which the new view surface is to appear. If a matching name is found, that color map will be used (even if its size differs from ***vwsurf.cmapsize***) and this map is shared among all windows on the device which reference that name. If the user specified a null name or the specified name does not match any current window's color map name, a new color map is allocated with the given size. The indices for each ***cgpizwindd*** view surface's color map run from 0 to ***vwsurf.cmapsize***−1. The current release of the Sun Window System enforces the restrictions that entry 0 of the color map is the background color for the desktop containing the window and entry ***vwsurf.cmapsize***−1 is the foreground color. The default background color for a desktop is white, and the default foreground color is black.

Currently, one optional string of initialization data may be passed to ***initialize_view_surface***. If ***vwsurf.ptr*** is non-NULL, it should point to an array of character pointers, only the first of which will be used. The pointer should point to a string containing position and size information for a Core Tool which may be started up to provide a window for the new view surface. (If the WINDOW_GFX window is taken over by this new view surface and thus no Core Tool is started, the string will be ignored.) The string should consist of nine integers, separated by commas:

```
"nl,nt,nw,nh,il,it,iw,ih,I"
```

nl, and nt give the initial position of the top left corner of the Core Tool in its normal form. nw and nh give the initial width and height. The numbers are given in screen coordinates, where (0, 0) is the upper left corner. il, it, iw, and ih give the same initial information for the iconic form of the tool. I is a boolean flag which should be non-zero if the tool is to be started in its iconic form.

B.5. Input Considerations

SunCore uses window system routines to obtain user input from the keyboard and mouse, no matter what mix of raw device view surfaces and window device view surfaces the user has initialized. For purposes of input, a raw device view surface behaves just like a window device view surface; it exists as a window within the window system's data structures, and the user may direct input to the window simply by positioning the mouse over it. The facts that window system input is directed to different windows depending on the location of the mouse and that the mouse position in the window system is reported in the coordinates of the window underlying the mouse have implications for the **SunCore** input functions.

For **SunCore** programs which are invoked from a window within the Suntools window environment, whenever the KEYBOARD device is initialized, ***await_keyboard*** will return characters typed when the mouse is located over any initialized view surface (belonging to a single user process) or over the tty subwindow from which the program was started. For programs run from outside a window environment, await_keyboard will return all characters typed on the keyboard, provided the KEYBOARD device is initialized.

The ACM Core specification defines input and output to be completely orthogonal functions. Thus, it is possible to initialize a locator device and read from it without ever initializing a view

surface. **SunCore** uses the mouse as the LOCATOR, STROKE, PICK, VALUATOR, and BUTTON devices. The only way **SunCore** can obtain mouse position and button click information to emulate these logical devices is to take input from a window. **SunCore** will return valid data in response to input requests for the LOCATOR, STROKE, PICK, and VALUATOR devices only when the user has associated these devices with an initialized view surface via the `set_echo_surface` function. Because all **SunCore** view surfaces are instantiations of generic view surface types, there is no default echo surface for any input device. The ***set_echo_surface*** function will accept a NULL pointer as its ***surface_name*** argument to allow the programmer to end the association of an input device with a view surface. Any input device may be echoed on any view surface independently of any other input device.

The input functions ***await_any_button_get_locator_2***, ***await_stroke_2***, ***await_pick***, and ***await_any_button_get_valuator*** will only use mouse input which the user directs to the window which is the echo surface for the indicated LOCATOR, STROKE, PICK, or VALUATOR device. This includes both position and button click input, so that the functions which are terminated by button clicks will terminate only when a button click occurs within the proper window (or a timeout occurs) Which buttons are listened to is still controlled by individually initializing or terminating each BUTTON device.

The user may also use ***set_echo_surface*** to choose from which window button clicks should be reported for a BUTTON device when the ***await_button*** function is called; alternatively, if the echo surface for a BUTTON device is NULL, ***await_button*** will check for button clicks from any view surface associated with a LOCATOR, STROKE, PICK, or VALUATOR device.

Note that the resolution obtained from a LOCATOR, STROKE, PICK, or VALUATOR device is limited by the width and/or height of its echo surface window, since mouse position information is provided by window system input routines in terms of window coordinates.

B.6. Notes on Window Device View Surfaces

Graphics primitives drawn on a view surface as part of a temporary segment normally remain visible on the view surface until a new-frame action occurs. For view surfaces which are windows within the Suntools window environment, several user actions can cause the view surface to be redrawn. Such actions include stretching the enclosing tool, exposing a previously obscured portion of the tool, and changing from the iconic form of the tool to the normal form. When the view surface is redrawn in this manner, all output primitives which previously appeared as part of temporary segments will disappear.

When a **SunCore** program is run from a Shell Tool, WINDOW_GFX is normally set to be the tool's tty subwindow. If this window is taken over and blanketed to serve as a view surface, output directed to the tty subwindow (for example, stdout and stderr, including **SunCore** error messages) will not be visible because the blanket window obscures the tty subwindow. When the program terminates or the view surface is terminated, any portion of this output which has not scrolled out of the subwindow will be visible. The fact that the tty subwindow is obscured also means that there is no way to type characters to that window, so that stdin will never see any input. However, if the KEYBOARD device is initialized, special characters, such as interrupt and suspend, typed to the blanket window will be recognized and will have their normal effect on the user process.

Appendix C

Alphabetical SunCore C Function Reference

This appendix contains an alphabetical list of **SunCore** functions and their arguments definitions. **SunCore** programs written in **C** must contain the statement:

```
#include <usercore.h>
```

at the start of each compilation unit. Programs are then compiled and linked with a **C** compiler command line like:

```
tutorial% cc files -lcore -lsunwindow -lpixrect -lm
```

