

# DRAFT

## Editing With

### SKANDHA

#### *Introduction*

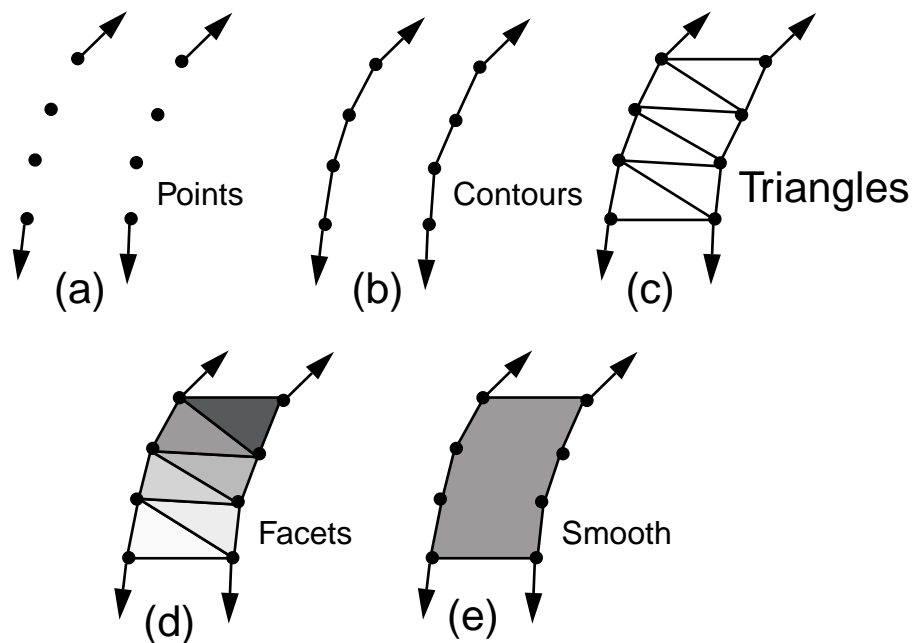
Skandha is a software package used to edit, surface and display static three dimensional images, to display rotating images in real time and to control recording equipment for video animation. The package, written entirely in C by Jeff Prothero, first ran on an Iris 3020 in the Spring of 1986. In an attempt to make it available on a low priced, reasonably high-speed machine, it was then ported to an AT clone configured with a Definicon DSI-780 68020 accelerator board and a Videoscope graphics card. About the time the port was completed, high-speed, moderately priced graphic workstations came on the market essentially finessing our effort in that direction. Our experience with the Iris 3020 had been favorable and led to the most recent port to the Iris 4D series, specifically the 4D20, 4D25 and 4D70. Only the 4D series continues to be supported. Skandha can image any object that can be described by a series of contours. Thus we have generated images from CT scans, MRI scans, microscopic and macroscopic tissue sections, and topographic maps.

Contoured data are digitized by an AT-type computer using another in-house program called MORPHO (also written by Jeff Prothero). A frame (or section) typically consists of several contours which represent parts (sub-objects) of the overall object. The digitizing process samples each contour at a pre-determined spacing which can be set from within MORPHO. The data for a specific contour consists of pairs of X-Y coordinates. In other words, after the object has been digitized, the resultant ASCII file con-

sists of a series of frames generally with a constant Z-spacing and pairs of X-Y coordinates representing the contours within a given frame. To be usable by Skandha, the contours belonging to a specific sub-object must be extracted from each of the sections and grouped together. Another program called MOR2DAT transfers a MORpho file into a Skandha DATa file. In the DATa file format each point is represented by an X, Y and Z coordinate. The X and Y coordinates are implicitly determined from the section X-Y coordinates while the Z coordinate is determined by multiplying the section spacing by the section number

## Surfacing

A brief explanation of the surfacing process is shown in **Figure 1**. Four points from contours at two adjacent levels are shown in **Figure 1(a)**. When the points are connect-



**Figure 1**

ed together, as in **Figure 1(b)**, contours are formed. The points of the adjacent contours are connected generating series of triangles, **Figure 1(c)**. Surfacing the triangles creates facets, **Figure 1(d)**. In this case the intensity of the facet surface is constant, determined by the dot product between a point light source and a vector normal to the facet (the facet normal). To generate the smooth surface, **Figure 1(e)**, intensity values at the vertices of each polygon (triangle) is determined by the dot product between the ver-

# DRAFT

tex normal and the point source of light. All other intensities for the surface are determined using a linear intensity interpolation scheme developed by Gouraud.

## *File Structure*

As noted earlier, any object that can be described by a set of contours can be surfaced by Skandha, and in that sense, the contour is the most basic structure handled by the software. However, a single contour does not have a surface - two adjacent contours are required in order to generate a surface. Hence, in terms of surfacing, a ribbon is the basic structure. A list of ribbons is inserted into a tube; tubes can be grouped together under a list; an object is typically constructed from several lists.

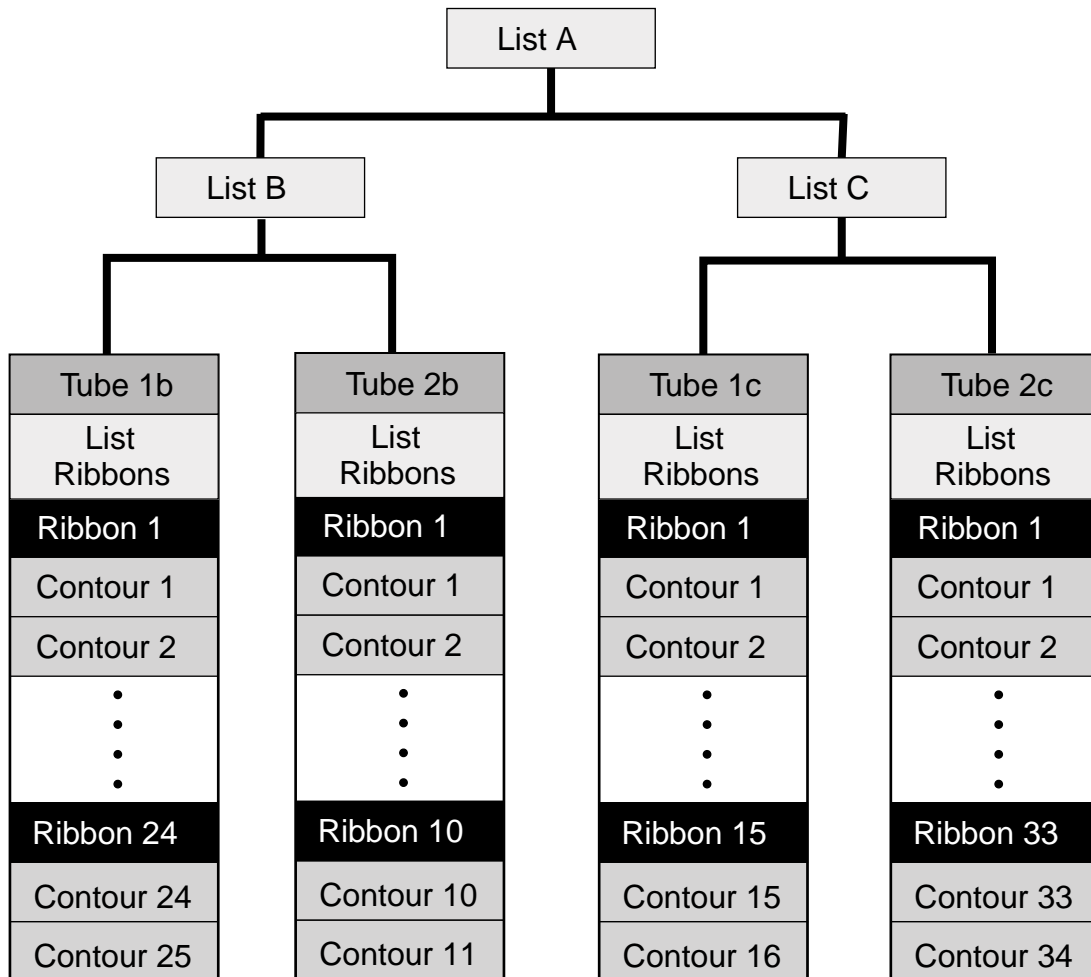
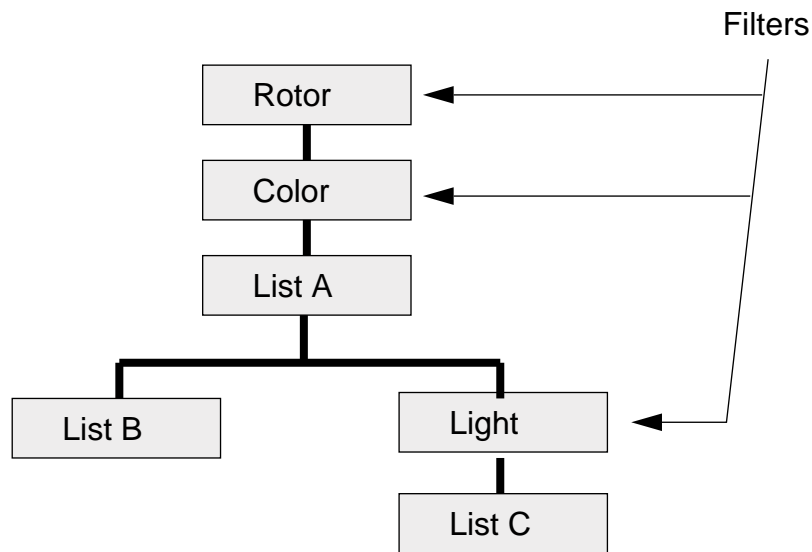


Figure 2

# DRAFT

The relationship of contours, ribbons, tubes and lists is illustrated in **Figure 2**. Note that a ribbon is always composed of two adjacent contours and those ribbons are always part of a list. A tube is another data class consisting of a variable length list of ribbons. From the users point of view, the tube merely adds a button to the list of ribbons which when activated sorts contours according to their Z-spacing and identifies which neighboring contours form a ribbon.

