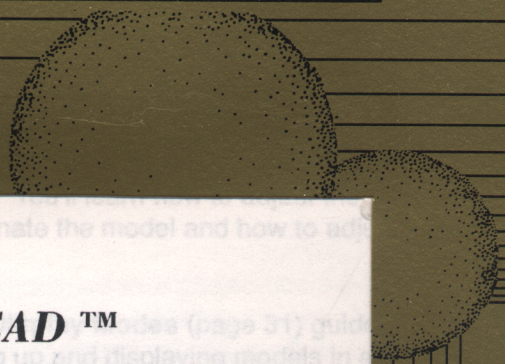
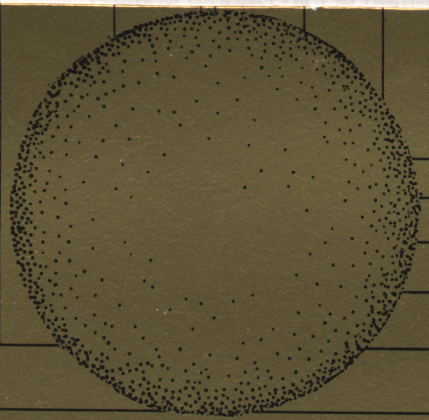
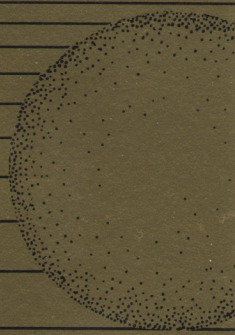
ChromaCAD ™

Sculptured-Surface 3-D Modeling System







ChromaCAD ™

SURFACE SHADER XE 91 Program

For Atari 130XE Computers

MARVER SEAMAN

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INTRODUCTION

Chromacad is a true sculptured-surface 3-D modeling system. With the Chromacad SURFACE SHADER XE program, you will be able to create complex scenes composed of Chromacad 3-D and 2-D models. At the present time, programs that can display sculptured-surface, 3-D models are some of the most expensive programs being sold for personal computers today — many selling in the $2000-$3000 range. (Believe it or not, that's without the computer!)

Most inexpensive 3-D modeling systems being sold today are "solid-modeling" systems that combine solid forms such as cubes, spheres, toroids, etc. to build models. They usually include "spin" and "extrusion" type tools. With this type of modeling, it's almost impossible to construct the type of contoured-surface models most needed by artists and sculptors. The Chromacad MODEL BUILDER program, however, constructs true sculptured models of human heads, animals, sculptures, etc. — any shape that is real or can be imagined.

You should not think of Chromacad as a scaled down 8-bit answer to 3-D modeling systems running on larger machines. In fact, the reverse is true. In the most important criteria, such as size and intricate sophistication of models, including complex surface shape and surface patterning, Chromacad models have no equal outside of those presently constructed on high-end professional systems and work-stations.

The size of the models you'll be able to display is immense. One of the models on Chromacad MODEL DISK #2 is a model of the human head. This model has more than 8000 individually oriented and colored surface facets and requires more than 50K of disk storage. Never before has a home computer been able to construct and display such a model.

The Chromacad sculptured-surface 3-D modeling system will open the 130XE to a fascinating new application — the illustration of imaginative fantasies and ideas. Anyone who has seen a political cartoon or an advertisement for a computer game is immediately aware of the power of an imaginative graphic. Most of us have wished from time to time that we could support our own ideas with the same kind of immediate forceful illustration.

In most cases, imaginative illustrations can't be produced with photographs. Until now, the only way to illustrate your own fantasies and ideas was to hire a professional illustrator. Professional illustrations, however, are very expensive. With sculptured-surface 3-D modeling, you can add the creative touch of imaginative illustrations to your own presentations.

This manual is written in the form of a tutorial. The easiest way to learn to use the program is to set up and display actual models with your own computer. Chromacad MODEL DISK #1 is included with the program. MODEL DISK #1 contains the demonstration models which are referred to in this manual. One of the demonstration models, a Roman "C" block-letter model, was one of the letter models used to make the "CHROMACAD" face screen. The other letter models used for the face screen are also included on this disk. All Chromacad model disks contain at least 10 models.

The SURFACE SHADER XE requires very little time to learn. If you follow the steps printed in bold letters with your own computer and read the accompanying commentary, you'll be introduced to the options and registers of the program in the natural order they are needed to display the demonstration models.

In addition to the 6 sections listed in the TABLE OF CONTENTS, there are 3 appendices located at the end of the manual. These are: the REGISTER RANGE APPENDIX, the HARDWARE SPECIFICS APPENDIX and the KEYSTROKE COMMANDS APPENDIX. The REGISTER RANGE APPENDIX lists the input register range values used by this program. The HARDWARE SPECIFICS APPENDIX provides specific data on a few hardware features that may be subject to change. The KEYSTROKE COMMANDS APPENDIX provides a summary of the keystroke commands used in this program.

Some features of the SURFACE SHADER XE program, such as booting up, inputting values into the registers and orientating models in space, are shared by the MODEL BUILDER program. These features are covered in the first two sections. If you have already read the MODEL BUILDER manual, you can skip the first two sections (SECTION 1 — A BRIEF STROLL and SECTION 2 — MODEL ORIENTATION REGISTERS).

We would like to keep in touch with those who use our programs. Please send us you name and address (or fill out the enclosed registration card) so that we can keep you in touch with new developments.

Palette Imaging Inc.
47 South St. STE 127
Norwood N.J. 07648

Tele: 201 767-3913

SECTION 1 -- A BRIEF STROLL

When most people receive a new piece of software they are curious and want to boot the program to see what the MAIN MENU selections look like. To begin, therefore, let's take a brief look at the MAIN MENU and the ten 3-D MENUS that are used for viewing models in space. Follow the directions printed in bold lettering using your own computer while reading the accompanying commentary.

Booting Up

NOTE: "Basic" must be disabled when booting the program. Either the "Basic" cartridge must be removed or the "OPTION" key must be pressed for several seconds while turning on the computer, whichever is applicable for your computer.

To boot the program, turn off the computer, turn on the disk drive and the T.V. or monitor. Insert the Chromacad MODEL BUILDER program disk or the Chromacad SURFACE SHADER XE program disk into the disk drive and turn on the computer.

You will soon be presented with the chromacad face screen.

Tap any key to exit the face screen

You will then be presented with the following *information prompt:*

PRESS **SPACE BAR** TO CONTINUE
OR
TYPE **I** TO VIEW **CHROMACAD** INFORMATION

The Chromacad program disks contains general information on the Chromacad modeling system, including prices and ordering information on programs that are available as of the time of the printing of the disk. This information may change from time to time. Accessing the disk information is an option that can only be called from the above *information prompt* while the program disk is still in the disk drive.

Accessing The Disk Information Screens

If you want to access the disk information, type the "I" (Information) key while viewing the above prompt. The information screens will prompt your return back.

Tap the SPACE BAR while viewing the *information prompt.*

You will then be presented with the Chromacad COPYRIGHT SCREEN. The COPYRIGHT SCREEN prompts you to insert a model disk and then to press "START"

While viewing the COPYRIGHT SCREEN, if you have the MODEL BUILDER program booted, insert an Atari formatted blank disk. If you have the SURFACE SHADER XE program booted, insert Chromacad MODEL DISK #1 included with the program.

Press "START" to boot either disk.

If you have the MODEL BUILDER program booted and you have inserted a blank disk, the disk drive will turn on and a Chromacad disk index will be formatted and stored on the disk. In your case, since no Chromacad data has yet been stored on the disk, the program will format a new Chromacad index for storage on the disk. If the disk would have had information stored on it other than Chromacad models, the information *would have been destroyed.* Chromacad has a disk filing system designed for model storage. It is not compatible with any other disk filing system. Chromacad model disks should be used only for Chromacad model storage.

If you have the SURFACE SHADER XE program booted and you have inserted Chromacad MODEL DISK #1, the index of the model disk will be loaded into the computer. The SURFACE SHADER XE program will only accept disks with at least one Chromacad model stored on them. If an attempt is made to load a disk with no models, an "IMPROPER MODEL DISK" message will be displayed.

You will now be viewing the MAIN MENU of the program.

Do the following exercises but be careful not to type keys inadvertently. Many of the keys have functions that will be covered later and could produce confusing results. If this happens while following the exercises, go back to the MAIN MENU by typing " → " (Out) and start again.

Using the " ↑ " (Up), " ↓ " (Down), the " ← " (In) and " → " (Out) Keys to Select Menu Options

Options are selected by using the " ↑ " (Up) key or the " ↓ " (Down) key to scroll the cursor up or down until it is aligned with the option that you want. The fastest way to get to the bottom from the top of the menu is to press the " ↑ " (Up) key when the cursor is positioned at the top of the menu. The most used options are placed at the top and bottom of the menus. All of the Chromacad menus operate the same way. For clarity, any reference to a key in this manual will always be followed by the Chromacad name for that key in parenthesis.