C.1. Alphabetical List of C Interfaces

```
allocate_raster(raster)
    struct {
    int width, height, depth;
    short *bits; } *raster;

await_any_button(time, button_number)
    int time;
    int *button_number;

await_any_button_get_locator_2(time, locator_number, button_number, x, y)
    int time;
    int locator_number;
    int *button_number;
    float *x, *y;

await_any_button_get_valuator(time, valuator_number, button_number, value)
    int time;
    int valuator_number;
    int *button_number;
    float *value;

await_keyboard(time, keyboard_number, input_string, length)
    int time;
    int keyboard_number;
    char *input_string;
    int *length;
```

```
await_pick(time, pick_number, segment_name, pick_id)
    int time;
    int pick_number;
    int *segment_name;
    int *pick_id;

await_stroke_2(time, stroke_number, array_size, x_array, y_array, number_points)
    int time;
    int stroke_number;
    int array_size;
    float x_array[];
    float y_array[];
    int *number_points;

begin_batch_of_updates()

close_retained_segment()

close_temporary_segment()

create_retained_segment(segment_name)
    int segment_name;

create_temporary_segment()

define_color_indices(surface_name, i1, i2, red_array, green_array, blue_array)
    struct vwsurf *surface_name;
    int i1, i2;
    float red_array[], green_array[], blue_array[];

delete_all_retained_segments()

delete_retained_segment(segment_name)
    int segment_name;

deselect_view_surface(surface_name)
    struct vwsurf *surface_name;

end_batch_of_updates()
```

```
file_to_raster(fd, raster, map)
    int fd;
    struct {
    int width, height, depth;
    short *bits; } *raster; struct {
    int type;
    int nbytes;
    char *data; } *map;

free_raster(raster)
    struct {
    int width, height, depth;
    short *bits; } *raster;

get_mouse_state(device_class, device_number, x, y, buttons)
    int device_class;
    int device_number;
    float *x, *y;
    int *buttons;

get_raster(surface_name, xmin, xmax, ymin, ymax, x, y, raster)
    struct vwsurf *surface_name;
    float xmin, ymin, xmax, ymax;
    int x, y; struct {
    int width, height, depth;
    short *bits; } *raster;

initialize_core(output_level, input_level, dimension)
    int output_level;
    int input_level;
    int dimension;

initialize_device(device_class, device_number)
    int device_class;
    int device_number;

initialize_view_surface(surface_name, type)
    struct vwsurf *surface_name;
    int type;

inquire_charjust(just)
    int *just;

inquire_charpath_2(dx, dy)
    float *dx, *dy;

inquire_charpath_3(dx, dy, dz)
    float *dx, *dy, *dz;
```

```
inquire_charprecision(charprecision)
    int *charprecision;

inquire_charsize(charwidth, charheight)
    float *charwidth, *charheight;

inquire_charspace(charspace)
    float *charspace;

inquire_charup_2(dx, dy)
    float *dx, *dy;

inquire_charup_3(dx, dy, dz)
    float *dx, *dy, *dz;

inquire_color_indices(surface_name, i1, i2, red_array, green_array, blue_array)
    struct vwsurf *surface_name;
    int i1, i2;
    float red_array[];
    float green_array[];
    float blue_array[];

inquire_current_position_2(x, y)
    float *x, *y;

inquire_current_position_3(x, y, z)
    float *x, *y, *z;

inquire_detectability(detectability)
    int *detectability;

inquire_echo(device_class, device_number, echo_type)
    int device_class;
    int device_number;
    int *echo_type;

inquire_echo_position(device_class, device_number, echo_x, echo_y)
    int device_class;
    int device_number;
    float *echo_x;
    float *echo_y;

inquire_echo_surface(device_class, device_number, surface_name)
    int device_class;
    int device_number;
    struct vwsurf *surface_name;
```

```
inquire_fill_index(index)
    int *index;

inquire_font(font)
    int *font;

inquire_highlighting(highlighting)
    int *highlighting;

inquire_image_transformation_2(sx, sy, a, tx, ty)
    float *sx, *sy;
    float *a;
    float *tx, *ty;

inquire_image_transformation_3(sx, sy, sz, ax, ay, az, tx, ty, tz)
    float *sx, *sy, *sz;
    float *ax, *ay, *az;
    float *tx, *ty, *tz;

inquire_image_transformation_type(type)
    int *type;

inquire_image_translate_2(tx, ty)
    float *tx, *ty;

inquire_image_translate_3(tx, ty, tz)
    float *tx, *ty, *tz;

inquire_inverse_composite_matrix(array)
    float array[4][4];

inquire_keyboard(keyboard_number, buffer_size, initial_string,
                 initial_cursor_position)
    int keyboard_number;
    int *buffer_size;
    char *initial_string;
    int *initial_cursor_position;

inquire_line_index(index)
    int *index;

inquire_linestyle(linestyle)
    int *linestyle;

inquire_linewidth(linewidth)
    float *linewidth;
```

```
inquire_locator_2(locator_number, x, y)
    int locator_number;
    float *x;
    float *y;

inquire_marker_symbol(symbol)
    int *symbol;

inquire_ndc_space_2(width, height)
    float *width, *height;

inquire_ndc_space_3(width, height, depth)
    float *width, *height, *depth;

inquire_open_retained_segment(segment_name)
    int *segment_name;

inquire_open_temporary_segment(open)
    int *open;

inquire_pen(pen)
    int *pen;

inquire_pick_id(pick_id)
    int *pick_id;

inquire_polygon_edge_style(style)
    int *style;

inquire_polygon_interior_style(style)
    int *style;

inquire_primitive_attributes(attributes)
    struct {
    int lineindx, fillindx, textindx;
    int linestyl, polylinestyl, polyedgestyl;
    float linwidth;
    int pen, font;
    float charwidth, charheight;
    float charupx, charupy, charupz, charupw;
    float charpathx, charpathy, charpathz, charpathw;
    float charspacex, charspacey, charspacez, charspacew;
    int chjust, chquality;
    int marker, pickid, rasterop; } *attributes;
```

```
inquire_projection(projection_type, dx, dy, dz)
    int *projection_type;
    float *dx, *dy, *dz;

inquire_rasterop(rop)
    int *rop;

inquire_retained_segment_names(array_size, name_array, number_of_segments)
    int array_size;
    int name_array[];
    int *number_of_segments;

inquire_retained_segment_surfaces(segment_name, array_size, view_surface_array,
                                  number_of_surfaces)
    int segment_name;
    int array_size;
    struct vwsurf view_surface_array[];
    int *number_of_surfaces;

inquire_segment_detectability(segment_name, detectability)
    int segment_name;
    int *detectability;

inquire_segment_highlighting(segment_name, highlighting)
    int segment_name;
    int *highlighting;

inquire_segment_image_transformation_2(segment_name, sx, sy, a, tx, ty)
    int segment_name;
    float *sx;
    float *sy;
    float *a;
    float *tx;
    float *ty;

inquire_segment_image_transformation_3(segment_name, sx, sy, sz, ax, ay, az,
                                       tx, ty, tz)
    int segment_name;
    float *sx;
    float *sy;
    float *sz;
    float *ax;
    float *ay;
    float *az;
    float *tx;
    float *ty;
    float *tz;
```

```
inquire_segment_image_transformation_type(segment_name, type)
    int segment_name;
    int *type;

inquire_segment_image_translate_2(segment_name, tx, ty)
    int segment_name;
    float *tx;
    float *ty;

inquire_segment_image_translate_3(segment_name, tx, ty, tz)
    int segment_name;
    float *tx;
    float *ty;
    float *tz;

inquire_segment_visibility(segment_name, visibility)
    int segment_name;
    int *visibility;

inquire_stroke(stroke_number, buffer_size, distance, time)
    int stroke_number;
    int *buffer_size;
    float *distance;
    int *time;

inquire_text_extent_2(string, dx, dy)
    char *string;
    float *dx, *dy;

inquire_text_extent_3(string, dx, dy, dz)
    char *string;
    float *dx, *dy, *dz;

inquire_text_index(index)
    int *index;

inquire_valuator(valuator_number, initial_value, low, high)
    int valuator_number;
    float *initial_value;
    float *low;
    float *high;

inquire_view_depth(front_distance, back_distance)
    float *front_distance, *back_distance;

inquire_view_plane_distance(view_distance)
    float *view_distance;
```

```
inquire_view_plane_normal(dx, dy, dz)
    float *dx, *dy, *dz;

inquire_view_reference_point(x, y, z)
    float *x, *y, *z;

inquire_view_up_2(dx, dy)
    float *dx, *dy;

inquire_view_up_3(dx, dy, dz)
    float *dx, *dy, *dz;

inquire_viewing_control_parameters(windowclip, frontclip, backclip, type)
    int *windowclip;
    int *frontclip;
    int *backclip;
    int *type;

inquire_viewing_parameters(view_parameters)
    struct {
    float vwrefpt[3];
    float vwplnorm[3];
    float viewdis;
    float frontdis;
    float backdis;
    int projtype;
    float projdir[3];
    float window[4];
    float vwupdir[3];
    float viewport[6]; } *view_parameters;

inquire_viewport_2(xmin, xmax, ymin, ymax)
    float *xmin, *xmax;
    float *ymin, *ymax;

inquire_viewport_3(xmin, xmax, ymin, ymax, zmin, zmax)
    float *xmin, *xmax;
    float *ymin, *ymax;
    float *zmin, *zmax;

inquire_visibility(visibility)
    int *visibility;

inquire_window(umin, umax, vmin, vmax)
    float *umin, *umax;
    float *vmin, *vmax;
```

```
inquire_world_coordinate_matrix_2(array)
    float array[3][3];

inquire_world_coordinate_matrix_3(array)
    float array[4][4];

line_abs_2(x, y)
    float x, y;

line_abs_3(x, y, z)
    float x, y, z;

line_rel_2(dx, dy)
    float dx, dy;

line_rel_3(dx, dy, dz)
    float dx, dy, dz;

map_ndc_to_world_2(ndcx, ndcy, wldx, wldy)
    float ndcx, ndcy;
    float *wldx, *wldy;

map_ndc_to_world_3(ndcx, ndcy, ndcz, wldx, wldy, wldz)
    float ndcx, ndcy, ndcz;
    float *wldx, *wldy, *wldz;

map_world_to_ndc_2(wldx, wldy, ndcx, ndcy)
    float wldx, wldy;
    float *ndcx, *ndcy;

map_world_to_ndc_3(wldx, wldy, wldz, ndcx, ndcy, ndcz)
    float wldx, wldy, wldz;
    float *ndcx, *ndcy, *ndcz;

marker_abs_2(x, y)
    float x, y;

marker_abs_3(x, y, z)
    float x, y, z;

marker_rel_2(dx, dy)
    float dx, dy;

marker_rel_3(dx, dy, dz)
    float dx, dy, dz;
```

```
move_abs_2(x, y)
    float x, y;

move_abs_3(x, y, z)
    float x, y, z;

move_rel_2(dx, dy)
    float dx, dy;

move_rel_3(dx, dy, dz)
    float dx, dy, dz;

new_frame()

polygon_abs_2(x_array, y_array, n)
    float x_array[], y_array[];
    int n;

polygon_abs_3(x_array, y_array, z_array, n)
    float x_array[], y_array[], z_array[];
    int n;

polygon_abs_3(x_array, y_array, z_array, n)
    float x_array[], y_array[], z_array[];
    int n;

polygon_rel_2(dx_array, dy_array, n)
    float dx_array[], dy_array[];
    int n;

polygon_rel_3(dx_array, dy_array, dz_array, n)
    float dx_array[], dy_array[], dz_array[];
    int n;

polyline_abs_2(x_array, y_array, n)
    float x_array[], y_array[];
    int n;

polyline_abs_3(x_array, y_array, z_array, n)
    float x_array[], y_array[], z_array[];
    int n;

polyline_abs_3(x_array, y_array, z_array, n)
    float x_array[], y_array[], z_array[];
    int n;
```

```
polyline_rel_2(dx_array, dy_array, n)
    float dx_array[], dy_array[];
    int n;

polyline_rel_3(dx_array, dy_array, dz_array, n)
    float dx_array[], dy_array[], dz_array[];
    int n;

polymarker_abs_2(x_array, y_array, n)
    float x_array[], y_array[];
    int n;

polymarker_abs_3(x_array, y_array, z_array, n)
    float x_array[], y_array[], z_array[];
    int n;

polymarker_rel_2(dx_array, dy_array, n)
    float dx_array[], dy_array[];
    int n;

polymarker_rel_3(dx_array, dy_array, dz_array, n)
    float dx_array[], dy_array[], dz_array[];
    int n;

print_error("Your message", error_number);
    int error_number;

put_raster(raster)
    struct {
    int width, height, depth;
    short *bits; } *raster;

raster_to_file(raster, map, fd, replicate)
    struct {
    int width, height, depth;
    short *bits; } *raster; struct {
    int type;
    int nbytes;
    char *data; } *map;
    int fd;
    int replicate;

rename_retained_segment(segment_name, newname)
    int segment_name;
    int newname;

report_most_recent_error(error_number)
    int *error_number;
```

```
restore_segment(segment_name, filename)
    int segment_name;
    char *filename;

save_segment(segment_name, filename)
    int segment_name;
    char *filename;

select_view_surface(surface_name)
    struct vwsurf *surface_name;

set_back_plane_clipping(back_on_off)
    int back_on_off;

set_charjust(just)
    int just;

set_charpath_2(dx, dy)
    float dx, dy;

set_charpath_3(dx, dy, dz)
    float dx, dy, dz;

set_charprecision(charprecision)
    int charprecision;

set_charsize(charwidth, charheight)
    float charwidth, charheight;

set_charspace(charspace)
    float charspace;

set_charup_2(dx, dy)
    float dx, dy;

set_charup_3(dx, dy, dz)
    float dx, dy, dz;

set_coordinate_system_type(type)
    int type;

set_detectability(detectability)
    int detectability;

set_drag(mode)
    int mode;
```

```
set_echo(device_class, device_number, echo_type)
    int device_class;
    int device_number;
    int echo_type;

set_echo_group(device_class, device_number_array, n, echo_type)
    int device_class;
    int device_number_array[];
    int n;
    int echo_type;

set_echo_position(device_class, device_number, echo_x, echo_y)
    int device_class;
    int device_number;
    float echo_x;
    float echo_y;

set_echo_surface(device_class, device_number, surface_name)
    int device_class;
    int device_number;
    struct vwsurf *surface_name;

set_fill_index(index)
    int index;

set_font(font)
    int font;

set_front_plane_clipping(front_on_off)
    int front_on_off;

set_highlighting(highlighting)
    int highlighting;

set_image_transformation_2(sx, sy, a, tx, ty)
    float sx, sy;
    float a;
    float tx, ty;

set_image_transformation_3(sx, sy, sz, ax, ay, az, tx, ty, tz)
    float sx, sy, sz;
    float ax, ay, az;
    float tx, ty, tz;

set_image_transformation_type(type)
    int type;
```

```
set_image_translate_2(tx, ty)
    float tx, ty;

set_image_translate_3(tx, ty, tz)
    float tx, ty, tz;

set_keyboard(keyboard_number, buffer_size, initial_string,
             initial_cursor_position)
    int keyboard_number;
    int buffer_size;
    char *initial_string;
    int initial_cursor_position;

set_light_direction(dx, dy, dz)
    float dx, dy, dz;

set_line_index(index)
    int index;

set_linestyle(linestyle)
    int linestyle;

set_linewidth(linewidth)
    float linewidth;

set_locator_2(locator_number, x, y)
    int locator_number;
    float x;
    float y;

set_marker_symbol(marker)
    int marker;

set_ndc_space_2(width, height)
    float width, height;

set_ndc_space_3(width, height, depth)
    float width, height, depth;

set_output_clipping(on_off)
    int on_off;

set_pen(pen)
    int pen;
```

```
set_pick(pick_number, aperture)
    int pick_number;
    float aperture;

set_pick_id(pick_id)
    int pick_id;

set_polygon_edge_style(style)
    int style;

set_polygon_interior_style(style)
    int style;

set_primitive_attributes(&PRIMATTS)

set_primitive_attributes(attributes)
    struct {
    int lineindx, fillindx, textindx;
    int linestyl, polylinestyl, polyedgestyl;
    float linwidth;
    int pen, font;
    float charwidth, charheight;
    float charupx, charupy, charupz, charupw;
    float charpathx, charpathy, charpathz, charpathw;
    float charspacex, charspacey, charspacez, charspacew;
    int chjust, chquality;
    int marker, pickid, rasterop; } *attributes;

set_projection(projection, dx_proj, dy_proj, dz_proj)
    int projection;
    float dx_proj, dy_proj, dz_proj;

set_rasterop(rop)
    int rop;

set_segment_detectability(segment_name, detectability)
    int segment_name;
    int detectability;

set_segment_highlighting(segment_name, highlighting)
    int segment_name;
    int highlighting;
```

```
set_segment_image_transformation_2(segment_name, sx, sy, a, tx, ty)
    int segment_name;
    float sx;
    float sy;
    float a;
    float tx;
    float ty;

set_segment_image_transformation_3(segment_name, sx, sy, sz, ax, ay, az,
                                   tx, ty, tz)
    int segment_name;
    float sx;
    float sy;
    float sz;
    float ax;
    float ay;
    float az;
    float tx;
    float ty;
    float tz;

set_segment_image_translate_2(segment_name, tx, ty)
    int segment_name;
    float tx;
    float ty;

set_segment_image_translate_3(segment_name, tx, ty, tz)
    int segment_name;
    float tx;
    float ty;
    float tz;

set_segment_visibility(segment_name, visibility)
    int segment_name;
    int visibility;

set_shading_parameters(ambient, diffuse, specular, flood, bump, hue, style)
    float ambient;
    float diffuse;
    float specular;
    float flood;
    float bump;
    int hue;
    int style;

set_stroke(stroke_number, buffer_size, distance, time)
    int stroke_number;
    int buffer_size;
    float distance;
    int time;
```

```
set_text_index(index)
    int index;

set_valuator(valuator_number, initial_value, low, high)
    int valuator_number;
    float initial_value;
    float low;
    float high;

set_vertex_indices(color_index_list, n)
    int color_index_list[];
    int n;

set_vertex_normals(xlist, ylist, zlist, n)
    float xlist[], ylist[], zlist[];
    int n;

set_view_depth(front_distance, back_distance)
    float front_distance, back_distance;

set_view_plane_distance(distance)
    float distance;

set_view_plane_normal(dx_norm, dy_norm, dz_norm)
    float dx_norm, dy_norm, dz_norm;

set_view_reference_point(x, y, z)
    float x, y, z;

set_view_up_2(dx, dy)
    float dx, dy;

set_view_up_3(dx_up, dy_up, dz_up)
    float dx_up, dy_up, dz_up;

set_viewing_parameters(view_parameters)
    struct {
    float vwrefpt[3];
    float vwplnorm[3];
    float viewdis;
    float frontdis;
    float backdis;
    int projtype;
    float projdir[3];
    float window[4];
    float vwupdir[3];
    float viewport[6]; } *view_parameters;
```

```
set_viewport_2(xmin, xmax, ymin, ymax)
    float xmin, xmax;
    float ymin, ymax;

set_viewport_3(xmin, xmax, ymin, ymax, zmin, zmax)
    float xmin, xmax;
    float ymin, ymax;
    float zmin, zmax;

set_visibility(visibility)
    int visibility;

set_window(umin, umax, vmin, vmax)
    float umin, umax;
    float vmin, vmax;

set_window_clipping(on_off)
    int on_off;

set_world_coordinate_matrix_2(array)
    float array[3][3];

set_world_coordinate_matrix_3(array)
    float array[4][4];

set_zbuffer_cut(surface_name, xlist, zlist, n)
    struct vwsurf *surface_name;
    float xlist[], zlist[];
    int n;

size_raster(surface_name, xmin, xmax, ymin, ymax, raster)
    struct vwsurf *surface_name;
    float xmin, xmax, ymin, ymax; struct {
    int width, height, depth;
    short *bits; } *raster;

terminate_core()

terminate_device(device_class, device_number)
    int device_class;
    int device_number;

terminate_view_surface(surface_name)
    struct vwsurf *surface_name;

text(string)
    char *string;
```

Appendix D

Using SunCore with Fortran-77 Programs

All functions provided in **SunCore** may be called from FORTRAN-77 programs by linking them with the */usr/lib/libcore77.a* library. This is done by using the *f77* compiler with a command line such as:

```
tutorial%gf77 -o grab grab.f -lcore77 -lcore -lsunwindow -lpixrect -lm
```

where *grab.f* is the FORTRAN source program. Note that */usr/lib/libcore.a* must be linked with the program (the **-lcore** option), and */usr/lib/libcore77.a* must come before it (the **-lcore77** option).