An object displayed with the data structure represented by **Figure 2** would be drawn as a series of contours in the default color (red) in the orientation in which they were dig-



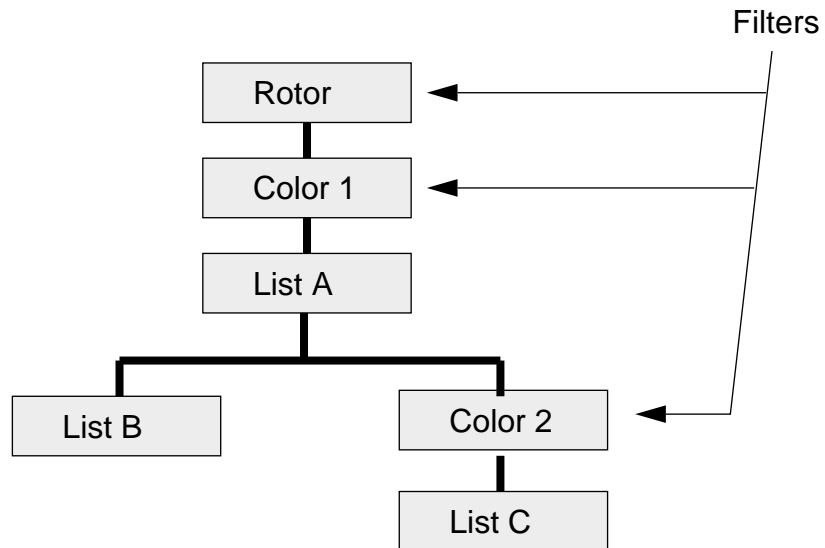
**Figure 3**

itized. Skandha has available a class of operators called filters which modify the properties of an object or any part of it. The most commonly used are the color filter, the rotor and the light filter. The main functions of the rotor are to rotate the object in the **X**, **Y** or **Z** plane, translate the object in three dimensions and scale the object. A color filter, as the name implies, imparts a choice of colors to the object and in addition, determines the surfacing mode (smooth, facets, triangles, contours or points) and the degree of translucency of the object. The light filter determines the direction and altitude of the light source (sun) and whether the light is fixed on the object or fixed in space. It should be noted that a filter affects only those objects below it in the data tree. Thus in **Figure 3** the rotor and color will affect both List B and List C but the light filter will only affect those objects under List C.

When two filters of the same type are at different levels of the data tree, the one lowest in the tree predominates for all those objects below it providing it is not set to default. For example, with the structure shown in **Figure 4**, the objects in List B will be

# DRAFT

drawn in Color 1 while all the objects under List C will be drawn in Color 2 (unless the color filter attached to List C is set to default).



**Figure 4**

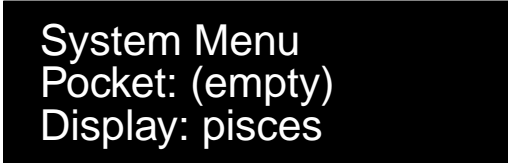
Before leaving the subject of the organization of files for a given object, it should be noted that the file structure is not static but can be varied to optimize the display of the object. For example, filters can be added or removed and tubes or lists can be re-grouped. The possibilities for most reasonably complicated objects are almost endless and it is very easy to become confused.

# DRAFT

## Menus

This section describes Skandha's menu system. Skandha has two types of menus:

**System Menu:** The system menu deals with functions common to the overall system. For example, some of its uses are to set the default lighting, select col-

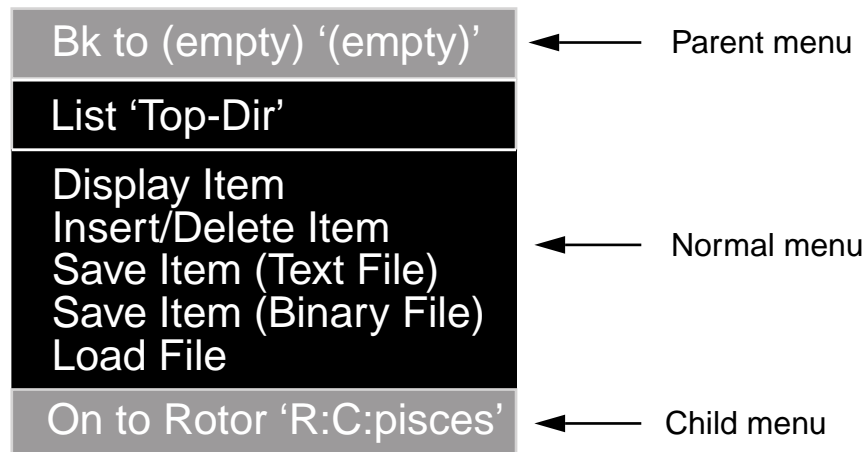


System Menu  
Pocket: (empty)  
Display: pisces

### Menu 1

ors from the palette, control real-time motion, set various switches, and determine the size and location of the drawing screen. The system menu can be selected from the three entries found at the bottom, right-hand side of the screen.

**Operational Menu:** The operational menu consists of three sub-menus, a parent menu, a normal menu and a child menu. Clicking the mouse on the parent



### Menu 2

menu moves one step up the data tree while clicking on the child menu moves one step down the tree. Clicking in the normal menu activates a switch or brings up a sub-menu.

*System Menu*

Selecting **System Menu** from the three-item menu at the bottom right-hand side of the screen (see **Menu 1**) brings up the **System Menu**. An index to a description of the items on the menu is show below.

Exit Submenu	page 8
action is OFF	page 8
back/flip if OFF	page 8
autodraw is OFF	page 8
NTSC mode is OFF	page 8
port shape == FULL	page 8
Edit Color Palette	page 10
Edit Special Color	page 11
Hardware Status	page 11
Switches	page 13
Diagnostics	page 13
-- Matrix --	page 13
Pick	page 13
Save Configuration	page 13
Videotape	page 13
Redraw Display	page 13
Sun Altitude = 90.000 -90.000 90.000	page 14
Sun Azimuth = 0.000 -180.000 180.000	page 14
Z-Clip Plane = 0.000 -1.000 1.000	page 14

# DRAFT

**Exit Submenu:** Clicking on *Exit Submenu* performs as advertised - the user exits from the system menu and is returned to the operational menus.

The next four entries are switches. Clicking with the mouse turns the selection *on* if it is *off*, and *off* if it is *on*.

**action:** This switch turns the real-time rotation on or off. The direction and speed of rotation are selected from the *Rotor* menu. The Personal Iris is not fast enough to rotate any but the most simple solid objects in real time, however, it will do a reasonable job of rotating an object represented by points or contours.

**back/flip:** This switch determines the direction of the normals for hidden surfaces. The usual setting is on but this can produce an aurora affect around the edge of the object.

**autodraw:** When **autodraw** is *on*, the screen will automatically re-draw after any change. This can be useful in certain instances - if, for example, the user is trying to position an object on the screen. Normally it will result in the image being re-drawn at inopportune times and since there is no "abort drawing" command, it can result in a lot of wasted time while waiting for an image to draw.

**NTSC mode:** When **NTSC mode** is *on*, the image is drawn in the lower left-hand part of the screen in a size suitable for video recording, 640 wide by 480 high. Unless the machine is equipped with the genlock option, this switch will not be used.

**port shape ==:** Selection of **port shape ==** brings up the following sub-menu:

Exit Submenu	
Use FULL	port
Use TOP-LEFT	port
Use TOP-RIGHT	port
Use BOT-LEFT	port
Use BOT-RIGHT	port
Use HUGE	port

**Menu 3**

# DRAFT

Choosing from this submenu will determine which part of the current window is used for drawing the image. The mouse cursor disappears while the object is being drawn and in all drawing modes except for huge, reappears when the screen has finished drawing.

**Use FULL:** This is the normal drawing mode. The image is drawn in the left-hand three quarters of the overall screen and the menus are along the right-hand quarter of the screen.

**Use TOP-LEFT:** When **TOP-LEFT** is selected, the image is drawn in the top-left quarter of the **FULL** screen.

**Use TOP-RIGHT:** When **TOP-RIGHT** is selected, the image is drawn in the top-right quarter of the **FULL** screen.

**Use BOT-LEFT:** When **BOT-LEFT** is chosen, the image is drawn in the bottom-left quarter of the **FULL** screen.

**Use BOT-RIGHT:** When **BOT-RIGHT** is selected, the image is drawn in the bottom-right quarter of the **FULL** screen.

**Use HUGE:** When **HUGE** is selected, the entire window is used for drawing. No menus are shown. The mouse cursor becomes invisible and a beep sounds when the object has finished drawing. To restore the menu, the left mouse button must be clicked twice.

**Edit Color Palette:** Selecting **Edit Color Palette** brings up the following sub-menu: These are the colors that are specified for drawing images.



**Menu 4**

# DRAFT

Selection of any of the seven colors brings up **Menu 5**. The menu allows

Exit Submenu	
Red =	0.000
0.000	1.000
Green =	0.000
0.000	1.000
Blue =	0.000
0.000	1.000

*Clicking on this line allows the user to enter a value between zero and one from the keyboard.*

*Clicking on this line between zero and one will cause the corresponding color value to be entered.*

## Menu 5

the user to define the colors in terms of its red, green and blue components.

**Edit Special Color:** Selecting **Edit Special Color** brings up **Menu 6**.

Exit Submenu
Background
Normal Menu
Parent Menu
Child Menu
Menu Text
Vertex Normal
Facet Normal

## Menu 6

Selecting an item in **Menu 6** brings up a sub-menu similar to **Menu 5**, except the color selected is also shown. Selection of the desired color is made by one of the two options discussed in association with **Menu 5**.