Practice using the " ↑ "(Up) and " ↓ " (Down) keys a few seconds and then place the cursor opposite EDIT 3-D MENUS and select EDIT 3-D MENUS by typing the " ← " (In) key.

You will now see a menu of the input registers that are used to orientate a model in space in preparation for displaying the model. All registers contain values that can be changed by the user. The value currently stored in each register is located to the right of the register. The menu on display is 3-D MENU #1. Don't worry, you won't have to fill all of these registers to display each model. Most of the time you will only want to change a few of the registers before displaying a model.

Actually, these registers are quite simple. Only the top 11 registers (down to ANGLE OF VIEW) are accessed by both the MODEL BUILDER and the SURFACE SHADER XE. The rest are accessed only by the SURFACE SHADER XE to select colors, highlighting, number of shading tones, reverse imaging, etc. (i.e., different ways of rendering a shaded model). There are 10 of these 3-D MENUS stored on each model disk. You can use each menu to display a different model. All 10 of them can be used at once to display 10 different models on the screen at the same time

Type one of the number keys ("4", for example).

Notice that 3-D MENU #4 is presented as indicated by the change of value in the THIS MENU NO. register on the top row. While viewing any 3-D MENU, you can call any other 3-D MENU by typing the corresponding number key (0 to 9). You can go directly out to the MAIN MENU from any 3-D MENU by typing " → " (Out). These ten 3-D MENUS, along with any values you may store in the

registers are stored on the disks with the models. These menus can be accessed by both the MODEL BUILDER and SURFACE SHADER XE programs.

Inputting Register Values

Return to 3-D MENU #1 by typing "1". Use the " ↓ " (Down) key to place the cursor opposite the X OFFSET register. Select that register by typing the" ← " (In) key. The cursor will jump to the left, awaiting your input value. Type any value within the range of -32767 to +32767. Press RETURN.

Notice that the value to the right of the X OFFSET register has changed. This indicates that the register has accepted your input value. Input registers are selected in the same manner as MAIN MENU options -- by using the " ↑ " (Up) key and the " ↓ " (Down) keys to select the register and the " ← " (In) key to position the cursor for input. If, after typing the " ← " (In) key to access an input register, you change your mind and decide to leave the same value in the register, type any letter key; then press "RETURN". The value in the register will be retained.

You can enter a "0" by simply pressing "RETURN". If you type an incorrect digit while typing a value, press the "DELETE" key to back up and erase the entry. The limits for the X OFFSET, Y OFFSET and Z OFFSET registers are -32767 to +32767. If you attempt to enter any number outside of these limits (i.e., 40000) the program will ignore your attempted entry and leave the current number entered.

All input registers have a limited range of values that can be input to the registers. You'll learn the ranges of the registers used in this program as you go through this tutorial. In addition, you'll find the ranges of the registers used in this program listed in the REGISTER RANGE APPENDIX at the end of the manual. Values are entered in all Chromacad registers the same way. The input registers were organized in the above way so that, when inputting values to any register, you can see at a glance what values are stored in other related registers.

Practice with the OFFSET registers. Try entering out-of-range values. Press the " ← " (In) key to access a register and then reenter the same value by typing any letter key and then pressing "RETURN". Access a register and enter a "0" by just

pressing "RETURN". Use the "DELETE" key to delete typed digits.

When you are finished, return to the MAIN MENU by typing " → " (Out) to go out to the MAIN MENU.

CHANGE MODEL DISK Option (MAIN MENU)

Place the cursor opposite CHANGE MODEL DISK. Select that option by typing the " ← " (In) key.

You will end up back on the COPYRIGHT SCREEN again and the prompt to insert a model disk and to press "START". This is important -- when you want to change a model disk, you must use this option!!! When the program is first booted, it prompts you to insert a model disk. The program then boots the index and 3-D MENUS of that model disk (or, in the case of a new model disk, formats and stores a new index). If you change a disk without using the CHANGE MODEL DISK option, the program will be attempting to use the index of the previous model disk. This will cause a malfunction.

Press "START" to re-boot the same disk.

Normally, you would insert a different model disk before pressing "START". Whenever you select CHANGE MODEL DISK, you can, of course, re-boot the same disk if you desire.

This ends our brief look at some of Chromacad's menus. The next step will be to take a look at those registers of the 3-D MENUS that are used for orientating models in space. These are quite important. Before model construction or display can proceed, it is necessary to understand the use of these registers.

Note: Both the SURFACE SHADER XE and the MODEL BUILDER programs are extremely large, among the largest programs ever installed on an 8-bit system (code size). For this reason they take a long time to boot. We have installed a special routine to make this wait time a little bit shorter. If you press the SPACE BAR as the program is loading, the boot process will not load and display the FACE SCREEN and will skip the *information prompt.* You will, instead, go directly to the COPYRIGHT SCREEN, which will prompt you to insert a model disk.

SECTION 2 -- MODEL ORIENTATION REGISTERS

Model Orientation Registers (3-D MENUS): Setting Up Models to View in Space

Select EDIT 3-D MENUS from the MAIN MENU and then make sure the values listed below are stored in the following 11 registers of 3-D MENU #1. If any value is different, change it to that listed below. Do not change any of the other register values.

THIS MENU NO. =.....1	DISTANCE =.....400
MENU DISPLAY ORDER = ...0	X OFFSET = ...0
MODEL BASE LINE = ...0	Y OFFSET = ...0
PITCH ANGLE =.....0	Z OFFSET = ...0
YAW ANGLE =.....0	ANGLE OF VIEW = ..50
ROLL ANGLE = ...0	

The ten 3-D MENU registers from MENU DISPLAY ORDER to ANGLE OF VIEW are the MODEL ORIENTATION registers. They are used by the MODEL BUILDER and SURFACE SHADER XE programs to select, position and orientate models in space.

Chromacad can also display a test pattern. The test pattern, like a model, is positioned and orientated in space by means of the orientation registers. The test pattern is a simple plot of a letter "L". The "L" is assumed to be plotted on a graph (called the BASE LINE GRAPH). The long stem of the "L" lies on the +Y axis and the short stem lies on the +X axis. The intersection of the two stems lies at the 0,0 center of the graph (see fig. 1). We will use the test pattern to demonstrate the use of the MODEL ORIENTATION registers.

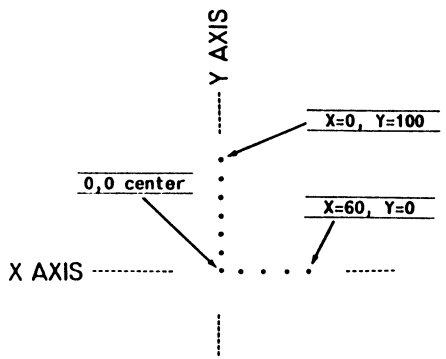

Fig. 1

"Q" (Quick) Key (3-D MENUS): Calling a 3-D MENU to Display the Test Pattern

While viewing 3-D MENU #1, type the "Q" (Quick) key.

The "L" test pattern is displayed in the SPACE SCREEN according to the values that you loaded in the orientation registers of 3-D MENU #1. These values call for an overhead view of the "L" from a distance of 400 units above the graph. You are, therefore, looking straight down on the "L" and seeing the "L" as it appears from 400 units above (see fig. 2A).

The "Q" (Quick) key provides a fast, easy way to view the effects of changed values in the orientation registers. When the "Q" (Quick) key is typed while viewing a 3-D MENU, the test pattern will always be displayed. The SPACE SCREEN appearance should be similar to that depicted in fig. 2B.

NOTE: For print clarity, the SPACE SCREEN illustrations in this manual are printed black on white, whereas the computer display is rendered white on black.

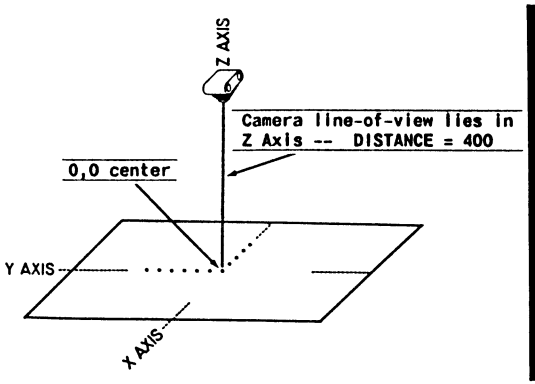

fig. 2A

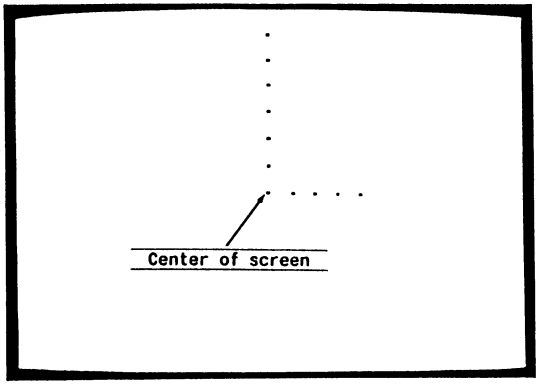

fig. 2B (SPACE SCREEN)

It helps to imagine that the SPACE SCREEN displays a picture of the "L" taken by a camera that is always aimed directly at the 0,0 point of the graph (fig. 2A). The graph is always at zero elevation. The "L" can be positioned anywhere in space by using the X OFFSET, Y OFFSET and Z OFFSET registers.