Defined constants may be referenced in source programs by including */usr/include/f77/usercore77.h* In a FORTRAN program, this must be done via a source statement like:

```
include "/usr/include/f77/usercore77.h"
```

This include statement must be in each FORTRAN program unit which uses the defined constants, not just once in each source program file. The default primitive attribute structure PRIMATTS which is provided in *usercore.h* and is described in section 6.1.23 of this manual is not provided in *usercore77.h* because of FORTRAN's restrictions on the ordering of specification statements and data statements.

In the Sun release of FORTRAN-77, names are restricted to sixteen characters in length and may not contain the underline character. For this reason, FORTRAN programs must use abbreviated names to call the corresponding **SunCore** functions. The correspondence between the full **SunCore** names and the FORTRAN names appears later in this appendix. In addition, FORTRAN-77 declarations for all **SunCore** functions appear at the end of this appendix.

D.1. Programming Tips

- The abbreviated names of the **SunCore** functions are less readable than the full length names because the underline character cannot be used in the FORTRAN names. However, since FORTRAN doesn't distinguish between upper-case and lower-case letters in names, upper-case characters can be used to improve readability. There is an example of this later in this appendix.
- Character strings passed from FORTRAN programs to **SunCore** cannot be longer than 256 characters.
- FORTRAN passes all arguments by reference. Although some **SunCore** functions receive arguments by value, the FORTRAN programmer need not worry about this. The interface routines in */usr/lib/libcore77.a* handle this situation correctly. When in doubt, look at the FORTRAN

declarations for **SunCore** functions at the end of this appendix.

- **SunCore** uses pointers in some places. For instance, view surface structures contain pointers to device driver functions. Also, the ***raster*** data type includes a pointer to an array of short's containing the raster data. There are no pointer types in FORTRAN, but there are ways to handle all uses of pointers required to use **SunCore**. For view surface names, the following fragments of C code and FORTRAN code do the same thing:

C Code	FORTRAN Code
`struct vwsurf vsurf = NULL_VWSURF;`	`integer vsurf(VWSURFSIZE)`
`int bw1dd();`	`integer bw1dd` `external bw1dd`
`vsurf.dd = bw1dd;`	`data vsurf /VWSURFSIZE*0/` `vsurf(DDINDEX) = loc(bw1dd)`
`initialize_view_surface(&vsurf, FALSE);`	`call InitializeVwsurf(vsurf, FALSE)`

The constants VWSURFSIZE and DDINDEX are defined in ***usercore77.h***. The constant VWSURFNEWFLG is also defined in ***usercore77.h***. See appendix B for more details on view surfaces.

As shown above, all required pointer manipulation can be done with the FORTRAN `loc` library function, which returns the address of its argument as an integer.

SunCore function arguments which are pointers to structures can be declared as arrays in FORTRAN. For example, the C and FORTRAN declarations of the **SunCore** ***raster*** structure are shown below:

C Code	*FORTRAN Code*

`struct {`
`  int width, height, depth;`
`  short *bits;`
`  } raster;`
	`integer raster(4)`

Then the following fragments of C and FORTRAN code are equivalent:

C Code	FORTRAN Code
`short data[16];`	`integer*2 data(16)`

`raster.width = 16;`
`raster.height = 16;`
`raster.depth = 1;`
`raster.bits = data;`
	`raster(1) = 16`
	`raster(2) = 16`
	`raster(3) = 1`
	`raster(4) = loc(data)`

- Some **SunCore** structures contain both int's and `float`'s. For instance, the argument to `inquire_viewing_parameters` contains both int's and `float`'s. This can be handled in

FORTRAN by declaring a REAL array and an INTEGER array which are made to share storage by an EQUIVALENCE statement. Then following the call to the inquiry function, the REAL components can be accessed by using the REAL array and the INTEGER components accessed via the INTEGER array.

- Since FORTRAN does not distinguish between upper-case and lower-case letters in identifiers, any FORTRAN program unit which includes the ***usercore77.h*** header file cannot use identifiers with the same spelling as any constant defined in that header file (regardless of case).
- The `filetoraster` and `rastertofile` functions in C take an argument that is a UNIX† file descriptor. The corresponding argument to the FORTRAN functions is a logical unit number (LUN). This unit should be explicitly opened by using the FORTRAN `open` statement. I/O to the opened file should be done ***only*** via the `filetoraster` and `rastertofile` functions.

D.2. Example Program

This example is the FORTRAN equivalent of the very simple program for drawing a martini glass.

```
include "/usr/include/f77/usercore77.h"

integer vsurf(VWSURFSIZE)
integer bwldd
external bwldd
integer InitializeCore, InitializeVwsurf, SelectVwsurf
real glassdx(9), glassdy(9)
data glassdx /-10.0,9.0,0.0,-14.0,30.0,-14.0,0.0,9.0,-10.0/
data glassdy /0.0,1.0,19.0,15.0,0.0,-15.0,-19.0,-1.0, 0.0/
data vsurf /VWSURFSIZE*0/

vsurf(DDINDEX) = loc(bwldd)
if (InitializeCore(BASIC, NOINPUT, TWOD) .ne. 0) call exit(1)
if (InitializeVwsurf(vsurf, FALSE) .ne. 0) call exit(2)
if (SelectVwsurf(vsurf) .ne. 0) call exit(3)
call SetViewport2(0.125, 0.875, 0.125, 0.75)
call SetWindow(-50.0, 50.0, -10.0, 80.0)
call CreateTempSeg()
call MoveAbs2(0.0, 0.0)
call PolylineRel2(glassdx, glassdy, 9)
call MoveRel2(-12.0, 33.0)
call LineRel2(24.0, 0.0)
call CloseTempSeg()
call sleep(10)
call DeselectVwsurf(vsurf)
call TerminateCore()
end
```

† UNIX is a trademark of Bell Laboratories.

D.3. Correspondence Between C Names and FORTRAN Names

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
allocate_raster	allocateraster
await_any_button	awaitanybutton
await_any_button_get_locator_2	awtbuttongetloc2
await_any_button_get_valuator	awtbuttongetval
await_keyboard	awaitkeyboard
await_pick	awaitpick
await_stroke_2	awaitstroke2
begin_batch_of_updates	beginbatchupdate
close_retained_segment	closeretainseg
close_temporary_segment	closetempseg
create_retained_segment	createretainseg
create_temporary_segment	createtempseg
define_color_indices	defcolorindices
delete_all_retained_segments	delallretainsegs
delete_retained_segment	delretainsegment
deselect_view_surface	deselectvwsurf
end_batch_of_updates	endbatchupdate
file_to_raster	filetoraster
free_raster	freeraster
get_mouse_state	getmousestate
get_raster	getraster
initialize_core	initializecore
initialize_device	initializedevice
initialize_view_surface	initializevwsurf
inquire_charjust	inqcharjust
inquire_charpath_2	inqcharpath2
inquire_charpath_3	inqcharpath3
inquire_charprecision	inqcharprecision
inquire_charsize	inqcharsize
inquire_charspace	inqcharspace
inquire_charup_2	inqcharup2
inquire_charup_3	inqcharup3
inquire_color_indices	inqcolorindices
inquire_current_position_2	inqcurrpos2
inquire_current_position_3	inqcurrpos3
inquire_detectability	inqdetectability
inquire_echo	inqecho

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
inquire_echo_position	inqechoposition
inquire_echo_surface	inqechosurface
inquire_fill_index	inqfillindex
inquire_font	inqfont
inquire_highlighting	inqhighlighting
inquire_image_transformation_2	inqimgtransform2
inquire_image_transformation_3	inqimgtransform3
inquire_image_transformation_type	inqimgxformtype
inquire_image_translate_2	inqimgtranslate2
inquire_image_translate_3	inqimgtranslate3
inquire_inverse_composite_matrix	inqinvcompmatrix
inquire_keyboard	inqkeyboard
inquire_line_index	inqlineindex
inquire_linestyle	inqlinestyle
inquire_linewidth	inqlinewidth
inquire_locator_2	inqlocator2
inquire_marker_symbol	inqmarkersymbol
inquire_ndc_space_2	inqndcspace2
inquire_ndc_space_3	inqndcspace3
inquire_open_retained_segment	inqopenretainseg
inquire_open_temporary_segment	inqopentempseg
inquire_pen	inqpen
inquire_pick_id	inqpickid
inquire_polygon_edge_style	inqpolyedgestyle
inquire_polygon_interior_style	inqpolyintrstyle
inquire_primitive_attributes	inqprimattribs
inquire_projection	inqprojection
inquire_rasterop	inqrasterop
inquire_retained_segment_names	inqretainsegname
inquire_retained_segment_surfaces	inqretainsegsurf
inquire_segment_detectability	inqsegdetectable
inquire_segment_highlighting	inqseghighlight
inquire_segment_image_transformation_2	inqsegimgxform2
inquire_segment_image_transformation_3	inqsegimgxform3
inquire_segment_image_transformation_type	inqsegimgxfrmtyp
inquire_segment_image_translate_2	inqsegimgxlate2
inquire_segment_image_translate_3	inqsegimgxlate3
inquire_segment_visibility	inqsegvisibility
inquire_stroke	inqstroke

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
inquire_text_extent_2	inqtextextent2
inquire_text_extent_3	inqtextextent3
inquire_text_index	inqtextindex
inquire_valuator	inqvaluator
inquire_view_depth	inqviewdepth
inquire_view_plane_distance	inqviewplanedist
inquire_view_plane_normal	inqviewplanenorm
inquire_view_reference_point	inqviewrefpoint
inquire_view_up_2	inqviewup2
inquire_view_up_3	inqviewup3
inquire_viewing_control_parameters	inqvwgcntrlparms
inquire_viewing_parameters	inqviewingparams
inquire_viewport_2	inqviewport2
inquire_viewport_3	inqviewport3
inquire_visibility	inqvisibility
inquire_window	inqwindow
inquire_world_coordinate_matrix_2	inqworldmatrix2
inquire_world_coordinate_matrix_3	inqworldmatrix3
line_abs_2	lineabs2
line_abs_3	lineabs3
line_rel_2	linerel2
line_rel_3	linerel3
map_ndc_to_world_2	mapndctoworld2
map_ndc_to_world_3	mapndctoworld3
map_world_to_ndc_2	mapworldtondc2
map_world_to_ndc_3	mapworldtondc3
marker_abs_2	markerabs2
marker_abs_3	markerabs3
marker_rel_2	markerrel2
marker_rel_3	markerrel3
move_abs_2	moveabs2
move_abs_3	moveabs3
move_rel_2	moverel2
move_rel_3	moverel3
new_frame	newframe
polygon_abs_2	polygonabs2
polygon_abs_3	polygonabs3
polygon_rel_2	polygonrel2
polygon_rel_3	polygonrel3