**Background:** Allows selection of the background color for the image being drawn. The default background color is blue (Red = 0.0, Green = 0.0, Blue = 0.4), but often black is substituted.

**Normal Menu:** See the definition of the **Normal Menu** shown in **Menu 2**, page 6. The default color is blue (0.0, 0.0, 0.4).

# DRAFT

**Parent Menu:** See the definition of the **Parent Menu** shown in **Menu 2**, page 6. The default color is red (0.4, 0.0, 0.0).

**Child Menu:** See the definition of the **Child Menu** shown in **Menu 2**, page 6. The default color is green (0.0, 0.4, 0.0).

**Menu Text:** Selection of the color for all menu text. The default color is white (0.7, 0.7, 0.7).

**Vertex Normals:** Selects the color of the normals to the surface at the intersection of the polygons. The vertex normal default color is green (0.0, 1.0, 0.0)

**Facet Normals:** Selects the color of the normals to the surface at center of the polygons. The facet normal default color is blue (0.0, 0.0, 1.0).

**Hardware Status:** Selecting **Hardware Status** brings up a menu that shows the status of graphics library functions used in the program. They are for de-bugging only and are not used operationally.

**Switches:** Selecting **Switches** brings up a menu with a series of switches. Many of the switches were not designed to be activated by the user and

```
Exit Submenu
backfaces are OFF
onebuffer is ON
onemap is ON
zbuffering is ON
blanking is OFF
scale&center is ON
clearing is ON
flipping is OFF
zShading is OFF
debugging is OFF
autodraw is OFF
bigMap is ON
```

**Menu 7**

only a brief description will be given. The default settings are shown in **Menu 7**.

# DRAFT

**backfaces:** This switch determines whether or not the inside of an object is drawn.

**onebuffer:** The **IRIS** has two video buffers. Both are used for real time rotations when **action** is on. Otherwise only onebuffer is active.

**onemap:** It is technically possible to select one large color map or several smaller maps. However, this option has yet to be implemented.

**zbuffering:** **zbuffering** is for hidden surface removal using system hardware and is normally on.

**blanking:** When **blanking** is on, the screen remains blank until the object has finished drawing and then it is displayed. Otherwise, parts of the object appear as they are drawn.

**scale&center:** When **scale&center** is on, the software scales and centers the object within the clipping cube each time it is drawn. This is essential the first time an object is drawn, but for subsequent renderings, it only adds to the drawing time. **Hint:** if the first time an object is rendered, it doesn't appear to draw or draws as an inappropriately small object, check this switch.

**clearing:** The drawing surface is cleared before a new object is drawn when **clearing** is on. Otherwise the new object is simply drawn over the previous one.

**flipping:** When **flipping** is on, the surface normals on the inside of objects are flipped 180° so that the colors are drawn correctly. **Hint:** Occasionally an undesirable corona affect will occur at the edge of an object which can be eliminated by turning **flipping** off.

**zshading:** **zshading** gives the appearance of distance to a rendering by making objects that are farther away from the viewer, darker.

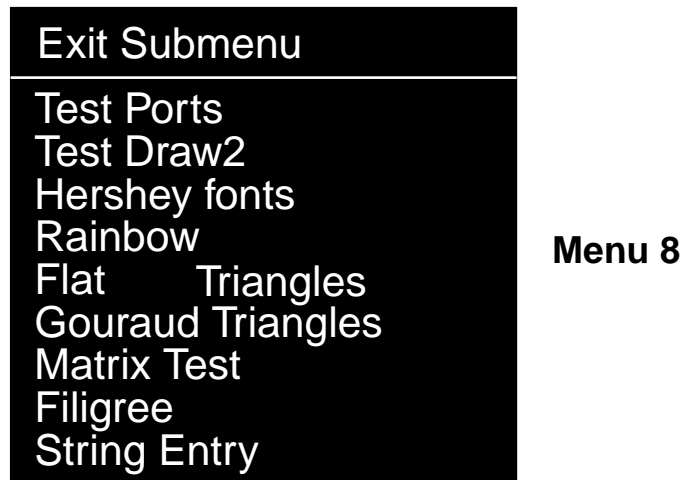
**debugging:** **debugging** is not a user option. It is used as needed for debugging during software development.

**autodraw:** The screen will automatically re-draw after any change when **autodraw** is on. This can be useful in certain instances - if, for example, the user is trying to position an object on the screen. Normally it will result in the image being re-drawn at inopportune times and since there is no "abort drawing" command, it can result in a lot of wasted time while waiting for an image to draw.

**bigMap:** **bigMap** chooses between one large color map or several smaller ones. The single color map is the default mode.

# DRAFT

**Diagnostics:** Selecting **Diagnostics** brings up the sub-menu shown as **Menu 8**. The menu items are normally used to test additions to the software. If you wish to experiment no harm will result from selecting any of



the items.

-- **Matrix** --: Selection of -- **Matrix** -- displays the rotation matrix used to scale and center the object within the clipping cube.

**Pick:** This function allows the user to pick a point on an object, then the software will search through the ribbon list and display the ribbon that contains the point.

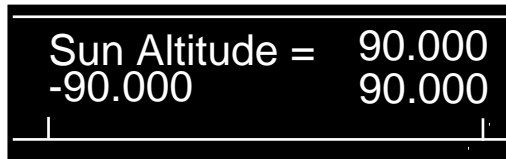
**Save Configuration:** **Save Configuration** saves the configuration of the **System Menu** to a file **skandha.ini**. The contents of the file will be loaded and the configuration restored the next time **skandha** is loaded from within the current directory.

**Videotape:** **Videotape** brings up an extensive sub-menu which is used for video animation.

**Redraw Display:** This function is provided so the display can be re-drawn while staying within the **System Menu**.

# DRAFT

**Sun Altitude:** This selects the altitude for the default light. The default light is for those objects that do not have their own light filters and, unlike a



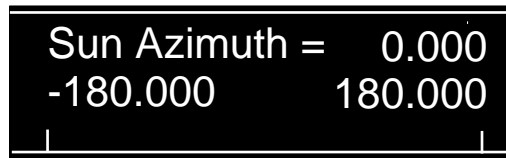
**Menu 9**

*Clicking on this line allows the user to enter a value between  $-90^{\circ}$  and  $+90^{\circ}$  from the keyboard.*

*Clicking on this line between  $-90^{\circ}$  and  $+90^{\circ}$  will cause the corresponding value to be entered.*

**Light filter,** is always fixed in space. An altitude of  $90^{\circ}$  is at the top of the screen (**+Y axis**), while  $-90^{\circ}$  is at the bottom (**-Y axis**).

**Sun Azimuth:** This selects the azimuth for the default light. An azimuth of  $0^{\circ}$  is directly in front of the object along the **-Z axis**, an azimuth of  $+90^{\circ}$  is



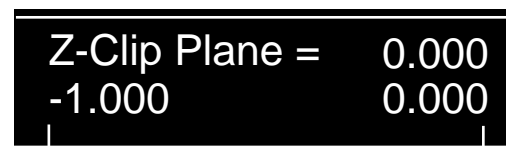
**Menu 10**

*Clicking on this line allows the user to enter a value between  $-180^{\circ}$  and  $+180^{\circ}$  from the keyboard.*

*Clicking on this line between  $-180^{\circ}$  and  $+180^{\circ}$  will cause the corresponding value to be entered.*

from the right-hand side of the screen (**+X axis**),  $-90^{\circ}$  from the left-hand side of the screen (**-X axis**) and  $\pm 180^{\circ}$  directly behind the object along the **+ Z axis**.

**Z-Clip Plane:** This selection allows the user to select the Z-clipping plane. Selecting a number  $< 0$  moves the clipping plane along the **-Z axis** (to-



**Menu 11**

*Clicking on this line allows the user to enter a value between  $-1$  and  $+1$  from the keyboard.*

*Clicking on this line between  $-1$  and  $+1$  will cause the corresponding value to be entered.*

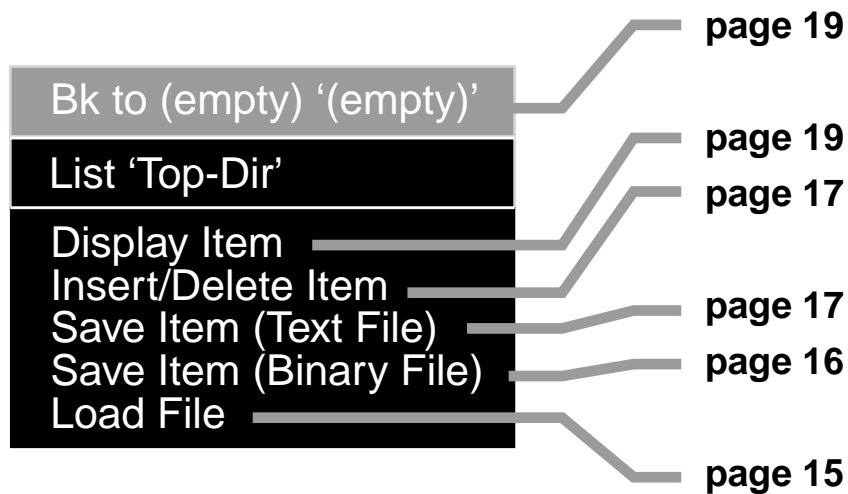
# DRAFT

ward the user) while a number > 0 moves the clipping plane away from the user in the +Z direction.