The camera can be positioned anywhere in space by using the PITCH ANGLE, YAW ANGLE, ROLL ANGLE and DISTANCE

registers. Since the camera is always aimed at the 0,0 point of the graph, the corner of the "L" is currently displayed at the center of the SPACE SCREEN. Let's go back to 3-D MENU #1 and move the "L" by using the X OFFSET and Y OFFSET registers.

Tap the " → " (Out) key to exit the SPACE SCREEN and return to the 3-D MENU that was called (in this case, 3-D MENU #1). (Don't hold the " → " (Out) key down or you'll return to the MAIN MENU. If this does happen, select EDIT 3-D MENUS again.)

X OFFSET and Y OFFSET Registers (3-D MENUS): Repositioning the Model on the BASE LINE GRAPH

Store *"-100"* in the X OFFSET register of 3-D MENU #1. Leave the other registers unchanged. Type "Q" (Quick) to display the "L" again. (NOTE: For emphasis, negative input values will be printed in italics.)

Notice that the "L" is no longer centered. By loading *"-100"* in X OFFSET, you have offset it *-100* units on the X Axis. You are now viewing the "L" as it appears from 400 units directly overhead after being moved *-100* units on the X Axis of the graph.

Return to 3-D MENU #1 again and store *"-100"* in Y OFFSET. Leave the other registers unchanged. Type "Q" (Quick) to display the "L" again.

Notice that the "L" has now also been offset *-100* units on the Y Axis. The X OFFSET and Y OFFSET registers can be used to offset the drawing to any location on the graph. The limits for the offset registers are -32767 to +32767, but be careful about inputting large values at this time, because the drawing may be moved off the SPACE SCREEN. You can, however, view a larger area of the graph by using the DISTANCE register to move the camera further away from the 0,0 point of the graph.

DISTANCE Register (3-D MENUS): Setting the Distance between the Camera and the 0,0 Point of the Graph

The DISTANCE register sets the distance between the camera and 0,0 point of the graph. This length is depicted by the LINE-OF-VIEW line in fig. 2A. The DISTANCE range limits are also -32767 to +32767. (The X OFFSET, Y OFFSET, Z OFFSET and DISTANCE registers all have the same input ranges.)

Practice moving the "L" around on the graph with the X OFFSET and Y OFFSET registers of 3-D Menu #1 and viewing the result in the SPACE SCREEN. Try a few different values in DISTANCE to observe the effect of changing the DISTANCE between the camera and the 0,0 point. Try some large value in DISTANCE (like 4000) to observe the effect. Notice how you can use larger X,Y OFFSETS when you use a large DISTANCE and still keep the drawing in the SPACE SCREEN. For this exercise, be sure to change only the values in the X OFFSET, Y OFFSET and DISTANCE registers.

Z OFFSET Register (3-D MENUS): Lifting the Drawing Off the BASE LINE GRAPH

Store, where necessary (change the values in the registers where necessary), "400" in DISTANCE, "200" in Z OFFSET, "50" in ANGLE OF VIEW and "0" in all of the other orientation registers (from MENU DISPLAY ORDER to ANGLE OF VIEW) of 3-D MENU #1. View the test pattern in the SPACE SCREEN.

Notice that the "L" is now larger. In fact, the top of the "L" is now cut off in the SPACE SCREEN. A positive value in Z OFFSET has the effect of raising the model in space (i.e., offsetting it on the Z Axis). The "L" is now 200 units higher than the BASE LINE GRAPH. The camera is aimed straight down at the 0,0 point of the graph (fig. 2A). The "L" has now been offset 200 units closer to the camera and the displayed image is larger because the distance from the camera to the drawing is only 200 units. (The same size image can be obtained by loading "0" in Z OFFSET and "200" in DISTANCE.)

Remember, the X OFFSET, Y OFFSET and Z OFFSET registers are used to reposition the model anywhere in 3-D space. The DISTANCE register sets the distance between the camera and the 0,0 center of the graph.

Practice inputting different values in the X OFFSET, Y OFFSET, Z OFFSET and DISTANCE registers, until you can predict the combined effect in the SPACE SCREEN.

When using the X OFFSET, Y OFFSET and Z OFFSET registers, it is possible to move a model so far out that some coordinates of points of the models may fall in a "danger" zone. If a model is moved by the offset registers so far that some points of the model fall out beyond -18918 to +18918 in any direction (X, Y or Z), it is possible that, when viewing the model from certain angles, the

points, when translated, could fall outside the dimensions of the drawing universe.

This could mean that, when viewing a 3-D model, those surfaces using the point would disappear or, worse, be weirdly distorted and possibly fill the entire screen. To be on the safe side, keep the entire model within the -18918 to +18918 range. Chromacad does not limit coordinates to within the above values because models can usually be moved and displayed successfully beyond these values. This is something to keep in mind, although it's not something to worry about. Such extreme offsets are rarely used. The number, "18918", is listed in the REGISTER RANGE Appendix.

PITCH ANGLE Register (3-D MENUS): Swinging the Camera Away from the Z Axis

Return to 3-D MENU #1 and store, where necessary, "60" in PITCH ANGLE, "400" in DISTANCE, "50" in ANGLE OF VIEW and "0" in all of the other orientation registers of 3-D MENU #1. View the "L" in the SPACE SCREEN.

When the PITCH, YAW and ROLL ANGLES were all "0", the camera was aimed straight down at the 0,0 center from directly overhead. The camera LINE-OF-VIEW coincided with the Z Axis. Now the PITCH ANGLE is 60 degrees. This means that the angle between the camera LINE-OF-VIEW and the Z Axis is 60 degrees. This has the effect of swinging the camera LINE-OF-VIEW 60 degrees away from the Z Axis so that the camera lens is now directly over a point on the -Y Axis (see fig. 3A).

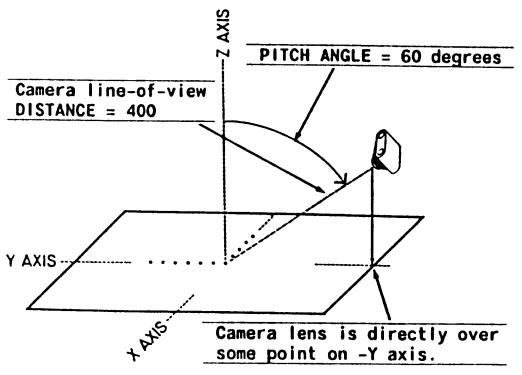

fig. 3A

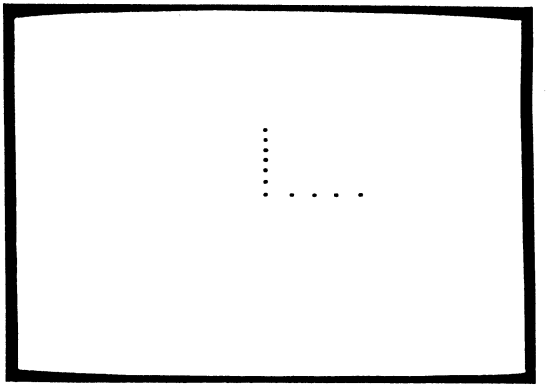

fig. 3B (SPACE SCREEN)

The camera is still aimed at the 0,0 point of the graph and the camera distance to the 0,0 point is still 400 units, but the angle the camera views the drawing has been changed. The long stem of the "L" appears shortened in the SPACE SCREEN because the letter is being viewed on a slant (fig. 3B).

Return to 3-D MENU #1 and change the PITCH ANGLE to 90 degrees and view the result in the SPACE SCREEN.

The camera LINE-OF-VIEW has now swung down so far that it is in the X,Y drawing plane. The LINE-OF-VIEW now lies directly on the -Y Axis of the X,Y plane. The camera is now on the same plane the "L" is plotted on (see fig. 4A). From this camera position, the "L" appears only as one horizontal line on the screen (fig. 4B).

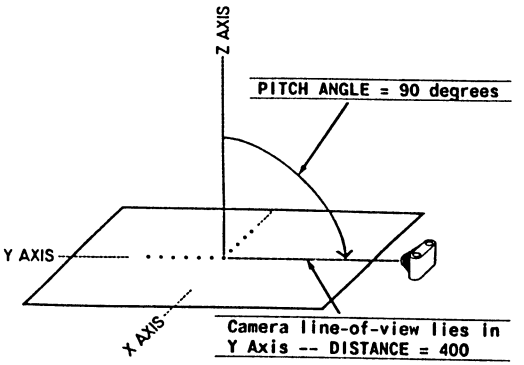

fig. 4A

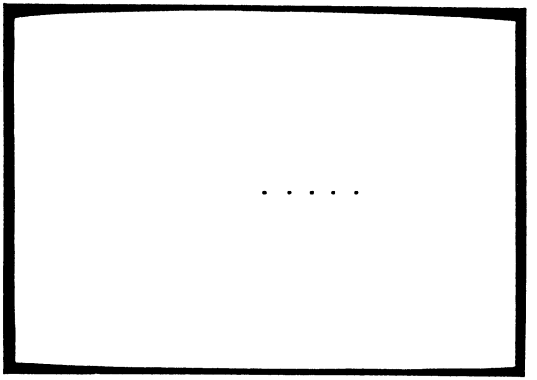

fig. 4B (SPACE SCREEN)

Practice with various PITCH ANGLE values until the effects of PITCH ANGLE become clear to you. Use PITCH ANGLE values in the range of -180 to +180 degrees.