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
polyline_abs_2	polylineabs2
polyline_abs_3	polylineabs3
polyline_rel_2	polylinerel2
polyline_rel_3	polylinerel3
polymarker_abs_2	polymarkerabs2
polymarker_abs_3	polymarkerabs3
polymarker_rel_2	polymarkerrel2
polymarker_rel_3	polymarkerrel3
print_error	printerror
put_raster	putraster
raster_to_file	rastertofile
rename_retained_segment	renameretainseg
report_most_recent_error	reportrecenterr
restore_segment	restoresegment
save_segment	savesegment
select_view_surface	selectvwsurf
set_back_plane_clipping	setbackclip
set_charjust	setcharjust
set_charpath_2	setcharpath2
set_charpath_3	setcharpath3
set_charprecision	setcharprecision
set_charsize	setcharsize
set_charspace	setcharspace
set_charup_2	setcharup2
set_charup_3	setcharup3
set_coordinate_system_type	setcoordsystype
set_detectability	setdetectability
set_drag	setdrag
set_echo	setecho
set_echo_group	setechogroup
set_echo_position	setechoposition
set_echo_surface	setechosurface
set_fill_index	setfillindex
set_font	setfont
set_front_plane_clipping	setfrontclip
set_highlighting	sethighlighting
set_image_transformation_2	setimgtransform2
set_image_transformation_3	setimgtransform3
set_image_transformation_type	setimgxformtype
set_image_translate_2	setimgtranslate2

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
set_image_translate_3	setimgtranslate3
set_keyboard	setkeyboard
set_light_direction	setlightdirect
set_line_index	setlineindex
set_linestyle	setlinestyle
set_linewidth	setlinewidth
set_locator_2	setlocator2
set_marker_symbol	setmarkersymbol
set_ndc_space_2	setndcspace2
set_ndc_space_3	setndcspace3
set_output_clipping	setoutputclip
set_pen	setpen
set_pick	setpick
set_pick_id	setpickid
set_polygon_edge_style	setpolyedgestyle
set_polygon_interior_style	setpolyintrstyle
set_primitive_attributes	setprimattribs
set_projection	setprojection
set_rasterop	setrasterop
set_segment_detectability	setsegdetectable
set_segment_highlighting	setseghighlight
set_segment_image_transformation_2	setsegimgxform2
set_segment_image_transformation_3	setsegimgxform3
set_segment_image_translate_2	setsegimgxlate2
set_segment_image_translate_3	setsegimgxlate3
set_segment_visibility	setsegvisibility
set_shading_parameters	setshadingparams
set_stroke	setstroke
set_text_index	settextindex
set_valuator	setvaluator
set_vertex_indices	setvertexindices
set_vertex_normals	setvertexnormals
set_view_depth	setviewdepth
set_view_plane_distance	setviewplanedist
set_view_plane_normal	setviewplanenorm
set_view_reference_point	setviewrefpoint
set_viewport_2	setviewport2
set_viewport_3	setviewport3
set_view_up_2	setviewup2
set_view_up_3	setviewup3

Correspondence Between C Names and FORTRAN Names

Long Name	*FORTRAN Equivalent*
set_viewing_parameters	setviewingparams
set_visibility	setvisibility
set_window	setwindow
set_window_clipping	setwindowclip
set_world_coordinate_matrix_2	setworldmatrix2
set_world_coordinate_matrix_3	setworldmatrix3
set_zbuffer_cut	setzbuffercut
size_raster	sizeraster
terminate_core	terminatecore
terminate_device	terminatedevice
terminate_view_surface	terminatevwsurf
text	text

D.4. FORTRAN Interfaces to SunCore

Note: Although all SunCore procedures are declared here as functions, each may also be called as a subroutine if the user does not want to check the returned value.

```
integer function allocateraster(raster)
integer raster(4)

integer function awaitanybutton(time, buttonnum)
integer time, buttonnum

integer function awtbuttongetloc2(time, locatornum, buttonnum, x, y)
integer time, locatornum, buttonnum
real x, y

integer function awtbuttongetval(time,valuatornum,buttonnum,value)
integer time, valuatornum, buttonnum
real value

integer function awaitkeyboard(time, keyboardnum, inputstring, length)
integer time, keyboardnum
character*(*) inputstring
integer length

integer function awaitpick(time, picknum, segname, pickid)
integer time, picknum, segname, pickid
```

```
integer function awaitstroke2(time, strokenum, arraysize, xarray, yarray, n)
integer time, strokenum, arraysize
real xarray, yarray
integer n

integer function beginbatchupdate()

integer function closeretainseg()

integer function closetempseg()

integer function createretainseg(segname)
integer segname

integer function createtempseg()

integer function defcolorindices(surfacename, i1, i2, red, green, blue)
integer surfacename(*)
integer i1, i2
real red(*), green(*), blue(*)

integer function delallretainsegs()

integer function delretainsegment(segname)
integer segname

integer function deselectvwsurf(surfacename)
integer surfacename(*)

integer function endbatchupdate()

integer function filetoraster(rasfid, raster, map)
integer rasfid
integer raster(4)
integer map(3)

integer function freeraster(raster)
integer raster(4)


integer function getmousestate(devclass, devnum, x, y, buttons)
integer devclass, devnum
real x, y
integer buttons
```

```
integer function getraster(surfacename, xmin, xmax, ymin, ymax, xd, yd, raster)
integer surfacename(*)
real xmin, xmax, ymin, ymax
integer xd, yd
integer raster(4)

integer function initializecore(outputlevel, inputlevel, dimension)
integer outputlevel, inputlevel, dimension

integer function initializedevice(deviceclass, devicenum)
integer deviceclass, devicenum

integer function initializevwsurf(surfacename, type)
integer surfacename(*)
integer type

integer function inqcharjust(just)
integer just

integer function inqcharpath2(dx, dy)
real dx, dy

integer function inqcharpath3(dx, dy, dz)
real dx, dy, dz

integer function inqcharprecision(charprecision)
integer charprecision

integer function inqcharsize(charwidth, charheight)
real charwidth, charheight

integer function inqcharspace(charspace)
real charspace

integer function inqcharup2(dx, dy)
real dx, dy

integer function inqcharup3(dx, dy, dz)
real dx, dy, dz

integer function inqcolorindices(surfacename, i1, i2, red, green, blue)
integer surfacename(*)
integer i1, i2
real red(*), green(*), blue(*)
```

```
integer function inqcurrpos2(x, y)
real x, y

integer function inqcurrpos3(x, y, z)
real x, y, z

integer function inqdetectability(detectability)
integer detectability

integer function inqecho(deviceclass, devicenum, echotype)
integer deviceclass, devicenum, echotype

integer function inqechoposition(deviceclass, devicenum, echox, echoy)
integer deviceclass, devicenum
real echox, echoy

integer function inqechosurface(deviceclass, devicenum, surfacename)
integer deviceclass, devicenum
integer surfacename(*)

integer function inqfillindex(index)
integer index

integer function inqfont(font)
integer font

integer function inqhighlighting(highlighting)
integer highlighting

integer function inqimgtransform2(sx, sy, a, tx, ty)
real sx, sy, a, tx, ty

integer function inqimgtransform3(sx, sy, sz, ax, ay, az, tx, ty, tz)
real sx, sy, sz, ax, ay, az, tx, ty, tz

integer function inqimgxformtype(type)
integer type

integer function inqimgtranslate2(tx, ty)
real tx, ty

integer function inqimgtranslate3(tx, ty, tz)
real tx, ty, tz

integer function inqinvcompmatrix(array)
real array(4,4)
```

```
integer function inqkeyboard(keyboardnum, buffersize, initstring, initcursor)
integer keyboardnum, buffersize
character*(*) initstring
integer initcursor

integer function inqlineindex(index)
integer index

integer function inqlinestyle(linestyle)
integer linestyle

integer function inqlinewidth(linewidth)
real linewidth

integer function inqlocator2(locatornum, x, y)
integer locatornum
real x, y

integer function inqmarkersymbol(symbol)
integer symbol

integer function inqndcspace2(width, height)
real width, height

integer function inqndcspace3(width, height, depth)
real width, height, depth

integer function inqopenretainseg(segname)
integer segname

integer function inqopentempseg(open)
integer open

integer function inqpen(pen)
integer pen

integer function inqpickid(pickid)
integer pickid

integer function inqpolyedgestyle(style)
integer style

integer function inqpolyintrstyle(style)
integer style
```

```
integer function inqprimattribs(primattr)
integer primattr(28)
```

Note: The actual argument in the calling program corresponding to primattr should be an array which can be referenced both as a real array and as an integer array in order to access both integer valued and real valued primitive attributes. This can be done using the equivalence *statement.*

```
integer function inqprojection(projection, dxproj, dyproj, dzproj)
integer projection real dxproj, dyproj, dzproj

integer function inqrasterop(rop)
integer rop

integer function inqretainsegname(arraysize, namearray, numberofsegments)
integer arraysize, namearray(*), numberofsegments

integer function inqretainsegsurf(segname, arraysize, vwsurfarray, numsurf)
integer segname, arraysize
integer vwsurfarray(*)
integer numsurf
```

Note: arraysize should give the number of view surface structures which can be held in vwsurfarray. Each structure requires VWSURFSIZE elements of vwsurfarray.

```
integer function inqsegdetectable(segname, detectability)
integer segname, detectability

integer function inqseghighlight(segname, highlighting)
integer segname, highlighting

integer function inqsegimgxform2(segname, sx, sy, a, tx, ty)
integer segname
real sx, sy, a, tx, ty

integer function inqsegimgxform3(segname, sx, sy, sz, ax, ay, az, tx, ty, tz)
integer segname
real sx, sy, sz, ax, ay, az, tx, ty, tz

integer function inqsegimgxfrmtyp(segname, type)
integer segname, type

integer function inqsegimgxlate2(segname, tx, ty)
integer segname
real tx, ty
```

```
integer function inqsegimgxlate3(segname, tx, ty, tz)
integer segname
real tx, ty, tz

integer function inqsegvisibility(segname, visibility)
integer segname, visibility

integer function inqstroke(strokenum, bufsize, dist, time)
integer strokenum, bufsize
real dist
integer time

integer function inqtextextent2(string, dx, dy)
character*(*) string
real dx, dy

integer function inqtextextent3(string, dx, dy, dz)
character*(*) string
real dx, dy, dz

integer function inqtextindex(index)
integer index

integer function inqvaluator(valuatornum, initialvalue, low, high)
integer valuatornum
real initialvalue, low, high

integer function inqviewdepth(frontdistance, backdistance)
real frontdistance, backdistance

integer function inqviewplanedist(viewdistance)
real viewdistance

integer function inqviewplanenorm(dxnorm, dynorm, dznorm)
real dxnorm, dynorm, dznorm

integer function inqviewrefpoint(x, y, z)
real x, y, z

integer function inqviewup2(dxup, dyup)
real dxup, dyup

integer function inqviewup3(dxup, dyup, dzup)
real dxup, dyup, dzup
```

```
integer function inqvwgcntrlparms(windowclip, frontclip, backclip, type)
integer windowclip, frontclip, backclip, type

integer function inqviewingparams(viewparams)
real viewparams(26)
```