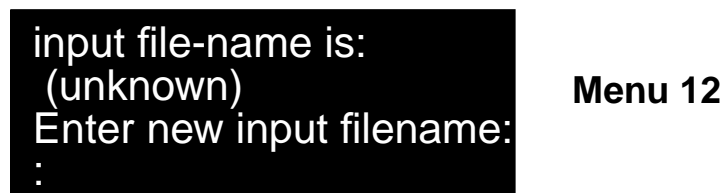
## Operational Menus

### Initial Menu -

The **Initial Menu** that appears when **Skandha** is loaded is depicted below. Descriptions of the selections are found on the pages indicated.



**Load File:** Data files are loaded into **Skandha** with the **Load File** command. Selecting Load File brings up the following sub-menu. The file-



name is entered via the keyboard. By default, the file is loaded from the directory from which you ran Skandha, defined as the current directory. If

# DRAFT

the desired file is not in the current directory, the entire path in standard Unix notation must be entered. After the file is loaded, a child menu is generated. If, for example, the file **pisces** has been loaded, the current opera-

```
Bk to (empty) '(empty)'
List 'Top-Dir'
Display Item
Insert/Delete Item
Save Item (Text File)
Save Item (Binary File)
Load File
On to Tube 'pisces'
```

## Menu 13

tional menu will be similar to that shown in **Menu 13**.

**Save Item (Binary File):** Data files are saved to disk in binary format using the **Save Item (Binary File)** command. Selecting this option brings up the **Select Menu** similar to **Menu 14**. Only one choice, **Tube 'pisces'**, is

```
Exit Submenu
List 'Top Dir'
Select One:
*Tube 'pisces'
```

## Menu 14

shown in this example, but it is possible to have a long list of files that have been loaded. Select the file that you want to save by clicking on it with the mouse cursor. An asterisk will appear beside the selected file and **Menu 15** will appear. A filename must be entered and if no path is speci-

```
output filename is:
(unknown)
Enter new output filename:
:
```

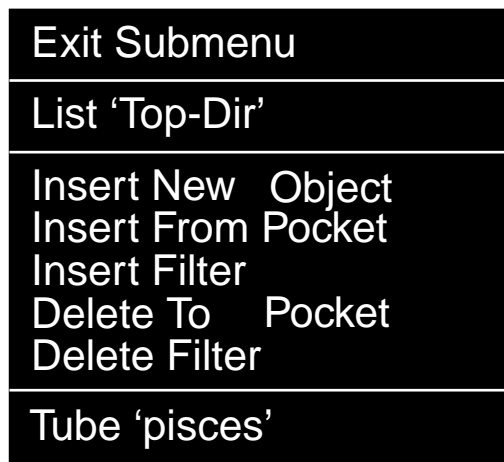
## Menu 15

# DRAFT

fied, the file will be saved to the current directory. If the file is to be saved to other than the current directory, the entire path, in standard Unix notation, must be specified.

**Save Item (Text File):** Data files are saved to disk in **ASCII** format using **Save Item (Text File)**. Selecting this option brings up the **Select Menu (Menu 14)**. The desired file must be selected with the mouse and **Menu 15** will appear. A filename must be entered and if no path is specified, the file will be saved to the current directory. If the file is to be saved to other than the current directory, the entire path must be specified.

**Insert/Delete Item:** When **Insert/Delete Item** is selected, a submenu similar to **Menu 16** appears. The menu shows the class of items that can be inserted and deleted plus a list of objects.



**Menu 16**

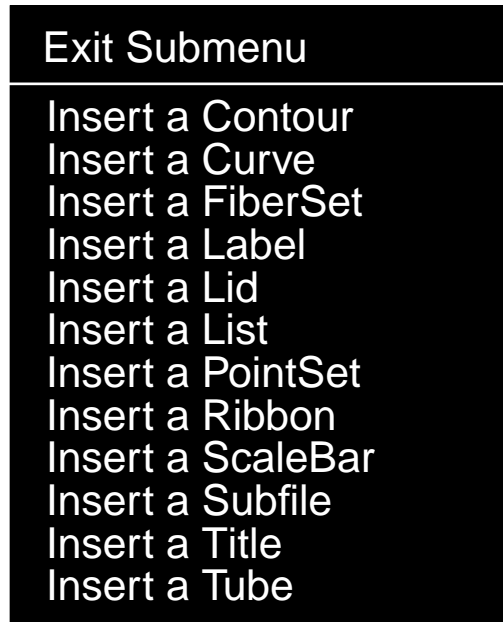
**Insert New Object:** There is an extensive list of objects that can be inserted into the file tree. Selecting **Insert New Object** brings up a submenu, depicted as **Menu 17**. A brief description of each of the objects follows (more detailed discussions of these objects will occur later).

**Contour:** Selecting this item will insert a single contour into the file tree. The **Contour** comes as a standard closed curve which must be modified to be used. However, since a single contour cannot be surfaced, a **Contour** is very seldom inserted. The more useful object is the **Ribbon**.

**Curve:** Selecting this item inserts an open curve into the file tree. The **Curve** was created for a special case and has no general use.

# DRAFT

**Fiber Set:** A **fiber set** is a set of two-point vectors in a plane. They are not normally used for drawing solid objects.



**Menu 17**

**Label:** A label of 72 characters can be specified. A menu is associated with the **Label** for entering the characters and which allows the user to move the label along the **X, Y and Z** axes. There is no provision for changing the font.

**Lid:** The basic geometrical shape of objects within **Skandha** is an open tube. A structure called a **Lid** is used to close the end of a tube. This object will automatically generate a cover (lid) attached to the end contour of a tube.

**List:** A **List** is a collection of other objects. The other objects can be any of those shown in **Menu 17** but the most common items in a list are tubes, other lists and subfiles. A **List** is often used to group together parts of a larger object.

**PointSet:** A **PointSet** is simply the set of points associated with the standard closed curve that makes a contour. The **PointSet** menu is rarely if ever used.

**Ribbon:** A ribbon is the basic solid object and consists of contours with points on two adjacent levels connected. Various schemes are used to represent a solid surface between the contours.

**ScaleBar:** The **ScaleBar** shows a unit distance along with the appropriate units. It may also be used to measure distances in the plane of the screen.

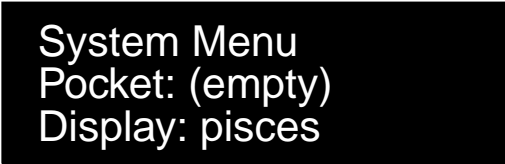
# DRAFT

**Subfile:** A **Subfile** points to a file tree which exists in memory and can be saved to disk. It is useful since the same file tree can be used in more than one file or in different parts of a larger file tree thus saving both disk and memory space. In addition, using subfiles insures only one, up-to-date copy of the file exists in a given directory.

**Title:** Selecting **Title** allows the user to create a four line title for the object being drawn. There are various menu items for selecting the font, the font weight and positioning the title.

**Tube:** A **Tube** is the basic three-dimensional object drawn with **Skandha** and consists of two or more contours. This selection inserts an empty **Tube** into the file tree and **Ribbons** must be loaded into it. Note that, although not common, a tube can consist of only one ribbon.

**Insert From Pocket:** The pocket is a stack used for temporary storage of objects. The last object put in the pocket is the first one removed. This selection simply moves the top object in the pocket to the current list or tube. The name of the object to be inserted from the



System Menu  
Pocket: (empty)  
Display: pisces

**Menu 18**

pocket will appear opposite **Pocket:** in **Menu 18**.

**Insert Filter:** Filters modify objects to which they are attached. This se-



Exit Submenu

Insert a Color  
Insert an Editor  
Insert a Light  
Insert a Rotor  
Insert a Viewport  
Insert a Z-Clipper

**Menu 19**

lection brings up **Menu 19**. Select the desired filter by clicking on it and the **Select Menu (Menu 14)** will appear. Click on the object which you wish to insert a filter.

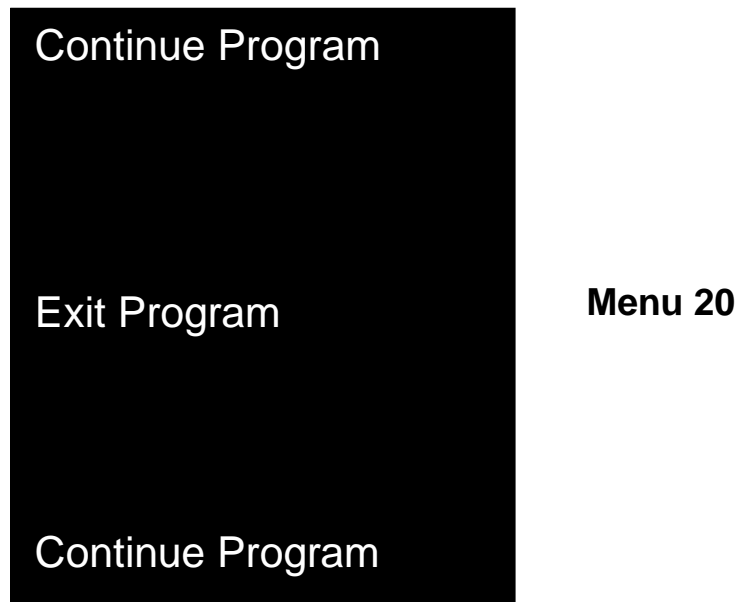
# DRAFT

**Delete to Pocket:** When this option is selected, a menu listing the objects which can be deleted will appear. Simply click with the mouse on each object you want to put in the pocket.

**Delete Filter:** Selecting **Delete Filter** brings up the **Select Menu**. Filters can be removed by clicking on the object to which they are attached. The last filter inserted will be the first filter removed.