The limits for the PITCH, YAW and ROLL ANGLE registers are -180 to +180 degrees. Notice that when you input a value in PITCH ANGLE of more than 90 degrees, the camera swings down under the X,Y plane and views the "L" from the underside. When you input negative PITCH ANGLE values, the camera swings away from the Z Axis in the opposite direction to a position directly over some point on the +Y Axis. In practice, negative PITCH ANGLE values are seldom used.

Store, where necessary, "60" in PITCH ANGLE, "45" in YAW ANGLE, "400" in DISTANCE, "50" in ANGLE OF VIEW and "0" in all of the other orientation registers of 3-D MENU #1 and then view the "L" in the SPACE SCREEN.

Previously, when YAW ANGLE contained "0" and PITCH ANGLE contained "60", the camera viewed the "L" from a point directly over the -Y Axis (fig. 3A). Storing "45" into YAW ANGLE has the effect of swinging the camera 45 degrees clockwise around the Z Axis while maintaining the same PITCH angle, so that the camera lens is directly over a point that lies midway between the -Y and the -X Axes (see fig. 5A).

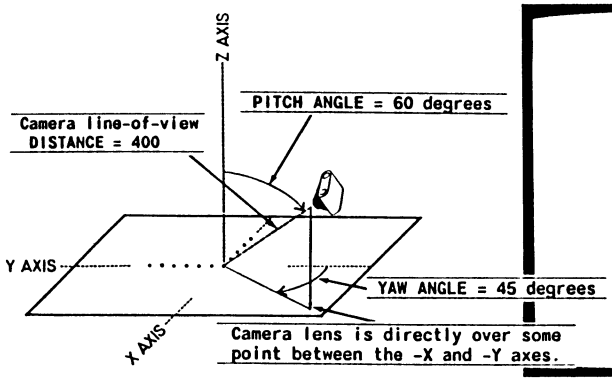

fig. 5A

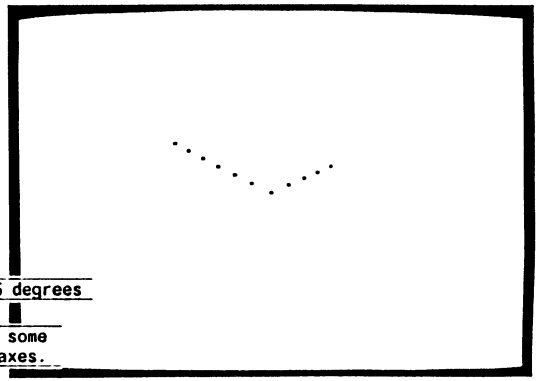

fig. 5B (SPACE SCREEN)

Practice with the YAW ANGLE register. Leave PITCH ANGLE at 60 degrees and store various angles in YAW ANGLE while viewing the result in the SPACE SCREEN. As you do this, imagine that the "L" is plotted on an X,Y plane at zero elevation and the camera is swinging around the Z Axis, viewing it from various angles. Notice that negative YAW angles have the effect of swinging the camera around the Z Axis in a counterclockwise direction. Soon you will be using negative YAW ANGLES to view the right side of models and positive YAW ANGLES to view the left side.

NOTE: Some straight lines, when plotted on a slant, may appear slightly wobbly. This is due to the screen resolution of the computer. The coordinate points of the straight line have been calculated

properly by the computer, and, if a higher resolution graphics mode were possible, the points would be plotted in a straighter line. This is nothing to be concerned about. The effect is not noticeable when models are displayed by the SURFACE SHADER XE program.

ROLL ANGLE Register (3-D MENUS): Spinning the Scene around the Center of the Screen

The ROLL ANGLE register is the easiest of all. After all of the other orientation registers are set, ROLL ANGLE simply spins the scene around the center point of the SPACE SCREEN. A positive ROLL ANGLE will spin the scene counterclockwise, and a negative ROLL ANGLE will spin the scene clockwise.

Display the "L" in the SPACE SCREEN by using any desired values in the orientation registers. Then change the value in ROLL ANGLE to see this spin effect.

ROLL is not used as often as PITCH and YAW in displaying models. It is sometimes used for models such as airplanes or missiles that have been constructed in an upright attitude to display them in a flying attitude. Sometimes, it's useful to display a tall model by using a 90 degree ROLL. This ensures that the longest dimension of the model (height) corresponds to the longest dimension of the monitor or T.V. (width). This technique often makes it possible to bring more pixels to bear in displaying the model.

ANGLE OF VIEW Register (3-D MENUS): Producing a Wide-angle or Telephoto View

The final orientation register is the ANGLE OF VIEW register. The default value for this register is 50. The ANGLE OF VIEW limits are 10 to 90 (degrees). Using "90" in ANGLE OF VIEW produces the effect of a wide-angle lens. Using "10" in ANGLE OF VIEW produces the effect of a telephoto lens. DISTANCE must be changed when ANGLE OF VIEW is changed in order to maintain the same image size. (As ANGLE OF VIEW increases, DISTANCE must be decreased to maintain similar image size.)

It might be assumed that a large ANGLE OF VIEW combined with a short DISTANCE would produce the same image as a small ANGLE OF VIEW combined with a long DISTANCE. This is not the case. A large ANGLE OF VIEW combined with a short DISTANCE will produce images which seem to relatively enlarge that portion of the model nearest the point of view (the camera). This can often be

used to produce dramatic model perspectives. The default value for ANGLE OF VIEW is 50. This is the angle of view of the "normal" camera lens.

A full discussion of the effect of ANGLE OF VIEW is beyond the scope of this manual. It should be noted, however, that Chromacad does reproduce this effect and can be used to study it in detail.

Try inputting a few different values in ANGLE OF VIEW and observing the changes in the SPACE SCREEN.

Notice how changing the value in ANGLE OF VIEW changes the size of the "L". It's not possible to study the artistic effects that ANGLE OF VIEW can produce by displaying a plot of the test pattern. These effects can be observed more clearly later when complete models are displayed.

OFFSET Registers (3-D MENUS): Placing the Test Pattern at a Desired Location in Space

You can easily orientate and place the test pattern at any desired location in the space of the SPACE SCREEN. Knowing this technique will be especially important when you want to place a number of models in the same 3-D space in various orientations and view them all together.

Store, where necessary, "60" in PITCH ANGLE, "45" in YAW ANGLE, "400" in DISTANCE, "50" in ANGLE OF VIEW and "0" in all of the other orientation registers of 3-D MENU #1. Read the following material while viewing the "L" in the SPACE SCREEN.

The long stem of the "L" always points in the direction of the +Y axis of the BASE LINE GRAPH and always has a length of 100 units. (Remember, you are now taking a slant view of the BASE LINE GRAPH.). If you were now to go back to 3-D MENU #1 and add "100" to the value presently in the Y OFFSET register and then view the "L" again, the "L" would be moved 100 units in the direction the long stem is now pointing. Since the long stem is 100 units long, the "L" would move a distance, on the screen, approximately equal to the displayed length of the long stem.

Similarly, the short stem of the "L" always points in the direction of the +X axis and has a length of 60 units. Adding "60" to the X OFFSET register will move the "L" the length of the short stem in

the direction the short stem is now pointing.

To see this graphically, make a mental note of the screen location of the tip of the short stem. Return to 3-D MENU #1 and add "60" to the value currently in the X OFFSET register (0 + 60 = 60). View the test pattern again.

Notice that the entire figure has now been moved the length of the short stem (60 units in perspective) in the direction of the short stem.

Think of the "L" as if it's inside a 3-D graph space with the long stem always pointed in the +Y direction and the short stem always pointing in the +X direction of the graph axis. This is always true regardless of from what PITCH, YAW or ROLL angles are used to view the 0,0,0 center of the graph or what X, Y or Z offsets are used to move the "L" within the graph space.

Changing X, Y or Z offsets serves to move the model (in this case, the test figure) around in the 3-D space and changing PITCH, YAW or ROLL angles serves to view the center of the graph from different angles, but no change of any value can ever change the axis orientation of the model within the 3-D graph. The long stem of the "L" will always point in the +Y direction and the short stem will always point in the +X direction of the 3-D graph space. (This is, of course, not a limitation because the model can always be placed anywhere in 3-D space with the offset registers and viewed from any angle with the PITCH, YAW or ROLL registers.)

Use the following procedure when you want to reposition the "L" to a new location in the 3-D graph space.