Note: The actual argument in the calling program corresponding to viewparams should be an array which can be referenced both as a real array and as an integer array in order to access both integer valued and real valued viewing parameters. This can be done using the equivalence *statement.*

```
integer function inqviewport2(xmin, xmax, ymin, ymax)
real xmin, xmax, ymin, ymax

integer function inqviewport3(xmin, xmax, ymin, ymax, zmin, zmax)
real xmin, xmax, ymin, ymax, zmin, zmax

integer function inqvisibility(visibility)
integer visibility

integer function inqwindow(umin, umax, vmin, vmax)
real umin, umax, vmin, vmax

integer function inqworldmatrix2(array)
real array(3,3)

integer function inqworldmatrix3(array)
real array(4,4)

integer function lineabs2(x, y)
real x, y

integer function lineabs3(x, y, z)
real x, y, z

integer function linerel2(dx, dy)
real dx, dy

integer function linerel3(dx, dy, dz)
real dx, dy, dz

integer function mapndctoworld2(ndcx, ndcy, wldx, wldy)
real ndcx, ndcy, wldx, wldy
```

```
integer function mapndctoworld3(ndcx, ndcy, ndcz, wldx, wldy, wldz)
real ndcx, ndcy, ndcz, wldx, wldy, wldz

integer function mapworldtondc2(wldx, wldy, ndcx, ndcy)
real wldx, wldy, ndcx, ndcy

integer function mapworldtondc3(wldx, wldy, wldz, ndcx, ndcy, ndcz)
real wldx, wldy, wldz, ndcx, ndcy, ndcz

integer function markerabs2(x, y)
real x, y

integer function markerabs3(x, y, z)
real x, y, z

integer function markerrel2(dx, dy)
real dx, dy

integer function markerrel3(dx, dy, dz)
real dx, dy, dz

integer function moveabs2(x, y)
real x, y

integer function moveabs3(x, y, z)
real x, y, z

integer function moverel2(dx, dy)
real dx, dy

integer function moverel3(dx, dy, dz)
real dx, dy, dz

integer function newframe()

integer function polygonabs2(xarray, yarray, n)
real xarray(*), yarray(*)
integer n

integer function polygonabs3(xarray, yarray, zarray, n)
real xarray(*), yarray(*), zarray(*)
integer n

integer function polygonrel2(dxarray, dyarray, n)
real dxarray(*), dyarray(*)
integer n
```

```
integer function polygonrel3(dxarray, dyarray, dzarray, n)
real dxarray(*), dyarray(*), dzarray(*)
integer n

integer function polylineabs2(xarray, yarray, n)
real xarray(*), yarray(*)
integer n

integer function polylineabs3(xarray, yarray, zarray, n)
real xarray(*), yarray(*), zarray(*)
integer n

integer function polylinerel2(dxarray, dyarray, n)
real dxarray(*), dyarray(*)
integer n

integer function polylinerel3(dxarray, dyarray, dzarray, n)
real dxarray(*), dyarray(*), dzarray(*)
integer n

integer function polymarkerabs2(xarray, yarray, n)
real xarray(*), yarray(*)
integer n

integer function polymarkerabs3(xarray, yarray, zarray, n)
real xarray(*), yarray(*), zarray(*)
integer n

integer function polymarkerrel2(dxarray, dyarray, n)
real dxarray(*), dyarray(*)
integer n

integer function polymarkerrel3(dxarray, dyarray, dzarray, n)
real dxarray(*), dyarray(*), dzarray(*)
integer n

integer function printerror(message, errornum)
character*(*) message
integer errornum

integer function putraster(raster)
integer raster(4)

integer function rastertofile(raster, map, rasfid, n)
integer raster(4)
integer map(3)
integer rasfid, n
```

```
integer function renameretainseg(segname, newname)
integer segname, newname

integer function reportrecenterr(errornum)
integer errornum

integer function restoresegment(segname, filename)
integer segname
character*(*) filename

integer function savesegment(segname, filename)
integer segname
character*(*) filename

integer function selectvwsurf(surfacename)
integer surfacename(*)

integer function setbackclip(onoff)
integer onoff

integer function setcharjust(just)
integer just

integer function setcharpath2(dx, dy)
real dx, dy

integer function setcharpath3(dx, dy, dz)
real dx, dy, dz

integer function setcharprecision(charprecision)
integer charprecision

integer function setcharsize(charwidth, charheight)
real charwidth, charheight

integer function setcharspace(charspace)
real charspace

integer function setcharup2(dx, dy)
real dx, dy

integer function setcharup3(dx, dy, dz)
real dx, dy, dz

integer function setcoordsystype(type)
integer type
```

```
integer function setdetectability(detectability)
integer detectability

integer function setdrag(mode)
integer mode

integer function setecho(deviceclass, devicenum, echotype)
integer deviceclass, devicenum, echotype

integer function setechogroup(deviceclass, devicenumarray, n, echotype)
integer deviceclass, devicenumarray(*), n, echotype

integer function setechoposition(deviceclass, devicenum, echox, echoy)
integer deviceclass, devicenum
real echox, echoy

integer function setechosurface(deviceclass, devicenum, surfacename)
integer deviceclass, devicenum
integer surfacename(*)

integer function setfillindex(index)
integer index

integer function setfont(font)
integer font

integer function setfrontclip(onoff)
integer onoff

integer function sethighlighting(highlighting)
integer highlighting

integer function setimgtransform2(sx, sy, a, tx, ty)
real sx, sy, a, tx, ty

integer function setimgtransform3(sx, sy, sz, ax, ay, az, tx, ty, tz)
real sx, sy, sz, ax, ay, az, tx, ty, tz

integer function setimgxformtype(type)
integer type

integer function setimgtranslate2(tx, ty)
real tx, ty

integer function setimgtranslate3(tx, ty, tz)
real tx, ty, tz
```

```
integer function setkeyboard(keyboardnum, buffersize, initstring, initcursor)
integer keyboardnum, buffersize
character*(*) initstring
integer initcursor

integer function setlightdirect(dx, dy, dz)
real dx, dy, dz

integer function setlineindex(index)
integer index

integer function setlinestyle(linestyle)
integer linestyle

integer function setlinewidth(linewidth)
real linewidth

integer function setlocator2(locatornum, x, y)
integer locatornum
real x, y

integer function setmarkersymbol(symbol)
integer symbol

integer function setndcspace2(width, height)
real width, height

integer function setndcspace3(width, height, depth)
real width, height, depth

integer function setoutputclip(onoff)
integer onoff

integer function setpen(pen)
integer pen

integer function setpick(picknum, aperture)
integer picknum
real aperture

integer function setpickid(pickid)
integer pickid

integer function setpolyedgestyle(style)
integer style
```

```
integer function setpolyintrstyle(style)
integer style

integer function setprimattribs(primattr)
integer primattr(28)
```

Note: The actual argument in the calling program corresponding to primattr should be an array which can be referenced both as a real array and as an integer array in order to access both integer valued and real valued primitive attributes. This can be done using the `equivalence` *statement.*

```
integer function setprojection(projection, dxproj, dyproj, dzproj)
integer projection
real dxproj, dyproj, dzproj

integer function setrasterop(rop)
integer rop

integer function setsegdetectable(segname, detectability)
integer segname, detectability

integer function setseghighlight(segname, highlighting)
integer segname, highlighting

integer function setsegimgxform2(segname, sx, sy, a, tx, ty)
integer segname
real sx, sy, a, tx, ty

integer function setsegimgxform3(segname, sx, sy, sz, ax, ay, az, tx, ty, tz)
integer segname
real sx, sy, sz, ax, ay, az, tx, ty, tz

integer function setsegimgxlate2(segname, tx, ty)
integer segname
real tx, ty

integer function setsegimgxlate3(segname, tx, ty, tz)
integer segname
real tx, ty, tz

integer function setsegvisibility(segname, visibility)
integer segname, visibility

integer function setshadingparams(ambient, diffuse, specular, flood, bump, hue, sty
real ambient, diffuse, specular, flood, bump
integer hue, style
```

```
integer function setstroke(strokenum, buffersize, distance, time)
integer strokenum, buffersize
real distance
integer time

integer function settextindex(index)
integer index

integer function setvaluator(valuatornum, initialvalue, low, high)
integer valuatornum
real initialvalue, low, high

integer function setvertexindices(colorindexlist, n)
integer colorindexlist(*), n

integer function setvertexnormals(xlist, ylist, zlist, n)
real xlist(*), ylist(*), zlist(*)
integer n

integer function setviewdepth(frontdistance, backdistance)
real frontdistance, backdistance

integer function setviewplanedist(distance)
real distance

integer function setviewplanenorm(dxnorm, dynorm, dznorm)
real dxnorm, dynorm, dznorm

integer function setviewport2(xmin, xmax, ymin, ymax)
real xmin, xmax, ymin, ymax

integer function setviewport3(xmin, xmax, ymin, ymax, zmin, zmax)
real xmin, xmax, ymin, ymax, zmin, zmax

integer function setviewrefpoint(x, y, z)
real x, y, z

integer function setviewup2(dx, dy)
real dx, dy

integer function setviewup3(dx, dy, dz)
real dx, dy, dz

integer function setviewingparams(viewparams)
real viewparams(26)
```

Note: The actual argument in the calling program corresponding to viewparams should be an array which can be referenced both as a real array and as an integer array in order to access both integer valued and real valued viewing parameters. This can be done using the `equivalence` *statement.*

```
integer function setvisibility(visibility)
integer visibility

integer function setwindow(umin, umax, vmin, vmax)
real umin, umax, vmin, vmax

integer function setwindowclip(onoff)
integer onoff

integer function setworldmatrix2(array)
real array(3,3)

integer function setworldmatrix3(array)
real array(4,4)

integer function setzbuffercut(surfacename, xlist, zlist, n)
integer surfacename(*)
real xlist(*), zlist(*)
integer n

integer function sizeraster(surfacename, xmin, xmax, ymin, ymax, raster)
integer surfacename(*)
real xmin, xmax, ymin, ymax
integer raster(4)

integer function terminatecore()

integer function terminatedevice(deviceclass, devicenum)
integer deviceclass, devicenum

integer function terminatevwsurf(surfacename)
integer surfacename(*)

integer function text(string)
character*(*) string
```

Appendix E

Using SunCore with Pascal Programs

All functions provided in **SunCore** may be called from Pascal programs by linking them with the */usr/lib/libcorepas.a* library by using the Pascal compiler with a command line of the form:

```
tutorial% pc -o grab grab.p -lcorepas -lcore -lsunwindow -lpixrect -lm
```

where *grab.p* is the Pascal source program. Note that */usr/lib/libcore.a* must be linked with the program (the **-lcore** option), and */usr/lib/libcorepas.a* must come before it (the **-lcorepas** option).

E.1. Programming Requirements

The files *typedefspas.h*, *usercorepas.h*, *devincpas.h* and *sunpas.h* from the */usr/include/pascal* directory must be included in the user's source code to provide the necessary declarations for the Pascal interface to **SunCore**. Pascal programs which call **SunCore** functions must place these include files in the most global declaration section of the program:

```
        program example (input,output)

#include  '/usr/include/pascal/typedefspas.h'
#include  '/usr/include/pascal/usercorepas.h'

        var
                {user declarations}

#include  '/usr/include/pascal/devincpas.h'
#include  '/usr/include/pascal/sunpas.h'
```

If the Pascal program is composed of separately compiled files, these include statements must be in each Pascal file which uses **SunCore** functions and the corresponding defined constants. Defined constants for **SunCore** (see section on *Useful Constants* in the introduction to this manual) are set in the file */usr/include/pascal/usercorepas.h*. The default primitive attribute structure PRIMATTS provided in *usercore.h* and described in the section describing *set_primitive_attributes* is not provided in *usercorepas.h*.

The Sun release of Pascal does not support the passing of variable length arrays as arguments in function or procedure calls. Therefore, fixed length arrays which are compatible with the **SunCore**-Pascal interface are declared as predefined types in the *typedefspas.h* file (see the *Declarations* section of this appendix). The length of these arrays in 256. The length of

character strings passed from Pascal programs to **SunCore** must also be 256 characters.

In the Sun release of Pascal, function names may not contain the underline character (_). Therefore, Pascal programs use abbreviated names to call the corresponding **SunCore** functions. The correspondence between the full **SunCore** names and the Pascal names appears in the Function Declarations section of this appendix. To provide a mechanism for returning the status of calls to **SunCore** routines, all **SunCore** routines must be called as functions from Pascal. Finally, although most **SunCore** functions use floats (32-bit reals), Pascal uses 64-bit reals. However, the Pascal programmer is only required to provide reals. **SunCore** functions which have structures as their arguments have corresponding predefined types in Pascal (see the *Type Declarations* section of this appendix).

E.1.1. Routines Using View Surface Names

View surface names in **SunCore** are structures containing pointers to device driver routines. The device driver names are supplied by the include file ***devincpas.h***. The user may then simply use one of these names:

`bw1dd`	for the Sun-1 monochrome display,
`bw2dd`	for the Sun-2 monochrome display,
`cg1dd`	for the Sun-1 color display,
`cg2dd`	for the Sun-2 color display,
`pixwindd`	for windows on the Sun-1 monochrome display,
`cgpixwindd`	for windows on a color display.

The **pasloc** function (provided in the **SunCore**-Pascal interface) transforms the function corresponding to the device driver into an integer which can then be inserted in the appropriate place in the device driver structure (see following example).

C Code	*Pascal Code*

`struct vwsurf dsurf = NULL_VWSURF;`
`int bw1dd();`
 	
`.`
`.`
`.`
 	
`dsurf.dd = bw1dd;`
 	
`initialize_view_surface(&dsurf, FALSE);`
	`var`
	`dsurf:vwsurf;`
	`tstr:vwsurfst;`
	
	`.`
	`.`
	`.`
	`tstr := '  ';`
	`dsurf.dd := pasloc(bw1dd);`
	`dsurf.screenname := tstr;`
	`dsurf.windowname := tstr;`
	`dsurf.windowfd := 0;`
	`dsurf.instance := 0;`
	`dsurf.cmapsize := 0;`
	`dsurf.cmapname := tstr;`
	`dsurf.flags := 0;`
	`dsurf.ptr := 0;`
	`x := InitializeVwsurf(dsurf, FALSE);`

Assigning a literal string of two spaces (blanks) to the ***tstr*** variable will initialize the character array to all spaces.