**Display Item:** Selecting **Display Item** brings up the **Select Menu**, similar to that shown as **Menu 14**. Although **Menu 14** only shows one possible selection, there can be multiple choices. Click with the mouse on the object you wish to display and, an asterisk will appear next to the selected object. The name of the object you have chosen to display will also be shown in the small menu at the bottom right corner of the screen (represented as **Menu 18**). However, the screen will not begin to re-draw until **Display** is selected with the mouse. **Hint:** Sometimes the object actually being displayed does not agree with what you think should be displayed. When this happens check the name opposite **Display:** in **Menu 18** to determine which object has been selected for drawing.

**Back to (empty) 'empty':** Selecting this option moves the user to the very top of the menu tree and the **Exit Menu (Menu 20)** appears. The

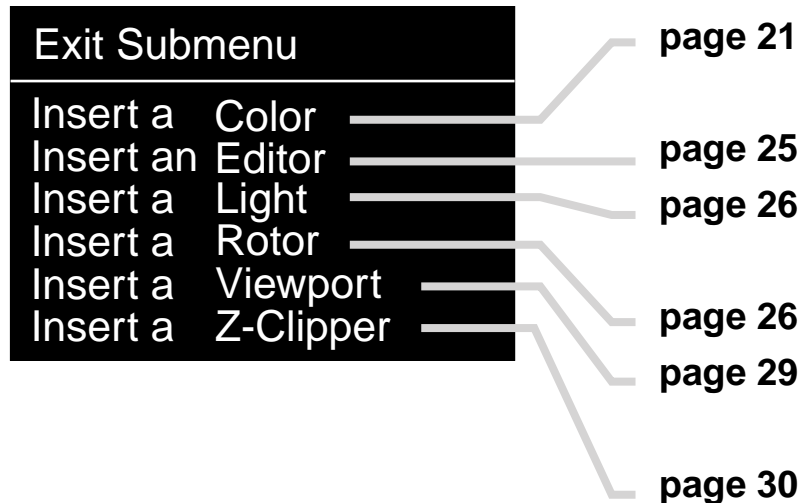


**Exit Menu** has three entries, two of which (**Continue Program**) return the user to Skandha. The third, **Exit Program**, causes a normal exit from Skandha.

# DRAFT

## *Filter Menus -*

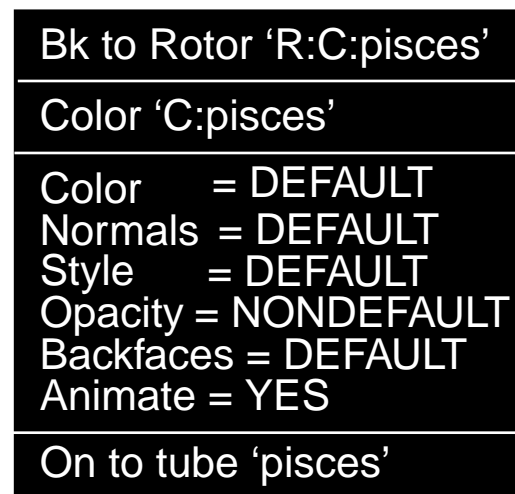
When **Insert/Delete Item** is selected from the **Initial Menu** a submenu appears (**Menu 16**) and one of the choices is **Insert Filter**. Selecting **Insert Filter** results in another submenu similar to that shown below. Descriptions of the filter menus begin on the pages indicated.



When a specific filter is selected, the **Select Menu (Menu 14)** appears. To insert a filter, click on the desired object with the mouse cursor. In order to access the options within a filter, the user must first exit from the **Select Menu** and the **Insert Filter Menu**. Then the user descends the file tree until the desired filter is reached. You can tell which filter you are in by looking at the second line of the submenu. For example, if you are in the color filter you will see: **Color 'C: name'**.

**Insert a Color:** Selecting **Insert a Color** brings up the color menu, an example of which is shown as **Menu 21**. The top line shows the name of the **Parent Menu** for the filter while the bottom line shown the name of the **Child Menu**. The items selected in the filter apply to all parts of the file tree below it. In addition to color, the filter is used to turn the normals on or off, determine the drawing style, set the opacity, turn the backfaces on or off and determine whether or not that part of the file tree will be included when creating the script for video animation. When the select-

ed item is shown as **DEFAULT**,



**Menu 21**

# DRAFT

the setting is determined by any filter farther up the file tree. If there is no filter between the object and the **Initial Menu**, the setting is determined by the program default.

**Color:** The program default color is red. If some other color is desired, click on **Color** and **Menu 22** will appear. Simply click on the color desired. The object



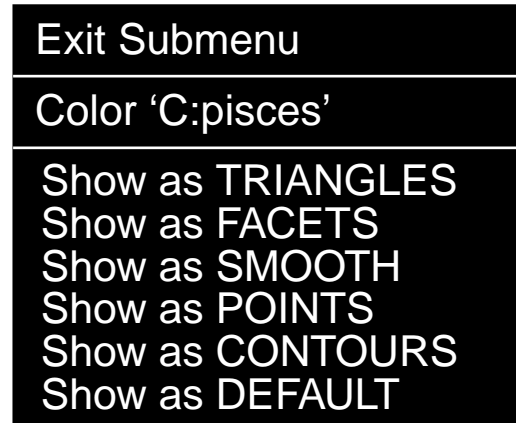
## Menu 22

will be drawn in that color as it is defined in the **System Menu**. The color selected will also apply to all objects down the file tree which have a **Color Filter** set to **DEFAULT** or have no **Color Filter** of their own.

**Normals:** This selects a three-position switch for the vertex and facet normals. The settings are **DEFAULT**, **OFF** and **ON**. Again, **Off** and **On** will apply to objects down the file tree. Normals are turned on mainly as an aid in editing to identify a particular object or ribbon. An object drawn with the normals

on can also produce some bizarre results.

**Style:** Selecting **Style** brings up **Menu 23**. The object (and all those below it in the file tree) will be drawn in the style selected. If **DEFAULT** is selected, filters above this level in the file



## Menu 23

tree will reign. Drawing styles are defined on **page 2** of this manual.

**Opacity:** When **Opacity** is selected, **DEFAULT** will change to **NONDEFAULT** and a small menu, **Menu 24**, will appear at the bottom of the **Color Filter**



## Menu 24

menu. Clicking on the bottom line between 0.0 and 1.0 will cause the corresponding opacity value to be set. Click on the top line and you may enter a value between 0 and 1 from

# DRAFT

the keyboard. Although the Iris has an alpha channel which provides a smooth transition from invisibility to complete opacity, it has yet to be implemented in Skandha. Thus partial opacity is accomplished by not drawing some of the pixels. This produces a blotchy effect except when opacity is set to 0.5.

**Backfaces:** This selects a three position switch to determine whether or not the inside of an object will be drawn. The three positions are **DEFAULT**, **OFF** and **ON**.

**Animate:** This switch determines if this part of the file tree can be accessed from the part of **Skandha** used to script video animation sequences. **ON** means that there is access; **OFF** means there is not.

**Insert an Editor:** Selecting **Insert an Editor** brings up a very extensive menu, **Menu 25**. The top line shows the name of the **Parent Menu** for the filter while the bottom line shown the name of the **Child Menu**. The items selected in the filter apply to all parts of the file tree below it. Basically, this filter is used to perform various calculations and geometrical transforms on the file tree. It should be noted that the Editor makes permanent changes to the data base so there should be due consideration before applying any of the options. **Note:** In the **Editor**, **X**, **Y** and **Z** coordinates refer to the default (not

the screen) orientation of the object.

**Volume & Center:** This option gives the **X**, **Y** and **Z** coordinates for the center of mass,

Bk to List 'Top-Dir'

Editor 'E:R:C: pisces'

Volume & Center  
Bounding Box  
XY Scaling  
XZ Shear  
YZ Shear  
X Slide  
Y Slide  
Z Slide  
Z Mirror  
Y Mirror  
X Mirror  
Sandpaper  
Normalize  
X--Scaling  
Y--Scaling  
Z--Scaling  
Z--Rotation  
Align Tube  
Insert Lids  
Export Tubes  
Open All Contours  
Close All Contours  
Count Points & Polygons

On to Rotor 'R:C:pisces'

## Menu 25

calculates the volume of the object using two different methods, calculates the area and also provides a measure of the

# DRAFT

diameter of the object.

**Bounding Box:** The dimensions of the smallest box that will contain the object is calculated when this option is selected.

**XY Scaling:** The user can change the **XY** dimensions of the object using this option.

**XZ Shear:** When **XZ Shear** is selected, the user is asked to enter a single number. That number is the fraction of the **Z** coordinate the section is slid in the **X** direction.

**XY Shear:** **XY Shear** causes a section to be slid in the **Y** direction by fraction of the **Z** coordinate that is entered.

**X Slide:** **X Slide** shifts all objects below the filter along the (default) **X** axis. You are required to enter a number; the units are in centimeters.

**Y Slide:** **Y Slide** is the same as **X Slide** except objects are shifted the desired amount along the (default) **Y** axis.

**Z Slide:** This selection shifts the objects along the (default) **Z** axis.

**Z Mirror:** When **Z Mirror** is selected, all **Z** coordinates are multiplied by -1 forming a mirror image of the object. The new object would be seen reflected in the plane **Z = 0**. It may be necessary to normalize the object before it will draw properly.

**Y Mirror:** When **Y Mirror** is selected, the user is requested to en-

ter the **Y Mirror** plane. Then all **Y** coordinates are multiplied by -1 and shifted by twice the amount entered. The new object would be seen reflected in the plane **Y = A**, where **A** is the value entered for **Y Mirror** plane.

**X Mirror:** The user is requested to enter the **X Mirror** plane when this option is selected. Then all **X** coordinates are multiplied by -1 and shifted by twice the amount entered. The new object would be seen reflected in the plane **X = B**, where **B** is the value entered for **X Mirror** plane.