1. Calculate the approximate amounts of X, Y or Z offsets needed to reposition the "L" to the new location. (Remember, adding 100 units to Y OFFSET will send the "L" the length of the long stem in the direction of the long stem and adding 60 units to X OFFSET will send the "L" the length of the short stem in the direction of the short stem. Adding or subtracting values to Z OFFSET raises or lowers the "L" on the Z axis of the 3-D graph.)

2.. Return to the 3-D MENU being used and add (or subtract) the calculated amounts to the current values in the registers. View the "L" again.

3. Repeat steps 1 and 2 until the "L" is properly positioned.

Practice moving the "L" around in 3-D space by first displaying the "L" using any desired PITCH, YAW and ROLL ANGLE values and then moving the "L" to other locations in space. Practice this until you understand the use of all of the orientation registers when moving the "L" around in 3-D space.

OFFSET and DISTANCE Registers (3-D MENUS): Changing the Displayed Size of Models

Sometimes you'll want to keep the model at the same screen location but change the size of the model. This can be accomplished by changing all the values in DISTANCE, X OFFSET, Y OFFSET and Z OFFSET inversely proportionally. For example, if DISTANCE were set at "200", X OFFSET at "100", Y OFFSET at "60" and Z OFFSET at "20", the model would be rendered in a size close to half its original size while remaining at the same screen location by setting DISTANCE to "400", X OFFSET to "200", Y OFFSET to "120 and Z OFFSET to "40" (i.e., double their original values).

Practice the procedure described above by first placing the "L" at some desired off-center location and then changing the size of the "L" without changing its screen location. Repeat the above procedures until you can accurately place the "L" anywhere in any orientation in the space of the SPACE SCREEN in any size desired.

Later, when you want to orientate, then place and size an actual model in space for the purpose of fitting it into a scene with other models, you can first place the "L" test pattern in the approximate orientation, location and size desired. Later, when the same register values are used to display a model, the model will be displayed in the same orientation, location and relative size as the "L" This is much faster than placing the model directly.

Whenever the test pattern is not displayed, check the X, Y and Z offset registers to make sure that the "L" isn't positioned outside the viewing range. If you have any doubts about this, load "0" into all of the offset registers, load a large value like "2000" into the DISTANCE register and a large number like "80" in ANGLE OF VIEW and try again. The model will be small when displayed but should fall within viewing range.

Eventually, you'll want to create multi-model scenes of different views of the same model or of different models in different orientations. Chromacad permits up to 10 model views to be displayed at once.

"CONTROL Q" Key-combination (3-D MENUS) and the MENU DISPLAY ORDER Registers (3-D MENUS): Displaying Multiple Views of the Test Pattern on One Screen

Load, as necessary, the following values into the first 11 input registers of 3-D MENU #1:

THIS MENU NO. =.....1	DISTANCE =.....600
MENU DISPLAY ORDER = ...2	X OFFSET = ...50
MODEL BASE LINE = ...0	Y OFFSET = ...100
PITCH ANGLE =.....50	Z OFFSET = ...0
YAW ANGLE =.....70	ANGLE OF VIEW = ..50
ROLL ANGLE = ...0	

Load, as necessary, the following values into the first 11 input registers of 3-D MENU #2: (Type "2" to access 3-D MENU # 2.)

THIS MENU NO. =.....2	DISTANCE =.....400
MENU DISPLAY ORDER = ...1	X OFFSET = ...10
MODEL BASE LINE = ...0	Y OFFSET = ...10
PITCH ANGLE =.....*-40*	Z OFFSET = ...0
YAW ANGLE =.....*-45*	ANGLE OF VIEW = ..50
ROLL ANGLE = ...0	

Hold the "CONTROL" key down and type the "Q" (Quick) key.

The program displays both views of the "L" on the same screen. First, you will see the "L" displayed using 3-D MENU #2, and then the "L" displayed using 3-D MENU #1. The "CONTROL Q" key-combination can call up to 10 different views of the test pattern (or of models) on one screen at a time -- one for each 3-D MENU. Later, when models are used, the views can all be of the same model or of any combination of up to 10 different models.

The 3-D MENUS will be called for display in the order of the numbers you enter into the the MENU DISPLAY ORDER register of the 3-D MENUS. Not all menus need be called for display. If you load "0" into the MENU DISPLAY ORDER register of a 3-D MENU, that menu will not be called.

The MENU DISPLAY ORDER register will only accept numbers in the range from 0 to 10. If a number in the series is skipped, the display of the 3-D MENUS will stop at that number.

For example, if you load the MENU DISPLAY ORDER register of MENU #7 with "1", the MENU DISPLAY ORDER register of MENU #3 with "2", the MENU DISPLAY ORDER register of MENU #5 with "3" and no menu has a "4" loaded in MENU DISPLAY ORDER, the "CONTROL Q" key-combination will first call MENU #7, then MENU #3 and finally MENU #5. No more menus will be called regardless of what the other menus have in MENU DISPLAY ORDER.

If two menus have the same number loaded in MENU DISPLAY ORDER, only the lower menu will be called. In the example above, if both MENU #3 and MENU #5 had "2" loaded in MENU DISPLAY ORDER, only MENU #3 would be called. MENU #5 would be skipped.

NOTE: When using the "Control Q" key-combination, all 3-D MENUS called for display use the same ANGLE OF VIEW value loaded in the ANGLE OF VIEW register of 3-D MENU #0. ANGLE OF VIEW values loaded in 3-D MENUS other than 3-D MENU #0 are ignored. One advantage of this feature is that once the group of models is "fitted" together in space, the image size of the entire group can be changed by changing the one value in the ANGLE OF VIEW register of 3-D MENU #0.

Practice with the "CONTROL Q" key-combination. See if you can display three "L"s in a row (LLL). (HINT: All of the positioning registers, except the X OFFSET register, should be loaded the same way in the three menus used.)

Now change the image size of the entire group by changing the value in the ANGLE OF VIEW register (range of 10 to 90) of 3-D MENU #0. (Remember, the image size changes inversely.)

Now that you have three "L"s displayed in a row, change the values in the PITCH, YAW, ROLL and DISTANCE registers of the menus used, but make sure the PITCH, YAW, ROLL and DISTANCE registers are loaded the same way in all three menus. View the results.

Notice that although you changed your point of view, the spatial

relationship between the three letters was maintained. Once you place a set of models together in the same space, the spatial relationships will be maintained when the group is viewed with different PITCH, YAW, ROLL and DISTANCE values.

SECTION 3 — SETTING UP THE LIGHTS

NOTE: Sections 3 to 5 contain instructions for demonstrations of actual 3-D models. Only two models will be used for the demonstrations so that you can more easily compare different renderings of the same models. Both models are on Chromacad MODEL DISK #1. The first model, a model of the block letter "C" in Roman font, was one of the models used to make the "CHROMACAD" face-screen.

Please use your own computer to follow the instructions printed in bold lettering while reading the commentary accompanying each model demonstration. Later, when you've completed the tutorial, you'll be able to use what you've learned in displaying the demonstration models to set up and display any model on any Chromacad model disk in any of the modes, surface renderings, lighting and viewing angles that you desire.

Go to the MAIN MENU. Select the LIST MODEL BASE LINES option.

You will see a list of the BASE LINE numbers of all the models that are presently stored on MODEL DISK #1. Each model has a different BASE LINE number. The number of disk sectors used by each model is displayed immediately to the right of the model's BASE LINE number.

No two models stored on the same disk ever have the same BASE LINE number. The BASE LINE number of a model is, therefore, used to reference and call the model for display. Notice that the 4th model listed has a BASE LINE number of "18" and uses 21 sectors of disk storage space.. This is the "C" model.

During model construction, the surfaces of models are "painted" with numbers (called surface paint numbers). When the model is displayed by the SURFACE SHADER XE program, any of 16 actual colors can be assigned to any surface paint number. (For more information on surface paint numbers, see the HARDWARE SPECIFICS APPENDIX.)

The "C" model was constructed using 2 lateral-facing side layers — somewhat like a C-shaped layer cake. Each side layer was painted

with a different surface paint number. The upper layer was painted with surface paint number 2 and the lower layer was painted with surface paint number 3. The top surface of the "C" was painted with surface paint number 1.

The first step in displaying a 3-D model is to load the BASE LINE number of the model to be displayed into the MODEL BASE LINE register of the 3-D MENU that will be used to display the model.

MODEL BASE LINE Register (3-D MENUS): Loading a 3-D MENU with the BASE LINE Number of the Model to be Displayed

Return to the MAIN MENU by typing " → " (Out) and select EDIT 3-D MENUS. Load "18" into the MODEL BASE LINE register of 3-D MENU #1.

The MODEL BASE LINE register of a 3-D MENU will only accept a "0" or a BASE LINE number of a model presently stored on the disk. 3-D MENU #1 is now, therefore, set to display the "C" model.

Orientation Registers (3-D MENUS): Orientating the Model in Space

The next step is to load the remaining orientation registers to obtain the desired viewing orientation of the model. These registers are used to orientate 3-D models in the SPACE SCREEN exactly as they were used to orientate the "L" test pattern.