E.1.2. Routines Using Rasters and Colormaps

For uses of **SunCore** functions which have rasters or colormaps as arguments which do not involve arithmetic direct manipulation by the programmer (for example, writing a raster to a file), the following restrictions on the functions do not apply and the programmer is only required to call the function. **SunCore** raster and colormap structures contain pointers to variable length data (that is, dynamic arrays). The **SunCore**-Pascal interface declares these varaibles as integers.

Pascal programmers wishing to alter the contents of the colormap or raster data within a program can write a C function which uses the pointer value returned in Pascal to copy the information into a fixed-length array. Arithmetic operations can then be performed on the data using conventional Pascal statements. The programmer can then write another C function to copy the information back into the array pointed to by the pointer returned by the **SunCore**-Pascal interface. These C functions are not provided because the size of the fixed-length array will vary greatly among different applications. Therefore, the individual Pascal programmer must decide how large an array to declare for each application.

E.2. Example Program

The use of the **SunCore**-Pascal interface is illustrated by showing the text of a program for drawing the martini glass used in previous tutorial examples.

```
        program martiniglass (input,output);

#include '/usr/include/pascal/usercorepas.h';
#include '/usr/include/pascal/typedefspas.h';

        var
             glassdx, glassdy: parr {type parr is an array of reals of
                                     length 256 declared in typedefs.h};
             x:integer;
             dsurf:vwsurf;
             tstr:vsurfst;
             function sleep(x:integer):integer; external;
#include '/usr/include/pascal/sunpas.h';
#include '/usr/include/pascal/devincpas.h';

        procedure loaddata;
                begin
                    glassdx[1] := -10.0;  glassdy[1] := 0.0;
                    glassdx[2] := 9.0;    glassdy[2] := 1.0;
                    glassdx[3] := 0.0;    glassdy[3] := 19.0;
                    glassdx[4] := -14.0;  glassdy[4] := 15.0;
                    glassdx[5] := 30.0;   glassdy[5] := 0.0;
                    glassdx[6] := -14.0;  glassdy[6] := -15.0;
                    glassdx[7] := 0.0;    glassdy[7] := -19.0;
                    glassdx[8] := 9.0;    glassdy[8] := -1.0;
                    glassdx[9] := -10.0;  glassdy[9] := 0.0;
                end;

        begin {main program}
        tstr := '  ';
        dsurf.screenname := tstr;
        dsurf.windowname := tstr;
        dsurf.windowfd := 0;
        dsurf.dd := pasloc(bw1dd);
        dsurf.instance := 0;
        dsurf.cmapsize := 0;
        dsurf.cmapname := tstr;
        dsurf.flags := 0;
        dsurf.charptr := 0;
            if (initializecore(BASIC, NOINPUT, TWOD) <> 0) then
                writeln (' error 1')
            else
              if (initializevwsurf(dsurf, FALSE) <> 0) then
                writeln (' error 2')
              else
                if (selectvwsurf(dsurf) <> 0) then
                  writeln (' error 3')
                else
                   x := setviewport2(0.125, 0.875, 0.125, 0.75);
                   x := setwindow(-50.0, 50.0, -10.0, 80.0);
                   x := createtempseg;
                   x := moveabs2(0.0, 0.0);
                   loaddata;
                   x := polylinerel2(glassdx, glassdy,9);
```

```
                x := moverel2(-12.0, 33.0);
                x := linerel2(24.0, 0.0);
                x := closetempseg;
                x := sleep(10);
                x := deselectvwsurf(dsurf);
                x := terminatecore;
        end.
```

E.3. Correspondence Between C Names and Pascal Names

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
allocate_raster	allocateraster
await_any_button	awaitanybutton
await_any_button_get_locator_2	awtbuttongetloc2
await_any_button_get_valuator	awtbuttongetval
await_keyboard	awaitkeyboard
await_pick	awaitpick
await_stroke_2	awaitstroke2
begin_batch_of_updates	beginbatchupdate
close_retained_segment	closeretainseg
close_temporary_segment	closetempseg
create_retained_segment	createretainseg
create_temporary_segment	createtempseg
define_color_indices	defcolorindices
delete_all_retained_segments	delallretainsegs
delete_retained_segment	delretainsegment
deselect_view_surface	deselectvwsurf
end_batch_of_updates	endbatchupdate
file_to_raster	filetoraster
free_raster	freeraster
get_mouse_state	getmousestate
get_raster	getraster
initialize_core	initializecore
initialize_device	initializedevice
initialize_view_surface	initializevwsurf
inquire_charjust	inqcharjust
inquire_charpath_2	inqcharpath2
inquire_charpath_3	inqcharpath3
inquire_charprecision	inqcharprecision
inquire_charsize	inqcharsize
inquire_charspace	inqcharspace
inquire_charup_2	inqcharup2
inquire_charup_3	inqcharup3
inquire_color_indices	inqcolorindices
inquire_current_position_2	inqcurrpos2
inquire_current_position_3	inqcurrpos3
inquire_detectability	inqdetectability
inquire_echo	inqecho

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
inquire_echo_position	inqechoposition
inquire_echo_surface	inqechosurface
inquire_fill_index	inqfillindex
inquire_font	inqfont
inquire_highlighting	inqhighlighting
inquire_image_transformation_2	inqimgtransform2
inquire_image_transformation_3	inqimgtransform3
inquire_image_transformation_type	inqimgxformtype
inquire_image_translate_2	inqimgtranslate2
inquire_image_translate_3	inqimgtranslate3
inquire_inverse_composite_matrix	inqinvcompmatrix
inquire_keyboard	inqkeyboard
inquire_line_index	inqlineindex
inquire_linestyle	inqlinestyle
inquire_linewidth	inqlinewidth
inquire_locator_2	inqlocator2
inquire_marker_symbol	inqmarkersymbol
inquire_ndc_space_2	inqndcspace2
inquire_ndc_space_3	inqndcspace3
inquire_open_retained_segment	inqopenretainseg
inquire_open_temporary_segment	inqopentempseg
inquire_pen	inqpen
inquire_pick_id	inqpickid
inquire_polygon_edge_style	inqpolyedgestyle
inquire_polygon_interior_style	inqpolyintrstyle
inquire_primitive_attributes	inqprimattribs
inquire_projection	inqprojection
inquire_rasterop	inqrasterop
inquire_retained_segment_names	inqretainsegname
inquire_retained_segment_surfaces	inqretainsegsurf
inquire_segment_detectability	inqsegdetectable
inquire_segment_highlighting	inqseghighlight
inquire_segment_image_transformation_2	inqsegimgxform2
inquire_segment_image_transformation_3	inqsegimgxform3
inquire_segment_image_transformation_type	inqsegimgxfrmtyp
inquire_segment_image_translate_2	inqsegimgxlate2
inquire_segment_image_translate_3	inqsegimgxlate3
inquire_segment_visibility	inqsegvisibility
inquire_stroke	inqstroke

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
inquire_text_extent_2	inqtextextent2
inquire_text_extent_3	inqtextextent3
inquire_text_index	inqtextindex
inquire_valuator	inqvaluator
inquire_view_depth	inqviewdepth
inquire_view_plane_distance	inqviewplanedist
inquire_view_plane_normal	inqviewplanenorm
inquire_view_reference_point	inqviewrefpoint
inquire_view_up_2	inqviewup2
inquire_view_up_3	inqviewup3
inquire_viewing_control_parameters	inqvwgcntrlparms
inquire_viewing_parameters	inqviewingparams
inquire_viewport_2	inqviewport2
inquire_viewport_3	inqviewport3
inquire_visibility	inqvisibility
inquire_window	inqwindow
inquire_world_coordinate_matrix_2	inqworldmatrix2
inquire_world_coordinate_matrix_3	inqworldmatrix3
line_abs_2	lineabs2
line_abs_3	lineabs3
line_rel_2	linerel2
line_rel_3	linerel3
map_ndc_to_world_2	mapndctoworld2
map_ndc_to_world_3	mapndctoworld3
map_world_to_ndc_2	mapworldtondc2
map_world_to_ndc_3	mapworldtondc3
marker_abs_2	markerabs2
marker_abs_3	markerabs3
marker_rel_2	markerrel2
marker_rel_3	markerrel3
move_abs_2	moveabs2
move_abs_3	moveabs3
move_rel_2	moverel2
move_rel_3	moverel3
new_frame	newframe
polygon_abs_2	polygonabs2
polygon_abs_3	polygonabs3
polygon_rel_2	polygonrel2
polygon_rel_3	polygonrel3

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
polyline_abs_2	polylineabs2
polyline_abs_3	polylineabs3
polyline_rel_2	polylinerel2
polyline_rel_3	polylinerel3
polymarker_abs_2	polymarkerabs2
polymarker_abs_3	polymarkerabs3
polymarker_rel_2	polymarkerrel2
polymarker_rel_3	polymarkerrel3
print_error	printerror
put_raster	putraster
raster_to_file	rastertofile
rename_retained_segment	renameretainseg
report_most_recent_error	reportrecenterr
restore_segment	restoresegment
save_segment	savesegment
select_view_surface	selectvwsurf
set_back_plane_clipping	setbackclip
set_charjust	setcharjust
set_charpath_2	setcharpath2
set_charpath_3	setcharpath3
set_charprecision	setcharprecision
set_charsize	setcharsize
set_charspace	setcharspace
set_charup_2	setcharup2
set_charup_3	setcharup3
set_coordinate_system_type	setcoordsystype
set_detectability	setdetectability
set_drag	setdrag
set_echo	setecho
set_echo_group	setechogroup
set_echo_position	setechoposition
set_echo_surface	setechosurface
set_fill_index	setfillindex
set_font	setfont
set_front_plane_clipping	setfrontclip
set_highlighting	sethighlighting
set_image_transformation_2	setimgtransform2
set_image_transformation_3	setimgtransform3
set_image_transformation_type	setimgxformtype
set_image_translate_2	setimgtranslate2

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
set_image_translate_3	setimgtranslate3
set_keyboard	setkeyboard
set_light_direction	setlightdirect
set_line_index	setlineindex
set_linestyle	setlinestyle
set_linewidth	setlinewidth
set_locator_2	setlocator2
set_marker_symbol	setmarkersymbol
set_ndc_space_2	setndcspace2
set_ndc_space_3	setndcspace3
set_output_clipping	setoutputclip
set_pen	setpen
set_pick	setpick
set_pick_id	setpickid
set_polygon_edge_style	setpolyedgestyle
set_polygon_interior_style	setpolyintrstyle
set_primitive_attributes	setprimattribs
set_projection	setprojection
set_rasterop	setrasterop
set_segment_detectability	setsegdetectable
set_segment_highlighting	setseghighlight
set_segment_image_transformation_2	setsegimgxform2
set_segment_image_transformation_3	setsegimgxform3
set_segment_image_translate_2	setsegimgxlate2
set_segment_image_translate_3	setsegimgxlate3
set_segment_visibility	setsegvisibility
set_shading_parameters	setshadingparams
set_stroke	setstroke
set_text_index	settextindex
set_valuator	setvaluator
set_vertex_indices	setvertexindices
set_vertex_normals	setvertexnormals
set_view_depth	setviewdepth
set_view_plane_distance	setviewplanedist
set_view_plane_normal	setviewplanenorm
set_view_reference_point	setviewrefpoint
set_view_up_2	setviewup2
set_view_up_3	setviewup3
set_viewing_parameters	setviewingparams
set_viewport_2	setviewport2

Correspondence Between C Names and Pascal Names

SunCore *Name*	*Pascal Equivalent*
set_viewport_3	setviewport3
set_visibility	setvisibility
set_window	setwindow
set_window_clipping	setwindowclip
set_world_coordinate_matrix_2	setworldmatrix2
set_world_coordinate_matrix_3	setworldmatrix3
set_zbuffer_cut	setzbuffercut
size_raster	sizeraster
terminate_core	terminatecore
terminate_device	terminatedevice
terminate_view_surface	terminatevwsurf
text	puttext