**Sandpaper:** **Sandpaper** applies a simple smoothing algorithm to the data.

**Normalize:** Selecting **Normalize** orders the contours according to their **Z**-spacing, repairs any problems in the data-structure, determines the neighbors and re-calculates tiling and normals if necessary.

**X-Scaling:** This selection scales the object only in the (default) **X** direction. The number entered is a decimal fraction of the original.

**Y-Scaling:** This selection scales the object only in the (default) **Y** direction. The number entered is a decimal fraction of the original.

**Z-Scaling:** This selection scales the object only in the (default) **Z** direction. The scale factor entered is a decimal fraction of

# DRAFT

the original.

**Z-Rotation:** The object is rotated around the (default) **Z** axis. The number of degrees of rotation is determined by user input.

**Align Tubes:** This option will insure that all contours in a given section are subject to the same transform, no matter when they were digitized and edited. The **reference tube** is the previously edited tube which has been rotated or translated using the appropriate option in the **Contour Menu**; the **target tube** is the current tube to be transformed.

**Insert Lids:** Selecting **Insert Lids** will insert a lid on each contour in the specified section.

**Export Tubes:** **Export Tubes** is used to export files to users not running **Skandha**. The data can be exported either as facets or contours. No color information is included.

**Open All Contours:** Selecting **Open All Contours** eliminates the connection between the first and last points in a contour. The open section will not be surfaced when the image is rendered.

**Close All Contours:** **Close All Contours** insures that the first and last points for all contours are connected.

**Count Points & Polygons:** This option performs the task of counting the number of points and polygons.

**Insert a Light:** When this option is chosen a **Light** filter is inserted

```
Bk to Rotor 'R:L:C:pisces'  
Light 'L:C:pisces'  
Lighting = DEFAULT  
Animate = YES  
On to Color 'C:pisces'
```

## Menu 26

and if it is not set to **DEFAULT** it takes precedent over the default light (which is defined in the **System Menu**). The initial menu for the **Light** is shown as **Menu 26**.

```
Bk to Rotor 'R:L:C:pisces'  
Light 'L:C:pisces'  
Lighting = NONDEFAULT  
Animate = Yes  
Light is FIXED IN SPACE  
Sun Altitude = 90.000  
-90.000 90.000  
Sun Azimuth = 0.000  
-180.000 180.000  
On to Color 'C:pisces'
```

## Menu 27

Clicking with the mouse on '**Lighting = DEFAULT**' brings up the main **Light** filter menu, **Menu 27**. The '**Light is**' line in **Menu 27** is a switch which causes the light to be fixed in space (as shown in **Menu**

27) or on the object. Fixing the light in space is the more natural of the two modes but has the disadvantage that when the light is perpendicular to the contours even very small differences between adjacent contours will exaggerate surface irregularities. The altitude and



## Menu 28

azimuth can be set via keyboard entry or by clicking with the mouse, similar to setting the default light (see **page 14**). When the light is fixed in space the conventions for the  $\pm 90^\circ$  altitude and  $\pm 180^\circ$  azimuth are the same as they are for the default light. When the light is fixed on the object the reference axes refer to the default position for the object. The default position is the position in which the object was digitized. **Hint:** If you

do not know the default position, reset the rotors and draw the object as contours and it will be automatically drawn in the default position. When in the default position an altitude of  $+90^\circ$  is along the **+Y** axis,  $-90^\circ$  the **-Y** axis. An azimuth of  $0^\circ$  is along the **-Z** axis and  $\pm 180^\circ$  is along the **+Z** axis.

**Insert a Rotor:** Selecting **Insert a Rotor** brings up the rotor menu, **Menu 28**. The menu is used to rotate, scale and translate objects. The direction of rotation is determined by the right-hand rule. **Hint:** For the right-hand rule, point your thumb in the **+ axis** direction and your fingers will curl in the direction of positive rotation.

**X-Rotation:** Selecting **X-Rotation** brings up a sub-menu similar to **Menu 29**. The magnitude of the rotation is determined by clicking on the desired value. The steps are cumulative so, for example, if a  $30^\circ$  rotation is desired, the user should just click twice on **XRot 15**. For convenience, the **X-Rotation** sub-menu can be used to rotate the object around the **Y** and **Z** axes in steps up to  $45^\circ$ . In addition, the **YRot Rate** for real time rotations can be specified.

**Y-Rotation:** See explanation for **X-Rotation**.

**Z-Rotation:** See explanation for **X-Rotation**.

**Rotation Rates:** Selecting **Rotation Rates** brings up **Menu 30**. As can be noted this menu is used to control zoom and translation rates as well as rotation

# DRAFT

Exit Submenu	
Rotor 'R:C:pisces'	
XRot -90	
XRot -45	
XRot -15	
XRot -10	
XRot -5	
XRot -1	
XRot 1	
XRot 5	
XRot 10	
XRot 15	
XRot 45	
XRot 90	
XRot 180	
Last XRot =	0.000
-45.000	45.000
Last YRot =	0.000
-45.000	45.000
Last ZRot =	0.000
-45.000	45.000
YRot Rate =	0.000
0.000	10.000

## Menu 29

rates. Values can be entered from the keyboard by clicking on the top line of each entry while clicking on the bottom line will cause the corresponding value to be entered. This menu is used to enter rotation rates for real time rotations on

the Iris. However, since real time rotations are limited by size to relatively small objects the **Rotation Rates** menu is used almost exclusively for video animations.

Exit Submenu	
Rotor 'R:C:pisces'	
XRot Rate =	0.000
-5.000	5.000
YRot Rate =	0.000
-5.000	5.000
ZRot Rate =	0.000
-5.000	5.000
Zoom Rate =	1.000
0.500	1.500
XMov Rate =	0.000
-20.000	20.000
YMov Rate =	0.000
-20.000	20.000
ZMov Rate =	0.000
-20.000	20.000

## Menu 30

**Translation:** The translation menu is shown as **Menu 31**. It is used to move objects on the screen. As with other menus of the same general configuration clicking on the top line of each entry allows the user to enter values via the keyboard. Click-

# DRAFT

ing on the bottom line will

Exit Submenu	
Rotor 'R:C:pisces'	
Last XMov =	0.000
-1.000	1.000
Last YMov =	0.000
-1.000	1.000
Last ZMov =	0.000
-1.000	1.000

## Menu 31

cause the corresponding value to be entered. For **X** and **Y** moves, a value of 1.0 moves the object about halfway across the screen. Values entered do not permanently alter the database and the user can reset everything under the rotor to the default position by selecting **Reset** from the main rotor menu (**Menu 28**).

**Shear:** The **shear** menu is shown as **Menu 32**. Each entry causes a point on the axis designated by the first letter to be moved the specified distance along the axis designated by the second letter. For example, selecting **Last XYShear** moves points on the **X** axis the specified distance along the **Y** axis. Clicking on the top line of each entry allows the user to enter values via the keyboard. Click-

ing on the bottom line will

Exit Submenu	
Rotor 'R:C:pisces'	
Last XYShear =	0.000
-1.000	1.000
Last YZShear =	0.000
-1.000	1.000
Last YXShear =	0.000
-1.000	1.000
Last YZShear =	0.000
-1.000	1.000
Last ZXShear =	0.000
-1.000	1.000
Last ZYShear =	0.000
-1.000	1.000

## Menu 32

cause the corresponding value to be entered.

**Scaling:** When the user chooses **Scaling** a sub-menu shown as **Menu 33** appears. Selecting the top line of each entry allows the user to enter values via the keyboard while clicking on the bottom line will cause the corresponding value to be entered. The top entry, **Last Zoom**, causes the entire object to be scaled. Each dimension

Exit Submenu	
Rotor 'R:C:pisces'	
Last Zoom =	1.000
0.250	1.750
Last XZoom =	1.000
0.250	1.750
Last YZoom =	1.000
0.250	1.750
Last ZZoom =	1.000
0.250	1.750

### Menu 33

can be scaled separately by choosing one of the other options.

**Reset:** None of the actions performed by this filter makes any permanent change to the database. Thus any changes made with a filter can be reversed and that is accomplished by selecting **Reset**. **Note: Reset** returns all objects under the filter to the default position - it is not just an undo command.

**Mirror:** Selecting **Mirror** brings up **Menu 34** and allows the user to construct a mirror image of the object. on any of the three axes. The mirror program simply changes the sign of the designated coordinate. Thus, when **X-Mirror** is selected, all **X** coordinates would be negated.

Exit Submenu	
Rotor 'R:C:pisces'	
X-Mirror	
Y-Mirror	
Z-Mirror	

### Menu 34

**Unlocked:** The entry shown as **Unlocked** in **Menu 28** is a switch which when activated results in **Menu 35**. Note that none of the usual functions found in the **Rotor** are accessible to the user. In order to un-

Bk to List 'Top-Dir'
Rotor 'R:C:work'
LOCKED
On to Color 'C:pisces'

### Menu 35

lock the rotor, simply select **LOCKED**. You will be asked if you really want to unlock the rotor and clicking **Yes** will unlock it. This feature is used when the object under the filter is to be permanently (more or less) rotated, shifted or scaled. It prevents the user from inadvertently changing the filter.

**POST-APPLY:** This selection is a switch with two options, **POST-APPLY** and **PRE-APPLY**. The option determines how the current transformation matrix is applied to the cumulative

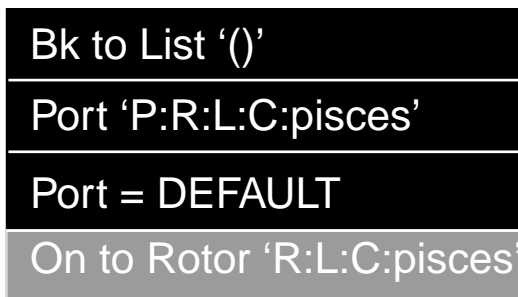
# DRAFT

transform for the file tree. **POST-APPLY** is the usual option and means that all previous transforms are applied before the current transform. When **PRE-APPLY** is selected, the current transform is applied prior to any other user generated transforms.