Make sure the following values are loaded into the orientation registers of 3-D MENU #1:

THIS MENU NO. = ...1	DISTANCE = ...160
MENU DISPLAY ORDER =....0	X OFFSET =.....*-75*
MODEL BASE LINE =.....18	Y OFFSET =.....*-25*
PITCH ANGLE = ...45	Z OFFSET =.....0
YAW ANGLE = ...*-40*	ANGLE OF VIEW =.....90
ROLL ANGLE =.....0	

The above values will produce a close-up wide-angle view of the "C" from the lower right side.

Type the Q (Quick) key to see the test pattern displayed according to the above values.

Notice that the 0,0 point of the test pattern is not centered in the SPACE SCREEN. The "C" was not constructed with the center of the "C" at the 0,0 point of the BASE LINE GRAPH. X OFFSET and Y OFFSET values are used, therefore, to move the center of the "C"to a location near the 0,0 point of the BASE LINE GRAPH. This insures that the "C" will be displayed in the center of the screen when viewed in the SPACE SCREEN.

At this point, it's necessary to turn on and adjust the direction of one or more of Chromacad's 3 lights. All 3-D models must be illuminated with at least one of the lights to be displayed in 3-D shaded form.

"L" (Lights) Key (3-D MENUS): Accessing the LIGHT MENU

Return to 3-D MENU #1 and type the "L" (Lights) key.

You will see a menu of the registers that are used to set the light directions and intensities of 3 light sources. There are a total of 12 registers — 4 registers for each light. Each 3-D MENU has its own 12-register LIGHT MENU. Each model can be lit with up to 3 lights. A combined scene of 10 models, therefore, could use up to 30 lights.

LIGHT 1 PITCH and LIGHT 1 YAW Registers (LIGHT MENU): Setting the Light Approach Direction for LIGHT #1

The first 2 registers are used to set the PITCH and YAW direction angles for LIGHT #1. The PITCH and YAW registers of a light set the direction from which the rays of the light approach the model in the same way as the PITCH and YAW orientation registers set the direction from which the camera views the model.

If, for example, you set the PITCH and YAW viewing angles (orientation registers) to PITCH = 90, YAW = 180, you would be calling for a view of the model from the back. If you then set the PITCH and YAW registers of one of the lights to PITCH = 90, YAW = 0, you would be setting that light to illuminate the model from the front. The result would be an unlit model because no light would be falling on the side of the model that you would be viewing (unless, of course, you used one of the other lights to light the back of the model).

Set the LIGHT 1 PITCH register of LIGHT #1 (the top register of the LIGHT MENU) to 90.

Set the LIGHT 1 YAW register of LIGHT #1 to *-40* — the same value used in the YAW ANGLE register of the orientation registers.

LT1 INTENSITIES-123 and LT1 INTENSITIES-456 Registers (LIGHT MENU): Setting LIGHT #1 Intensities Individually for Surfaces Painted 1, 2, 3, 4, 5 and 6

The next step is to individually set the amount of light (intensity or brightness) that each surface paint number will receive from LIGHT #1. In everyday life, when a light shines on a multi-colored object, the light shines on all parts of the object with the same intensity regardless of the color of the parts. In computer modeling we are not so confined by the restraints of reality. Being able to illuminate models with light that shines with different intensities on different colors can produce some striking effects.

The intensity of each light used can be individually set for each of the first 6 surface paint numbers. Notice the 3-digit LT1 INTENSITIES-123 and LT1 INTENSITIES-456 registers directly below the LIGHT 1 YAW register. These two registers are used to set the light intensity of LIGHT #1 separately for surface paint numbers 1 to 6.

Each digit of the LT1 INTENSITIES-123 and LT1 INTENSITIES-456 registers can hold a value from 0 to 9. The first digit of the LT1 INTENSITIES-123 register sets the intensity (0 to 9) of LIGHT #1 for those surfaces of the model that are painted with a "1". If the first digit of the LT1 INTENSITIES-123 register contains a "0", all model surfaces painted with a "1" will receive no light from LIGHT #1. If the first digit of the LT1 INTENSITIES-123 register contains a "9", LIGHT #1 will be turned on to its maximum intensity for all surfaces painted with a "1".

In other words, you can load the first digit of LT1 INTENSITIES-123 with any value from 0 to 9 to set the intensity of LIGHT #1 for surfaces of the model painted "1". Similarly, you can load the second digit of LT1 INTENSITIES-123 with any value from 0 to 9 to set the intensity of LIGHT #1 for surfaces painted "2". In the same way, the third digit sets the intensity for surfaces painted "3". The LT1 INTENSITIES-456 register works in the same way to adjust the light intensity of LIGHT #1 separately for surfaces painted "4", "5" and "6".

You can produce some interesting and creative effects with light that shines with different intensities on different model colors. Parts of models, for example, can be made to disappear by setting the light intensity to "0" for the paint number that was used to paint those parts. Other parts can be emphasized by setting the light intensity to a higher value for the paint number that was used for those parts than is used for the paint numbers of the rest of the model. Parts of models can be lit from one direction with one light and other parts of the model can be lit from a different direction using a different light. Unique lighting effects are possible that can only be produced by 3-D modeling.

Make sure"999" is loaded in the LT1 INTENSITIES-123 register and "000" in the LT1 INTENSITIES-456 register of LIGHT #1.

For now we will stick with reality. LIGHT #1 is now set to illuminate surface paint numbers 1, 2, and 3 with the same intensity — to its highest intensity for all three. Of course, the actual amount of illumination a particular surface receives will depend on the slant angle that the path of the light makes with the surface. Only those model surfaces that lie on a plane perpendicular to the path of the light can receive maximum illumination. The more a light strikes a surface on a slant the less illumination the surface will receive from that light.

From the angle we will be using to view the "C", no surface is visible that is painted with paint numbers 4, 5, or 6. It really makes no difference, therefore, what values are loaded in the LT1 INTENSITIES 456 register. (The underside surface of the model is, however, painted with paint number 4.)

In the present case, LIGHT #1 is now set to strike the "C" model from PITCH = 90, YAW = *-40*. From this direction, some of the lateral-facing surfaces of the "C" model are perpendicular to the direction of the incoming light of LIGHT #1. LIGHT #1 will, therefore, illuminate some lateral surfaces to maximum illumination.

The "C" model is best illuminated using at least two lights. A second light should be set to illuminate the top surface of the model to maximum illumination.

LIGHT 2 PITCH, LIGHT 2 YAW, LT2 INTENSITIES-123 and LT2 INTENSITIES-456 Registers (LIGHT MENU): Setting the Light Approach Direction and Intensities of LIGHT #2

Leave the default values of PITCH = 0, YAW = 0, in the LIGHT 2 PITCH and LIGHT 2 YAW registers of LIGHT #2. Load "900" in the LT2 INTENSITIES-123 register, but leave "000" in the LT2 INTENSITIES-456 register of LIGHT #2.

The "0" values in the LIGHT 2 PITCH and LIGHT 2 YAW registers of LIGHT #2 set this light to beam straight down on the model from directly overhead. The lateral-facing side surfaces of the model all lie parallel to the direction of travel of this light; therefore, this light will not illuminate, even slightly, any of the side surfaces. The top surface of the model, however, lies perpendicular to the direction of travel of this light. The top surface will, therefore, be illuminated by LIGHT #2 to the maximum extent possible.

The "900" loaded in the LT2 INTENSITIES-123 register sets LIGHT #2 to illuminate surfaces painted with a "1" to the maximum intensity of 9 and turns LIGHT #2 off for surfaces painted with a "2" or "3". The "000" loaded in the LT2 INTENSITIES-456 register turns LIGHT #2 off for surfaces painted with "4", "5" or "6". The top surface of the "C" model was painted with a "1". LIGHT #2 is, therefore, turned on to the highest intensity possible for the top surface of the model and off for the lateral-facing surfaces of the model.

In this case, loading "999" in both the LT2 INTENSITIES-123 and LT2 INTENSITIES-456 registers of LIGHT #2 would provide identical lighting. The lateral-facing side layers can receive no light from LIGHT #2 anyway because they lie parallel to the direction of travel of the light from LIGHT #2; therefore, there is really no need to turn LIGHT #2 off for these surfaces.

It is not necessary to use all lights to display a model. We will, therefore, leave LIGHT #3 turned off for all surface paint numbers by leaving the default values of "000" in both the LT3 INTENSITIES-123 and LT3 INTENSITIES-456 registers of LIGHT #3. If a light is turned off for all paint numbers it makes no difference what is stored in the PITCH or YAW angle registers of the light.