E.4. Declarations for SunCore-Pascal Interface

E.4.1. Type Declarations

```
type iarr =  array[1..256] of integer;

type parr =  array[1..256] of real;

type cct =  array[1..257] of char;

type ivarray =  array[1..4,1..4] of real;

type ivarray1 =  array[1..3,1..3] of real;

type  pttype = record
          x,y,z,w:real;
       end;

type aspect = record
          width, height:real;
       end;

type  primattr = record
          lineindx: integer;
          fillindx: integer;
          textindx: integer;
          linestyl: integer;
          polyintstyl: integer;
          polyedgstyl: integer;
          linwidth: real;
          pen: integer;
          font: integer;
          charsize: aspect;
          chrup, chrpath, chrspace: pttype;
          chjust: integer;
          chqualty: integer;
          marker: integer;
          pickid: integer;
          rasterop: integer;
       end;
```

```
type rasttyp =  record
                        width: integer;
                        height: integer;
                        depth: integer;
                        bits: integer; {var}
                        end;

type  cmap = record
                        typ: integer;
                        nbyt: integer;
                        dat :integer; {var}
                        end;

type  windtype = record
                                xmin, xmax, ymin, ymax:real;
                        end;

type  porttype = record
                                xmin,xmax,ymin,ymax,zmin,zmax:real;
                        end;

type vwprmtype = record
                        vwrefpt: array [1..3] of real;
                        vwplnorm: array [1..3] of real;
                        viewdis:real;
                        frontdis:real;
                        backdis:real;
                        projtype:integer;
                        projdir: array [1..3] of real;
                        window:windtype;
                        vwupdir: array [1..3] of real;
                        viewport:porttype;
                         end;

type  vwsurf = record
                        screenname: array [1..DEVNAMESIZE] of char;
                        windowname: array [1..DEVNAMESIZE] of char;
                        windowfd:integer;
                        dd:integer;
                        instance:integer;
                        cmapsize:integer;
                        cmapname: array [1..DEVNAMESIZE] of char;
                        flags:integer;
                        ptr: integer;
        end;

type  vwsurfst = array [1..DEVNAMESIZE] of char;

type vwarr =  array[1..MAXVSURF] of vwsurf;
```

E.4.2. Function Declarations

```
function allocateraster(var rptr:rasttyp):integer; external;

function awaitanybutton(tim:integer;
                        var buttonnum:integer):integer; external;

function awtbuttongetloc2(time:integer; locatornum:integer;
                        var buttonnum:integer; var x:real;
                        var y:real):integer; external;

function awtbuttongetval(time:integer; valnum:integer;
                        var buttonnum:integer; var val:real):
                        integer; external;

function awaitkeyboard(tim:integer;keynum:integer;var sptr:cct;
                        var length:integer):integer; external;

function awaitpick(time:integer; picknum:integer;
                        var segnam:integer; var pickid:integer)
                        :integer; external;

function awaitstroke2(tim:integer;picknum:integer;asize:integer;var x:parr;
                        var y:parr;numxy:integer):integer; external;

function beginbatchupdate:integer; external;

function closeretainseg:integer; external;

function closetempseg:integer; external;

function createretainseg(segname:integer):integer; external;

function createtempseg:integer; external;

function defcolorindices(surfacename:vwsurf;
                        i1:integer;i2:integer;
                        var r:parr;var g:parr;var b:parr
                        ):integer; external;

function delallretainsegs:integer; external;

function delretainsegment(segname:integer):integer; external;
```

```
function deselectvwsurf(surfacename:vwsurf
                        ):integer; external;

function endbatchupdate:integer; external;

function filetoraster(rasfid:integer;var rptr:rasttyp;
                              var map:cmap):integer; external;

function freeraster(var rptr:rasttyp):integer; external;

function getmousestate(var devclass: int; var devnum: int; var x:real;
                        var y:real;var buttons:integer):
                        integer; external;

function getraster(surfacename :vwsurf;
                              xmin:real;xmax:real;ymin:real;ymax:real;
                              xd:integer;yd:integer;var rptr:rasttyp):integer;
                              external;

function initializecore(outputlevel:integer;
                        inputlevel:integer;
                        dimension:integer):integer; external;

function initializedevice(deviceclass:integer;
                        devicenum:integer):integer; external;

function initializevwsurf(surfacename:vwsurf; typ:integer
                        ):integer; external;

function inqcharjust(var chjust:integer):integer; external;

function inqcharpath2(var x:real;var y:real):integer; external;

function inqcharpath3(var x:real;var y:real;var z:real):integer; external;

function inqcharprecision(var chquality:integer):integer; external;

function inqcharsize(var width:real;var height:real):integer; external;

function inqcharspace(var space:real):integer; external;

function inqcharup2(var x:real;var y:real):integer; external;

function inqcharup3(var x:real;var y:real;var z:real):integer; external;
```

```
function inqcolorindices(surfacename:vwsurf;
                         i1:integer;i2:integer;
                         var r:parr;var g:parr;var b:parr
                         ):integer; external;

function inqcurrpos2(var x:real;var y:real):integer; external;

function inqcurrpos3(var x:real;var y:real;var z:real):integer; external;

function inqdetectability(var detect:integer):integer; external;

function inqecho(devclass:integer;devnum:integer;
                 var echotype:integer):integer; external;

function inqechoposition(devclass:integer;devnum:integer;
                 var x:real;var y:real):integer; external;

function inqechosurface(devclass:integer;devnum:integer;
                 var surfacename:vwsurf):integer; external;

function inqfillindex(var color:integer):integer; external;

function inqfont(var font:integer):integer; external;

function inqhighlighting(var highlight:integer):integer; external;

function inqimgtransform2(var sx:real; var sy:real;var a:real
                         ;var tx:real; var ty:real
                         ):integer; external;

function inqimgtransform3(var sx:real; var sy:real;var sz:real
                         ;var ax:real; var ay:real;var az:real
                         ;var tx:real; var ty:real;var tz:real
                         ):integer; external;

function inqimgxformtype(var segtype:integer):integer; external;

function inqimgtranslate2(var tx:real; var ty:real):integer; external;

function inqimgtranslate3(var tx:real; var ty:real;var tz:real
                         ):integer; external;

function inqinvcompmatrix(var iarray:ivarray):integer; external;
```

```
function inqkeyboard(keynum:integer;var bufsize:integer;var string:cct;
                                    var pos:integer):integer; external;

function inqlineindex(var color:integer):integer; external;

function inqlinestyle(var linestyle:integer):integer; external;

function inqlinewidth(var linewidth:real):integer; external;

function inqlocator2(locnum:integer;
                          var x:real;var y:real):integer; external;

function inqmarkersymbol(var mark:integer):integer; external;

function inqndcspace2(var width:real;var height:real):integer; external;

function inqndcspace3(var width:real;var height:real;var
                          depth:real):integer; external;

function inqopenretainseg(var segname:integer):integer; external;

function inqopentempseg(var open:integer):integer; external;

function inqpen(var pen:integer):integer; external;

function inqpickid(var pick:integer):integer; external;

function inqpolyedgestyle(var pestyle:integer):integer; external;

function inqpolyintrstyle(var pistyle:integer):integer; external;

function inqprimattribs(var defprim:primattr):integer; external;

function inqprojection(var ptype:integer; var dx:real; var dy:real;
                                    var dz:real):integer; external;

function inqrasterop(var rastop:integer):integer; external;

function inqretainsegname(arraycnt:integer; var seglist:iarr;
                                    var segcnt:integer):integer; external;

function inqretainsegsurf(segname:integer; arraycnt:integer; var surflist:vwarr;
                                    var surfcnt:integer):integer; external;
```

Note: since vwarr is an array of MAXVSURF viewsurfaces, arraycnt should be MAXVSURF.

```
function inqsegdetectable(segname:integer;var dtable:integer)
                          :integer; external;

function inqseghighlight(segname:integer;var highlight:integer)
                          :integer; external;

function inqsegimgxform2(segname:integer;var sx:real;var sy:real;
                         var a:real;var tx:real;var ty:real
                         ):integer; external;

function inqsegimgxform3(segname:integer;var sx:real;var sy:real;
                                  var sz:real;var rx:real;var ry:real;
                                  var rz:real;var tx:real;var ty:real;var tz:real
):integer; external;

function inqsegimgxfrmtyp(segname:integer;var segtype:integer)
                          :integer; external;

function inqsegimgxlate2(segname:integer;var tx:real;var ty:real)
                          :integer; external;

function inqsegimgxlate3(segname:integer;var sx:real;var sy:real;
                                  var sz:real):integer; external;

function inqsegvisibility(segname:integer;var visible:integer):
                          integer; external;

function inqstroke(strokenum:integer;var bufsize:integer;var
                          dist:real;var time:integer):integer; external;

function inqtextextent2(var string:cct;var dx:real; var dy:real
                                  ):integer; external;

function inqtextextent3(var string:cct;var dx:real; var dy:real
                                  ; var dz:real):integer; external;

function inqtextindex(var color:integer):integer; external;

function inqvaluator(valnum:integer;var init:real;var low:real;var high:real)
                                  :integer; external;

function inqviewdepth(var fdist:real;var bdist:real)
                                  :integer; external;
```

```
function inqviewplanedist(var vdist:real):integer; external;

function inqviewplanenorm(var dx:real; var dy:real;
                          var dz:real):integer; external;

function inqviewrefpoint(var rx:real; var ry:real;
                          var rz:real):integer; external;

function inqviewup2(var dx:real; var dy:real
                          ):integer; external;

function inqviewup3(var dx:real; var dy:real;
                          var dz:real):integer; external;

function inqvwgcntrlparms(var wclip:integer;var fclip:integer;
                          var bclip:integer;var typ:integer)
                          :integer; external;

function inqviewingparams(var viewparm:vwprmtype):integer; external;

function inqviewport2(var xmin:real; var xmax:real;var ymin:real;var ymax:real
                          ):integer; external;

function inqviewport3(var xmin:real; var xmax:real;var ymin:real;var ymax:real
                          ;var zmin:real;var zmax:real)
                          :integer; external;

function inqvisibility(var visible:integer)
                      :integer; external;

function inqwindow(var umin:real; var umax:real;var vmin:real;var vmax:real
                          ):integer; external;

function inqworldmatrix2(var iarray:ivarray1):integer; external;

function inqworldmatrix3(var iarray:ivarray):integer; external;

function lineabs2(x:real;y:real):integer; external;

function lineabs3(x:real;y:real;z:real):integer; external;

function linerel2(x:real;y:real):integer; external;

function linerel3(x:real;y:real;z:real):integer; external;
```

```
function mapndctoworld2(ndx:real; ndy:real;
                        var wldx:real; var wldy:real)
                        :integer; external;

function mapndctoworld3(ndx:real; ndy:real; ndz:real;
                        var wldx:real; var wldy:real
                        ; var wldz:real)
                        :integer; external;

function mapworldtondc2(wldx:real; wldy:real;
                        var ndx:real; var ndy:real)
                        :integer; external;

function mapworldtondc3(wldx:real; wldy:real; wldz:real;
                        var ndx:real; var ndy:real
                        ; var ndz:real
):integer; external;

function markerabs2(mx:real;my:real):integer; external;

function markerabs3(mx:real; my:real;mz:real):integer; external;

function markerrel2(dx:real;dy:real):integer; external;

function markerrel3(dx:real; dy:real;dz:real):integer; external;

function moveabs2(x:real;y:real):integer; external;

function moveabs3(x:real;y:real;z:real):integer; external;

function moverel2(x:real;y:real):integer; external;

function moverel3(x:real;y:real;z:real):integer; external;

function newframe:integer; external;

function pasloc(function f:integer
                ):integer; external;

function polygonabs2(var xcoor:parr; var ycoor:parr;
                n:integer):integer; external;

function polygonabs3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;
```

```
function polygonrel2(var xcoor:parr; var ycoor:parr;
                n:integer):integer; external;

function polygonrel3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function polylineabs2(var xcoor:parr; var ycoor:parr;
                n:integer):integer; external;

function polylineabs3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function polylinerel2(var xcoor:parr;var ycoor:parr;
                n:integer):integer; external;

function polylinerel3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function polymarkerabs2(var xcoor:parr; var ycoor:parr;
                n:integer):integer; external;

function polymarkerabs3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function polymarkerrel2(var xcoor:parr; var ycoor:parr;
                n:integer):integer; external;

function polymarkerrel3(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function printerror(var string:cct;error:integer):integer; external;

function putraster(var rptr:rasttyp):integer; external;

function puttext(var string:cct):integer; external;

function rastertofile(var rptr:rasttyp;var map:cmap;rasfid:integer
                              ):integer; external;

function renameretainseg(segname:integer;newname:integer):integer; external;

function reportrecenterr(var error:integer):integer; external;

function restoresegment(segname:integer;var fname:cct):integer; external;
```

```
function savesegment(segname:integer;var fname:cct):integer; external;

function selectvwsurf(surfacename:vwsurf
                      ):integer; external;

function setbackclip(onoff:integer):integer; external;

function setcharjust(chjust:integer):integer; external;

function setcharpath2(dx:real; dy:real):integer; external;

function setcharpath3(dx:real; dy:real;dz:real):integer; external;

function setcharprecision(chquality:integer):integer; external;

function setcharsize(chwid:real;chht:real):integer; external;

function setcharspace(space:real):integer; external;

function setcharup2(dx:real; dy:real):integer; external;

function setcharup3(dx:real; dy:real;dz:real):integer; external;

function setcoordsystype(typ:integer):integer; external;

function setdetectability(detect:integer):integer; external;

function setdrag(drag:integer):integer; external;

function setecho(devclass:integer;devnum:integer;
                      echotype:integer):integer; external;

function setechogroup(devclass:integer;var devarray:iarr;n:integer;
                      echotype:integer):integer; external;

function setechoposition(devclass:integer;devnum:integer;
                      x:real;y:real):integer; external;

function setechosurface(devclass:integer;devnum:integer;
                surfacename:vwsurf):integer; external;

function setfillindex(color:integer):integer; external;
```

```
function setfont(font:integer):integer; external;

function setfrontclip(onoff:integer):integer; external;

function sethighlighting(highlight:integer):integer; external;

function setimgtransform2(sx:real; sy:real;a:real
                          ;tx:real; ty:real):integer; external;

function setimgtransform3(sx:real; sy:real;sz:real;
                          ax:real; ay:real;az:real;
                          tx:real; ty:real;tz:real)
                          :integer; external;

function setimgxformtype(segtype:integer):integer; external;

function setimgtranslate2(tx:real; ty:real):integer; external;

function setimgtranslate3(tx:real; ty:real;tz:real):integer; external;

function setkeyboard(keynum:integer;bufsize:integer;var string:cct;
                          pos:integer):integer; external;

function setlightdirect(dx:real; dy:real;dz:real
                          ):integer; external;

function setlineindex(color:integer):integer; external;

function setlinestyle(style:integer):integer; external;

function setlinewidth(width:real):integer; external;

function setlocator2(locnum:integer;x:real;y:real):integer; external;

function setmarkersymbol(mark:integer):integer; external;

function setndcspace2(width:real;height:real):integer; external;

function setndcspace3(width:real;height:real;depth:real)
                          :integer; external;

function setoutputclip(onoff:integer):integer; external;

function setpen(pen:integer):integer; external;
```

```
function setpick(picknum:integer; aperture: real):integer; external;

function setpickid(pickid:integer):integer; external;

function setpolyedgestyle(pestyle:integer):integer; external;

function setpolyintrstyle(pistyle:integer):integer; external;

function setprimattribs(var defprim:primattr):integer; external;

function setprojection(ptype:integer;dx:real; dy:real;dz:real)
                                    :integer; external;

function setrasterop(rop:integer):integer; external;

function setsegdetectable(segname:integer; detectbl:integer)
                                    :integer; external;

function setseghighlight(segname:integer; highlight:integer)
                                    :integer; external;

function setsegimgxform2(segname:integer;sx:real; sy:real;a:real;
                                    tx:real;ty:real):integer; external;

function setsegimgxform3(segname:integer; sx:real;  sy:real;
                                     sz:real; rx:real;  ry:real; rz:real
                                    ; tx:real;  ty:real; tz:real
                                    ):integer; external;

function setsegimgxlate2(segname:integer;tx:real; ty:real
                                    ):integer; external;

function setsegimgxlate3(segname:integer;tx:real; ty:real;tz:real
                                    ):integer; external;

function setsegvisibility(segname:integer;visible:integer):integer; external;

function setshadingparams(amb:real;dif:real;spec:real;flood:real;
                                    bump:real;hue:integer;style:integer
                                    ):integer; external;

function setstroke(strokenum:integer;bufsize:integer;
                            dist:real;time:integer)
                            :integer; external;
```

```
function settextindex(color:integer):integer; external;

function setvaluator(valnum:integer;init:real;low:real;high:real)
                        :integer; external;

function setvertexindices(var x:iarr;n:integer):integer; external;

function setvertexnormals(var xcoor:parr; var ycoor:parr;var zcoor:parr;
                n:integer):integer; external;

function setviewdepth(near:real;far:real):integer; external;

function setviewplanedist(dist:real):integer; external;

function setviewplanenorm(dx:real; dy:real;dz:real):integer; external;

function setviewrefpoint(x:real; y:real;z:real):integer; external;

function setviewup2(dx:real; dy:real):integer; external;

function setviewup3(dx:real; dy:real;dz:real):integer; external;

function setviewingparams(var viewparm:vwprmtype):integer; external;

function setviewport2(xmin:real;xmax:real;ymin:real;ymax:real):
                        integer; external;

function setviewport3(xmin:real;xmax:real;ymin:real;ymax:real;zmin:real;zmax:real)
                :integer; external;

function setvisibility(visibility:integer):integer; external;

function setwindow(umin:real;umax:real;vmin:real;vmax:real)
                        :integer; external;

function setwindowclip(onoff:integer):integer; external;

function setworldmatrix2(var iarray:ivarray1):integer; external;

function setworldmatrix3(var iarray:ivarray):integer; external;

function setzbuffercut(var surfacename:vwsurf;var x:parr;
        var z:parr;n:integer):integer; external;
```

```
function sizeraster(var surfacename:vwsurf;
                                xmin:real;xmax:real;ymin:real;ymax:real;
                                var rptr:rasttyp):integer; external;

function terminatecore:integer; external;

function terminatedevice(devclass:integer;devnum:integer):integer; external;

function terminatevwsurf(var surfacename:vwsurf):integer; external;
```