**Full Matrix:** Selecting **Full Matrix** shows the matrix used for all geometric transformations on the object including rotation, translation, scaling and skew. Matrix values can also be entered via the keyboard. Simply click on the value you wish to change and enter the new one. This feature can be used to reproduce a previous transformation where the matrix is known.

**Rot Matrix:** This selection is similar to **Full Matrix** except only the rotation matrix is shown.

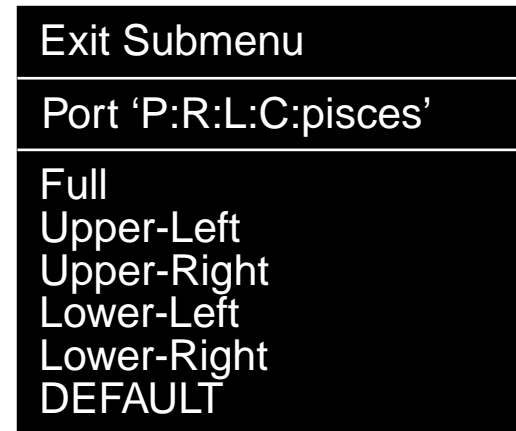
**Insert a Viewport:** This filter is ba-



**Menu 36**

sically a duplicate of the **port shape** selection found in the **System Menu**. When the filter is first inserted, **Menu 36** will appear indicating where the object will be drawn is determined by the **System Menu**. Clicking on **DEFAULT**

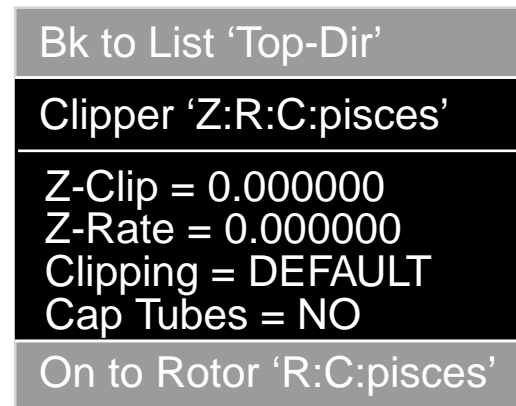
will bring up **Menu 37** where the



**Menu 37**

user can select which part of the current window will be used for drawing the object.

**Insert a Z-Clipper:** A **Z-Clipper** clips, i.e., does not draw, that part of the object greater than or less



**Menu 38**

than the specified z-clip plane.

**Z-Clip =:** The clipping plane is selected by clicking on **Z-Clip =** and entering the desired value. The units are those used for the **Z**-spacing of the object.

# DRAFT

**Z-Rate =:** **Z-Rate** is mainly used for video animation. It sets the amount of clipping that occurs each time the object is drawn.

**Clipping =:** In addition to specifying the clipping plane, the user must specify whether the clipping occurs at **Z** values greater than or less than the specified plane. Clicking on the **Clipping =** line brings up **Menu 39**. Selecting **Clip all < plane** means

Abort

Clip all < plane

Clip default

Clip all > plane

## Menu 39

that ribbons with z-spacing less than the clipping plane will be clipped (not drawn); **Clip all > plane** means that ribbons with z-spacing greater than plane will not be drawn. Selecting **Clip default** means that the filter defaults to and **Z-Clipper** higher up the file tree or if there is none, no clipping will take place.

**Cap Tubes =:** When **Cap Tubes = YES** a lid is automatically drawn on the tube each time clipping takes place.

## Editing Menus -

**Tube Menu:** If you continue to select the child menu you progressively move down the file tree and will eventually arrive at the tube menu, **Menu 40**. This menu is used for normalizing the contours in the tube. It performs the same

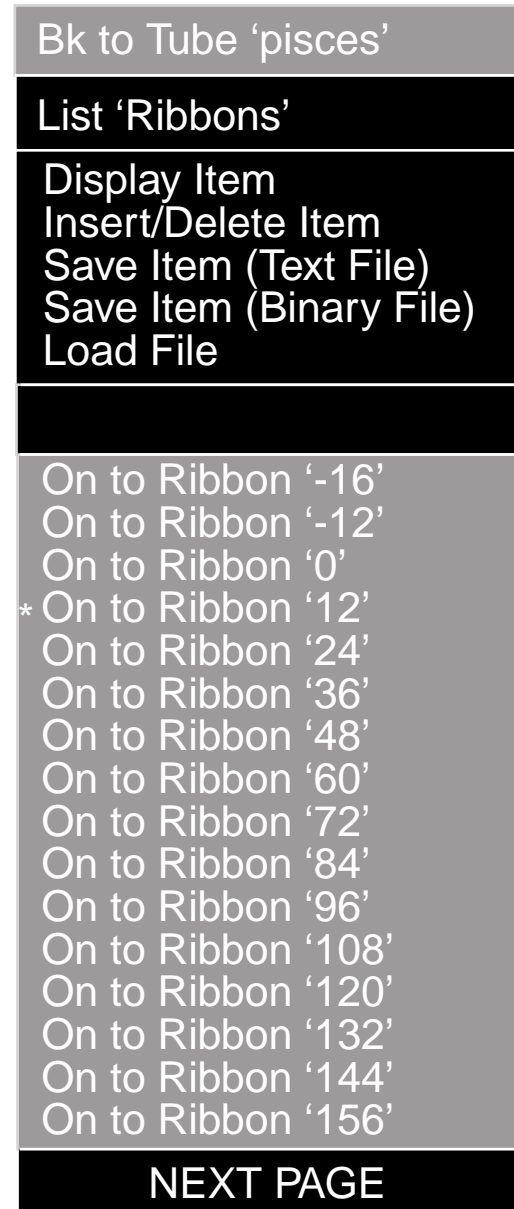


### Menu 40

functions as **Normalize** in the **Edit Filter**. Normalization orders the contours according to their **Z**-spacing, determines the neighbors for each contour, repairs problems in the data structure and, if necessary, re-calculates normals.

**List of Ribbons:** Selecting the child menu, **On to List 'Ribbons'**, brings up the list of ribbons, **Menu 41**. The child menu shows the ribbon list for the particular tube. Each ribbon is named for its **Z**-spacing, shown in centimeters. The **Normal Menu** allows various operations to be performed on the individual ribbons. The user can display an individual ribbon, insert or delete any of the objects found in the **Insert/Delete** menu, save an individual ribbon to disk as either a text or binary file and load individual ribbons or other objects from disk (although loading an indi-

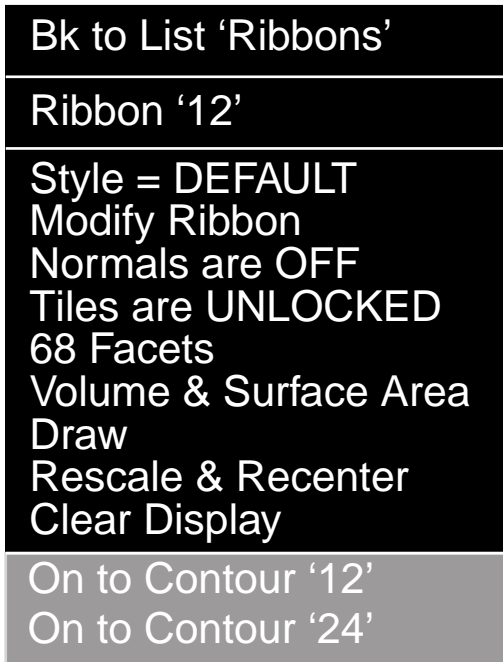
vidual ribbon is the only action that makes sense). To select a ribbon



### Menu 41

for editing, click on the desired ribbon. An asterisk will appear beside the selected ribbon and the ribbon menu will appear.

**Ribbon Menu:** When a ribbon is selected the ribbon menu, **Menu 42** appears.

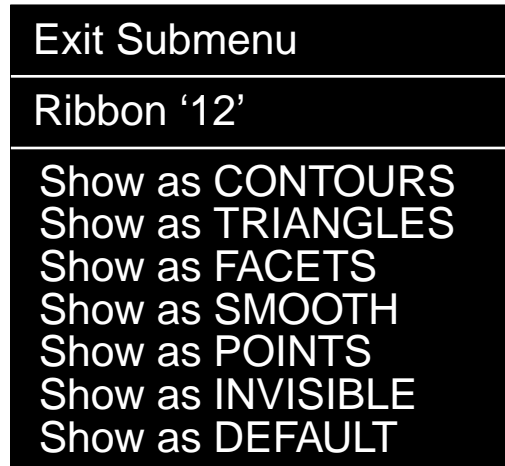


**Menu 42**

**Style:** Selecting this option allows the user to determine how an individual ribbon will be displayed. Selecting **Style** brings up **Menu 43**. Note the choices are very similar to those for the **Color** filter shown in **Menu 23**. There is one difference - a ribbon can be shown as invisible. This is used when one tube is connected or "patched" to another tube.

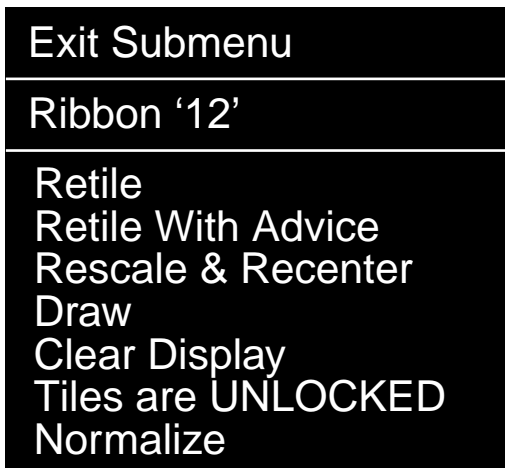
**Modify Ribbon:**When an object is surfaced, Skandha must determine which points on adjacent contours are connected. Essentially the rule that is used is to select a point on one contour and connect it to the nearest neighboring point on the adjacent contour. Most of the time

this scheme works well and the surface that is produced



**Menu 43**

agrees with what the user thinks it should be. However, there are times when this strategy breaks down and the user



**Menu 44**

must guide the tiling. The **Modify Ribbon** menu, **Menu 44** provides the tools that allows the user to specify ribbon tiling.