Make sure the LIGHT MENU contains the following values (change if necessary):

LIGHT 1 PITCH = ... 90
LIGHT 1 YAW = ... *-40*
LT1 INTENSITIES-123 = ... 999
LT1 INTENSITIES-456 = ... 000
LIGHT 2 PITCH = ... 0
LIGHT 2 YAW = ... 0
LT2 INTENSITIES-123 = ... 900
LT2 INTENSITIES-456 = ... 000
LIGHT 3 PITCH = ... 0
LIGHT 3 YAW = ... 0
LT3 INTENSITIES-123 = ... 000
LT3 INTENSITIES-456 = ... 000

Return to 3-D MENU #1 and make sure 3-D MENU #1 registers contain the values listed below. (At this point only the 5 registers printed in bold may need to be changed, -- change as necessary):

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....18
PITCH ANGLE = ...45
YAW ANGLE = ...*-40*
ROLL ANGLE =.....0
DISTANCE = ...160
X OFFSET =.....*-75*
Y OFFSET =.....*-25*
Z OFFSET =.....0

ANGLE OF VIEW =.....90
MODE/SCREENS = ...22
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 = ...000
TONES/CONTRAST-456 = ...000
MI HI IN NE = ...0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ..000
COL/LUM 1 =.....043
COL/LUM 2 =.....103
COL/LUM 3 =.....014

"V" (View) Key (3-D MENUS): Calling a 3-D MENU to Plot and Display a Model in the SPACE SCREENS.

While viewing 3-D MENU #1, type "V" (View) to plot and display the model.

The monitor screen will go dark and the disk drive will activate repeatedly as the model is being plotted in surface-shaded format by the program. After about 2-3/4 minutes the computer will beep three times and the model will be displayed according to the values currently loaded in the registers of 3-D MENU #1 (including the 3-D MENU #1 LIGHT MENU registers).Please refer to the screen display of the "C" model while reading the following material.

Adjust the color of your T.V. or monitor so that the top surface of the "L" is displayed in red and the two lateral-facing layers of the model are displayed in blue and green/yellow respectively.

Notice that the top surface of the model is lit to the maximum extent possible. This is because the light from LIGHT #2 is directed straight down and is striking the top surface of the "C" at a perpendicular angle and also, because the intensity of LIGHT #2 is turned up to the maximum intensity of "9" for surfaces painted "1" (in this case, the top surface).

The lateral-facing side surfaces of the model can receive no light from LIGHT #2 because these surfaces lie parallel to the direction of light from LIGHT #2. LIGHT #2 was, therefore, turned off for the lateral-facing surfaces.

The lateral-facing surfaces are lit in proportion to the slant angle that light from LIGHT #1 makes when striking the surfaces (the closer to perpendicular, the brighter) and, also, in proportion to the values loaded in the INTENSITIES registers of LIGHT #1 (in this case, "9" for all visible surface paint numbers).

All of the registers of 3-D MENU #1 had some effect on the final display of the model. The first 11 registers of the 3-D MENUS (down to ANGLE OF VIEW) function in the same manner when displaying a model as in displaying the "L" test pattern. It is not necessary, therefore to cover their function again.

MODE/SCREENS Register (3-D MENUS): Setting the Display Mode and the Number of SPACE SCREENS to be Plotted and Displayed

The value currently loaded in the MODE/SCREENS register is "22". The MODE/SCREENS register will only accept a 2-digit number. The first digit (the MODE digit) sets the Chromacad display mode (range of 1 to 4) that is used to plot and display the model. Chromacad has 4 display modes. The first two are multi-color, medium resolution modes, the 3rd is a high resolution mode and the 4th is a stereo-imaging mode. The display modes will be covered in detail in the next section.

The second digit of the MODE/SCREENS register sets the number of SPACE SCREENS to be plotted and displayed (any of 1, 2, 4, 6

or 8 SPACE SCREENS). The SURFACE SHADER XE program uses multiple display screens each plotted with a different pixel pattern and each displayed at 1/60 second ("flipped") at display time to produce the shading effect necessary for surface shading. The "C" was plotted and is being displayed using the MODE/SCREENS value of "22". It was, therefore, plotted in Chromacad's display MODE 2, on 2 SPACE SCREENS.

One advantage of using only two screens for display is that plotting is relatively faster because only two screens need be plotted. A disadvantage is that the model is displayed with a somewhat rougher, granular texture because of the small number of pixels used for the display. For casual viewing, two screens are usually enough. For a more accurate rendering of the model or for photography, eight screens are recommended.

The present values now loaded in 3-D MENU #1 (including the 3-D MENU #1 LIGHT MENU) will be used later in this manual. It's a good idea, therefore, before going on, to save these values to disk so that, in the event the computer is turned off, these values will automatically be loaded in 3-D MENU #1 whenever the program is booted and this model disk is used again.

Type " → " (Out) to exit the SPACE SCREENS and return to 3-D MENU #1. Type " → " (Out) again to exit 3-D MENU #1 and return to the MAIN MENU. Drop the cursor down to STORE 3-D MENUS TO DISK. Select STORE 3-D MENUS TO DISK by typing " ← " (In). At the STORE 3-D MENUS TO DISK? prompt, type "Y" (Yes).

The 3-D MENUS with the changed values will be stored on the model disk.

NOTE: Going out to the MAIN MENU and selecting various MAIN MENU options will not destroy images plotted in the SPACE SCREENS. An image of the "L" model is currently plotted on two SPACE SCREENS and will not be destroyed until the computer is turned off or a different image is plotted.

SECTION 4 — THE FOUR DISPLAY MODES

NOTE: This section requires an image of the **"C"** model to be plotted in the SPACE SCREENS. If you have turned the computer off since completing Section 3, please use 3-D MENU #1 to plot the "C" model again before going on.

Now that an image has been plotted in the SPACE SCREENS, it's possible to cover the use of the "R" (Redisplay Scene) key of the 3-D MENUS.

"R" (Redisplay Scene) Key (3-D MENUS): Displaying a Previously Plotted Scene in a Different Mode, A Different Number of Screens and in Different Colors

Chromacad makes it possible to plot and display a single or multi-model scene using one mode, set of colors and number of display screens and then redisplay the scene without replotting with a different mode, set of colors and number of screens. There are 5 registers that can be changed prior to redisplaying in order to modify the appearance of a plotted scene. They are:

MODE/SCREENS
COL/LUM BACKGROUND
COL/LUM 1
COL/LUM 2
COL/LUM 3

All other 3-D MENU registers are used only when a scene is initially plotted and displayed and changing their values has no effect when a scene is redisplayed. The first time a model is plotted it is, of course, also displayed using the values currently in the registers.

Go to 3-D MENU #1 and type the "R" (Redisplay Scene) key to redisplay the scene currently plotted in the SPACE SCREENS.

You will go directly to the SPACE SCREENS without replotting the image.

Whenever you are on a 3-D MENU and you want to view the currently plotted image according to the values currently loaded in the above 5 listed registers of that 3-D MENU, you can type the "R" (Redisplay Scene) key.

Type the " → " (Out) key to return to 3-D MENU #1, but don't hold it down too long or you will be returned back to the MAIN MENU. (If this does happen, select EDIT 3-D MENUS again.)

You are now back on 3-D MENU #1 again. This time, however, we will change the values in the COL/LUM registers before viewing the image in the SPACE SCREENS again. This will cause changes in the color of the image.

Notice the last four registers of the menu. They are, in order, the COL/LUM BACKGROUND, COL/LUM 1, COL/LUM 2 and COL/LUM 3 registers. These 4 color registers are used to assign actual colors to model surface paint numbers.

The COL/LUM registers are set differently for each of the 4 graphics modes. Graphics MODE 2 was used to create the current display of the "C". The following explanation pertains to the use of the color registers only while using graphics MODE 2.

COL/LUM Registers (3-D MENUS): Setting MODE 2 Color Assignments

MODE 2 is the most commonly used mode. MODE 2 produces a 7-color, medium resolution (192x160) display without a border. The model can be displayed in 6 colors and a separate color can be chosen for the background. In MODE 2, surfaces painted with a "1", "2" or "3" can be assigned any color from a palette of 16 user-selectable colors. Surfaces painted with a "4", "5" or "6" are automatically assigned colors by the program that are blends of the above 3 user-selectable colors.

The COL/LUM BACKGROUND register assigns the color that the display routines use for the background. The COL/LUM 1 register assigns the color that the display routines use for surfaces of the model painted with a "1". Similarly, COL/LUM 2 and COL/LUM 3 assign the colors used for surfaces painted with a "2" and "3" respectively.

Surfaces painted with "4" are automatically colored with an equal blend of the colors in COL/LUM 1 and COL/LUM 2. Similarly, surfaces painted "5" are colored with a blend of the colors in COL/LUM 1 and COL/LUM 3 and surfaces painted "6" are colored with a blend of the colors in COL/LUM 2 and COL/LUM 3.

All of the color registers hold 3-digit values. The first two digits hold the color-code number (range of 00 to 15) that assigns the actual color and the last digit holds the illumination (paint brightness) of the color (range of 0 to 7). The colors that the color-code numbers assign are listed in the table below:

COLOR TABLE

Color	Color-Code Number
grey	00
yellow-green	01
yellow-orange	02
dark orange	03
red	04
purple	05
purple-blue	06
ultramarine blue	07
medium blue	08
dark blue	09
blue-grey	10
blue-green	11
medium green	12
dark green	13
orange-green	14
orange	15

To load a particular color/illumination value into a color register, decide the color you want from the table above, and then decide the amount of paint brightness that you want to use for the color on a scale from 0 to 7. Load the color-code number corresponding to the desired color into the first two digits of the register and load the desired paint brightness value (0 to 7) into the last digit.