Appendix F

Higher Performance SunCore Library

SunCore programs which are to be run on machines with Sun's hardware floating point option may use an alternative **SunCore** library which provides higher floating point performance. This library is in */usr/lib/libcoresky.a*. A program linked with this library will ***only*** run on a machine with hardware floating point.

To use this library for C programs, use a C compiler command line like:

```
tutorial% cc -fsky -o grab grab.c -lcoresky -lsunwindow -lpixrect -lm
```

and to use this library for Fortran programs:

```
tutorial% f77 -fsky -o grab grab.f -lcore77 -lcoresky -lsunwindow -lpixrect -lm
```

Note that this library cannot be used with Pascal programs in the current release.

If compiling and linking are done in separate steps, the **-fsky** option must also be specified in the linking stage. The **-fsky** option may also be used in the compiling step. See the *cc*(1) and *f77*(1) manual pages for details.

Appendix G

SunCore Error Numbers

SunCore does not use the error numbers suggested by the ACM CORE standard. The following table matches an error number with the error message:

Error Number	*Description*
0	The CORE SYSTEM has already been initialized.
1	The specified level cannot be supported.
2	The surface has already been initialized.
3	No physical surface is associated with the specified logical surface.
4	The CORE SYSTEM has not been initialized.
5	The specified surface has not been initialized.
6	The specified surface is already selected.
7	The specified surface was not selected.
8	A segment is open.
9	The specified surface is not selected.
10	The specified surface has not been deselected.
11	This function has already been called once.
12	A segment has been opened.
13	A value specified for a default attribute is improper.
14	The specified segment does not exist.
15	The VIEW SURFACE ARRAY is not large enough.
16	Segment list overflow, can't create segment.
17	There has been no 'end batch' since last 'begin batch'.
18	There has been no corresponding 'begin batch'.
19	A viewing function has been invoked, or a segment has been created.
20	The value for TYPE is improper.
21	No segment is open.
22	n is <= 0.
23	String contains an illegal character.
24	The vectors established by CHARSPACE and CHARUP are parallel.
25	Invalid marker table offset.
26	Invocation when no open segment.
27	Invalid attribute value.
28	Invalid segment type.

Error Number	*Description*
29	Invalid segment number.
30	Invalid image transformation for the segment.
31	A retained segment named SEGNAME already exists.
32	The segment type is inconsistent with the current IMAGE_TRANSFORM.
33	No view surface is currently selected.
34	The current viewing specification is inconsistent.
35	No view surfaces have been initialized.
36	There is an existing retained segment named NEW_NAME.
37	There is no retained segment named SEGMENT_NAME.
38	No characters in string (n=0).
39	Dx, dy, and dz, are all zero: no direction can be established.
40	MIN is not less than MAX, for u or v bounds.
41	FRONT_DISTANCE exceeds BACK_DISTANCE; back clip plane is in front.
42	'ndcsp2' or 'ndcsp3' has been invoked since SunCore was last initialized.
43	The invocation of 'ndcspx' is too late, default values have been assumed.
44	A parameter value is greater than 1, or is less than or equal to 0.
45	Neither parameter has a value of 1.
46	Viewport extent is outside of normalized device coordinate space.
47	MIN is not less than MAX, for x, y, or z bounds.
48	Specified device already enabled.
49	DEVICE_CLASS or DEVICE_NUM invalid.
50	DEVICE_CLASS invalid.
51	Specified device is not enabled.
52	LOCATOR_NUM is invalid.
53	The specified LOCATOR device is not enabled.
54	VALUATOR_NUM is invalid.
55	The specified VALUATOR device is not enabled.
56	The TIME value is less than zero.
57	EVENT_CLASS and EVENT_NUM do not specify a valid event device.
58	EVENT_CLASS is not a legal event device class.
59	The specified association already exists.
60	EVENT_CLASS or SAMPLED_CLASS reference invalid or wrong type of class.
61	EVENT_NUM or SAMPLED_NUM are invalid device numbers for their classes.
62	The specified association does not exists.
63	The current event report is not from a PICK device.
64	The current event report is not from a KEYBOARD event.
65	Input string was not large enough to hold the string centered by user.
66	When event occurred, the LOCATOR device was not enabled or was not associated with the event device.
67	When event occurred, the VALUATOR device was not enabled or was not associated with the event device.

Error Number	*Description*
68	XECHO and YECHO specify positions outside NDC space.
69	PICK_NUM does not specify a valid PICK device.
70	LOCATOR_NUM does not specify a valid LOCATOR device.
71	XLOC, YLOC specify a position outside normalized device coordinate space.
72	VALUATOR_NUM is not a valid VALUATOR device.
73	LOW_VALUE is greater than HIGH_VALUE.
74	INITIAL_VALUE lies outside the range defined by LOW_VALUE and HIGH_VALUE.
75	KEYBOARD_NUM is not a valid KEYBOARD device.
76	BUFFER_SIZE is <= zero or > the defined maximum.
77	BUTTON_NUM is not a valid BUTTON device.
78	Incorrect arguments for the specified function.
79	Incorrect argument count for the specified function.
80	Specified function not supported.
81	More than MAXPOLY vertices in polygon.
82	Invalid Viewing Specification. Viewing Matrix Unchanged!
83	Invalid view surface name.
84	Selected view surface cannot support hidden surfaces.
85	No other view surface can be initialized at this time.
86	Raster depth is 1 or 8 bit pixels only.
87	Unable to allocate space for virtual memory display list.
88	Memory allocation failure.
89	Error in view reference point.
90	Error in view plane normal.
91	Error in view plane distance.
92	Error in view depth.
93	Error in projection.
94	Error in window.
95	Error in view up direction.
96	Error in viewport.
97	Set_ndc_space_2 or set_ndc_space_3 has already been invoked.
98	The default NDC space has already been established.
99	A parameter is not in the range of 0 to 1.
100	Neither width nor height has a value of 1.
101	Width or height is 0.
102	STROKE_NUM is not a valid STROKE device.
103	Input device is already initialized.
104	Input device is not initialized.
105	DEVICE_CLASS is not a valid device class.
106	Invalid echo type for PICK device.
107	Invalid echo type for KEYBOARD device.
108	Invalid echo type for STROKE device.
109	Invalid echo type for LOCATOR device.

Error Number	*Description*
110	Invalid echo type for VALUATOR device.
111	Invalid echo type for BUTTON device.
112	Echo position specified is outside NDC space.
113	No BUTTON device is initialized.

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READER COMMENT SHEET

Dear Customer,
We who work here at Sun Microsystems wish to provide the best possible documentation for our products. To this end, we solicit your comments on this manual. We would appreciate your telling us about errors in the content of the manual, and about any material which you feel should be there but isn't.

Typographical Errors:

Please list typographical Errors by page number and actual text of the error.

Technical Errors:

Please list errors of fact by page number and actual text of the error.

Content:

Did this guide meet your needs? If not, please indicate what you think should be added or deleted in order to do so. Please comment on any material which you feel should be present but is not. Is there material which is in other manuals, but would be more convenient if it were in this manual?

Layout and Style:

Did you find the organization of this guide useful? If not, how would you rearrange things? Do you find the style of this manual pleasing or irritating? What would you like to see different?