**Retile:** Selecting Retile causes Skandha to construct the tiling.

# DRAFT

**Retile With Advice:** This option allows the user to guide the tiling for the ribbon. When selected, the two contours comprising the ribbon appear on the screen. One contour is colored green, the other red. The user is instructed to connect a point on the green contour to the desired point on the red contour. Usually only a few points need be connected by hand and Skandha will fill in the remainder.

**Rescale & Recenter:** Clicking on **Rescale & Recenter** causes the two contours making up the ribbon to be scaled, centered and displayed on the screen.

**Draw:** This option causes the two contours comprising the ribbon along with the current tiling to be displayed on the screen. **Note:** This option does not scale or center the contours - it only draws them.

**Clear Display:** Selecting **Clear Display** clears the drawing area of the screen.

**Tiles are:** This entry is both a switch and an indicator. The tiles are automatically locked after retiling with advice and in that case you will see this entry as **Tiles are LOCKED**. When locked the tiling will not be changed when **Retile** or **Retile With Advice** is selected. If the tiling is

**LOCKED** it can be changed by clicking on this entry. Conversely, the tiling can be **LOCKED** by clicking on this line.

**Normalize:** Selecting this option performs functions similar to those performed by **Normalize** in the **Edit** filter and **Tube Menu** such as repairing any problems in the data-structure and re-calculating tiling and normals if necessary. It does not order the contours according to their **Z**-spacing.

**Normals are:** This is a switch to turn the facet and vertex normals on or off.

**Tiles are:** This entry is the same as the **Tiles are** option in the **Modify Ribbon** menu.

— **Facets:** This entry displays the number of facets for the current tube.

**Volume & Surface Area:** Clicking on this entry brings up a submenu that shows the volume and surface area for the current tube.

**Draw:** Selecting **Draw** causes the two contours of the ribbon along with the current tiling to be drawn. **Note:** No scaling and centering takes place so the first time the ribbon is drawn **Rescale & Recenter** will insure that the ribbon is displayed within the drawing area.

**Rescale & Recenter:** This option rescales and recenters the rib-

# DRAFT

bon so it will fit within the drawing area and then draws it.

**Clear Display:** Selecting this option causes the drawing area to be cleared.

**Contour Menu:** Selecting one of the contours from the **Ribbon Menu (Menu 42)** results in a sub-menu shown as **Menu 45**. This is where most of the real editing work is done.

The first time the **Ribbon Menu** is selected, the ribbon will be automatically scaled and centered and displayed in the drawing area. Essentially this initializes the scaling for the tube.

**Draw Contour:** Selecting this option simply draws the contour colored green. No scaling or centering takes place.

**Draw Neighbors:** When this option is selected, contours on either side of the current contour are drawn. The contour that is drawn in blue has a **Z**-coordinate less than the current contour, while the contour that is drawn in white has a **Z**-coordinate that is greater than the current contour.

**Clear Display:** Selecting this option causes the drawing area to be cleared.

**Draw Section:** Selection of this option causes all the contours in the section to be drawn. No scaling or centering occurs prior to drawing.

**Draw Neighbor Sections:** This option is similar to **Draw Neighbors** except that all neighboring contours in a section are

Bk to Ribbon '12'

Contour '12'

Draw Contour  
Draw Neighbors  
Clear Display  
Draw Section  
Draw Neighbor Sections

--Matrix--

Rescale & Recenter

Frame = 1

ZCoord = 12

Area = 4205.63

Reameasure Contour

Remeasure Part

Remeasure Most

Move Contour

Move Section

Rotate Contour

Rotate Section

Reverse Contour

Contour is Closed

Contour is CONNECTED

Pan / Zoom

On to PointSet '()

## Menu 45

drawn. The color code for the contours is the same as for the **Draw Neighbors** command.

**--Matrix--:** Selecting Matrix causes the cumulative translation and rotation matrix to be displayed.

# DRAFT

**Rescale & Recenter:** This option rescales and recenters the contour within the drawing area and then displays it.

**Frame =:** This tells the user the frame number for the contour.

**ZCoord =:** This entry provides the Z-coordinate for the contour in centimeters from the origin. It may be + or -.

**Area =:** The area of the contour in centimeters<sup>2</sup> is shown.

**Remeasure Contour:** This option allows the user to completely re-do the current contour. When selected, a sub-menu appears and the color of the contour changes to magenta. The user enters each point by pressing the mouse button. Selecting **DONE** from the sub-menu enters the new contour.

**Remeasure Part:** When this entry is selected, the current contour is drawn as yellow. The user is requested to pick the start and stop points. The arc to be measured for this option is the smaller of the two between the start and stop points. It turns red and the points are replaced by pressing the mouse button. Selecting **DONE** from the sub-menu enters the new contour.

**Remeasure Most:** When this entry is selected, the current contour is drawn as yellow. The user is requested to pick the start and stop points. The arc to be measured for this option is the larger of the two between the start and stop points. It

turns red and the points are replaced by pressing the mouse button. Selecting **DONE** from the sub-menu enters the new contour.

**Move Contour:** When this entry is selected, the current contour is drawn as magenta. The user is requested to pick the point to move (with the mouse button) and then the destination point. Essentially the user is dragging the old point to its new location. **Note:** As soon as the destination point is selected with the mouse button the contour is moved.

**Move Section:** Operation of this option is similar to **Move Contour** except all contours in the section are moved. When the entry is selected, the contours are drawn as magenta. The user is requested to pick the point to move and then the destination point. All contours in the section are moved in the same direction and the same distance. **Note:** As soon as the destination point is selected with the mouse button the contour is moved.

**Rotate Contour:** Selecting **Rotate Contour** causes the current contour to be drawn as magenta. The user is requested to pick the rotation axis, the reference radius and the rotation radius. The contour is rotated around the rotation axis by an amount equal to the angle between the reference radius and the rotation radius. **Note:** The

# DRAFT

contour is rotated as soon as the rotation radius is selected.

**Rotate Section:** Selecting **Rotate Section** causes all the contours in the current section to be drawn as magenta. The user is requested to pick the rotation axis, the reference radius and the rotation radius. The section is rotated around the rotation axis by an amount equal to the angle between the reference radius and the rotation radius. **Note:** The section is rotated as soon as the rotation radius is selected.

**Reverse Contour:** The direction of a contour is determined during digitizing. If the contours are closed there is no beginning or end and the tiling algorithm is smart enough that the direction is unimportant. When the contours are open the first and last points are not connected and there is a definite beginning and end. Consequently adjacent contours must have the same direction so the tiling will behave in a reasonable fashion. This option is a switch that, when selected, reverses the direction of the contour.

**Contour is CLOSED:** This selection is a switch that allows the user the option of displaying contours as **CLOSED** or with the gap between the first and last points not connected, or **OPEN**. If **OPEN** is selected a new menu entry appears, **Move Gap**. By selecting the new entry the user can move the gap to any location on the

contour. **Note:** The **CLOSED** option is the default and most often used. But there are some anatomic structures, such as alveoli, that have an open portion. For that reason, the **OPEN** option has been incorporated into Skandha.

**Contour is CONNECTED:** This is a switch that causes a contour to be displayed with the points **CONNECTED** or simply as **DOTS**.

**Pan/Zoom:** Selecting **Pan/Zoom** brings up a sub-menu shown as **Menu 46**. The main use for

Exit Submenu	
Draw Contour	
Draw Neighbors	
Clear Display	
Draw Section	
Draw Neighbor Sections	
Rescale & Recenter	
Pan X =	0.000
-1.000	1.000
Pan Y =	0.000
-1.000	1.000
Zoom =	1.000
0.250	1.750

## Menu 46

this menu is to move a contour in the **X** and **Y** directions on the display screen and to re-scale to a size that can be displayed

# DRAFT

with other contours in the section.

**Pan X** =: This option moves the object on the screen along the **X**-axis. Clicking on the top line allows a value between -1 and +1 to be entered from the keyboard. Clicking on the bottom line will move the object in the + or - direction and the object will be automatically re-drawn. A distance of 1 is approximately one-half the drawing surface width.

**Pan Y** =: This option moves the object on the screen along the **Y**-axis. Clicking on the top line allows a value between -1 and +1 to be entered from the keyboard. Clicking on the bottom line will move the object in the + or - direction and the object will be automatically re-drawn. A distance of 1 is approximately one-half the drawing surface height.

**Zoom** =: Selecting **Zoom** causes the object to be scaled on the screen. Clicking on the top line allows the user to enter a value between 0.25 and 1.75 from the keyboard. Clicking on the bottom line will enter the corresponding value. In either case, the object will be automatically re-drawn when the value is entered.

The remaining selections in this sub-menu are duplicates of entries found in the **Contour Menu, Menu 45**. They are repeated here for convenience.

**On to PointSet '()'**: Selecting this option moves the user on to a sub-menu. The top three entries show the number of points in the contour and the range of the **X** and **Y** coordinates. The **X**, **Y** and **Z** coordinates for the individual points comprise the remainder of the menu. Clicking on one of the lines brings up another sub-menu which shows the **X**, **Y** and **Z** coordinates for that particular point. If one of the coordinates is selected with the mouse, the user can enter a new value from the keyboard.