For example, the present value loaded in COL/LUM 1 is "043". This causes all surfaces of the model that are painted with a "1" to be displayed in red (color-code number of "04" loaded in the first 2 digits) with a paint brightness of "3" (brightness number of "3" loaded in the last digit). Accordingly, the "103" loaded in COL/LUM 2 causes all surfaces painted with a "2" to be displayed in blue-grey

("10") with a paint brightness of "3". The "014" loaded in COL/LUM 3 causes surfaces painted with a "3" to be displayed in yellow-green ("01") with a paint brightness of "4". (In this case, the higher brightness of "4" tends to shift the color slightly toward the yellow.)

The resulting colors, therefore, with the present values loaded in the COL/LUM registers are red for surfaces painted "1", blue for surfaces painted "2", yellow-green for surfaces painted "3", purple (red + blue) for surfaces painted "4", orange (red + yellow-green) for surfaces painted "5" and turquoise (blue-grey + yellow-green) for surfaces painted "6". The "000" loaded into COL/LUM BACKGROUND provides a grey background with "0" brightness (black).

NOTE: Not all monitors or T.V.'s produce the same colors. If, after adjusting your T.V. or monitor, the colors you get are significantly different from those above, you may eventually want to make your own color table.

When loading COL/LUM register values for MODE 2, use the "MODE 2 COL/LUM DIGIT GUIDE" below:

MODE 2 COL/LUM DIGIT GUIDE

COL/LUM BACKGROUND = CCB
- "CC" assigns color of background (use COLOR TABLE).
- "B" assigns paint brightness (0 to 7) to background.

COL/LUM 1 = CCB
- "CC" assigns paint color to surfaces painted "1" (use COLOR TABLE).
- "B" assigns paint brightness (0 to 7) to surfaces painted "1".

COL/LUM 2 = CCB
- "CC" assigns paint color to surfaces painted "2" (use COLOR TABLE).
- "B" assigns paint brightness (0 to 7) to surfaces painted "2".

COL/LUM 3 = CCB
- "CC" assigns paint color to surfaces painted "3" (use COLOR TABLE)
- "B" assigns paint brightness (0 to 7) to surfaces painted "3".

While viewing 3-D MENU #1, change, where necessary, the register values to the following values. (Unless register values have been changed since the last exercise, only the one register printed in bold should need to be changed.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....18
PITCH ANGLE = ...45
YAW ANGLE = ...*-40*
ROLL ANGLE =.....0
DISTANCE = ...160
X OFFSET =.....*-75*
Y OFFSET =.....*-25*
Z OFFSET =.....0

ANGLE OF VIEW =.....90
MODE/SCREENS = ...22
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 = ...000
TONES/CONTRAST-456 = ...000
MI HI IN NE =.....0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ...000
COL/LUM 1 =.....064
COL/LUM 2 = ...103
COL/LUM 3 = ...014

Type "R" (Redisplay Scene) to see the effect of the changed color assignment on the displayed scene.

The number "06" is the color-code number for purple-blue, therefore, the surfaces painted "1" (top surface of the model) are now displayed in purple-blue. The color of surfaces painted "4" or "5" would also have been affected by the change because they too use a color blend of the color loaded in COL/LUM 1. In MODE 2, if you assign the same color and paint brightness to a color number that you assign to the background, all model surfaces painted with that color number will disappear from the display.

Type the " → " (Out) key to return to the 3-D MENU #1. Load up the COL/LUM registers in any way you desire and observe the effect in the SPACE SCREENS. Repeat this exercise until you understand the use of the color registers as used in MODE 2. Try dropping out a color from the image by loading the COL/LUM register of that color with the same value that is used in the COL/LUM BACKGROUND register. Do not change the values in registers other than the COL/LUM registers.

COL/LUM Registers (3-D MENUS): Setting MODE 1 Color Assignments

MODE 1 was included as the result of an accident. During the development of the plotting and display routines, a model was plotted using MODE 2 plotting routines and accidentally displayed

using MODE 3 display routines. This produced a 7-color display of the model, similar to that produced by a MODE 2 display and, in addition, produced a color border similar to that produced by a MODE 3 display, for a total of 8 colors. As a bonus, with many T.V.'s and monitors, the colors are brighter, with more color saturation than those produced by MODE 2. The colors are produced by an effect called artifacting. The colors assignments, however, cannot be as easily changed as they can in MODE 2. In all other aspects, MODE 1 is like MODE 2. We feel that the unique features of this display justify it as a separate graphics mode.

The image of the "C" was plotted using MODE 2 plotting routines. Since MODE 1 and MODE 2 use the exact same plotting routines (but different display routines), it is possible to successfully display the current scene using MODE 1 display routines. In fact, any model plotted in either MODE 1 or MODE 2 can always be successfully displayed in the other mode.

While viewing 3-D MENU #1 change, where necessary, the register values to the values listed below. (Unless register values have been changed since the last exercise, only the registers printed in bold may need to be changed. The COL/LUM 3 register is not accessed by MODE 1; therefore, it can contain any value.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....18
PITCH ANGLE = ...45
YAW ANGLE = ...*-40*
ROLL ANGLE =.....0
DISTANCE = ...160
X OFFSET =.....*-75*
Y OFFSET =.....*-25*
Z OFFSET =.....0

ANGLE OF VIEW =.....90
MODE/SCREENS = ...12
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 = ...000
TONES/CONTRAST-456 = ...000
MI HI IN NE = ...0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ..150
COL/LUM 1 =.....007
COL/LUM 2 =.....023
COL/LUM 3 = ...XXX

Type the "R" (Redisplay Scene) key to see the MODE 1 display of the "C". Please refer to the display while reading the following material.

Notice that the colors are quite similar to those produced by the previous MODE 2 display. With many monitors or T.V.'s, the colors

have more saturation than those of MODE 2. In addition, there is a border in the display. In MODE 1, the one color-code number loaded into the first 2 digits of COL/LUM BACKGROUND automatically assigns three different colors to surfaces painted "1", "2" and "3". In the above case, the "15" in the first two digits of COL/LUM BACKGROUND assigned "red" to surfaces painted "1", "blue" to surfaces painted "2" and "yellow" to surfaces painted "3". (In MODE 1, the COLOR TABLE mentioned earlier cannot be used to directly assign different colors to model surface paint numbers as in MODE 2.)

Surfaces painted "4", "5" and "6" are, as in MODE 2, blends of the colors assigned to surfaces painted "1", "2" and "3". The "0" loaded in the 3rd digit of COL/LUM BACKGROUND assigned the background brightness (range of 0 to 7). The "7" loaded in the the 3rd digit of COL/LUM 1 assigned the same paint brightness (range of 0 to 7) to all model surface paint numbers. The first 2 digits of COL/LUM 1 were unused. COL/LUM 2 assigned both the color (1st two digits) and brightness (last digit) to the border. In this case, yellow-orange ("02" loaded in 1st two digits) with a paint brightness of "3" (last digit) was assigned to the border.

When loading COL/LUM registers for MODE 1, use the "MODE 1 COL/LUM DIGIT GUIDE" below:

MODE 1 COL/LUM DIGIT GUIDE

COL/LUM BACKGROUND = CCB ("15" or "01" recommended for "CC")
- "CC" automatically assigns 3 different paint colors to surfaces painted "1", "2" and "3".
- "B" assigns brightness (0 to 7) to background.

COL/LUM 1 = XXB ("7" recommended for "B")
- "XX" is not accessed.
- "B" assigns the same paint brightness (0 to 7) to all model surface paint numbers.

COL/LUM 2 = CCB
- "CC" assigns color to border (use COLOR TABLE).
- "B" assigns brightness (0 to 7) to border.

COL/LUM 3 is not accessed by MODE 1 and can contain any value.

The "150" in COL/LUM BACKGROUND and "007" in COL/LUM 1 are recommended values when using MODE 1 for display. In MODE 1, colors and color brightnesses cannot be directly assigned to individual surface paint numbers as in MODE 2. Using "150" in COL/LUM BACKGROUND and "007" in COL/LUM 1 produces a good color mixture on most color monitors and T.V.'s. The colors are lively and intense and any desired color/illumination combination can be chosen for the border.

If you have the MODEL BUILDER program, we recommend that you design your models so that surfaces painted "1" are to be displayed in red, surfaces painted "2" are to be displayed in blue, and surfaces painted "3" are to be displayed in green-yellow. By doing this, you can use "15" in the first two digits of COL/LUM BACKGROUND and get the planned color scheme when the model is displayed in MODE 1. Later, of course, you can always use MODE 2 to experiment with different color and color brightness combinations as you like.

(NOTE: Not all T.V.'s and monitors display color the same way. Another good color value to try in the first two digits of COL/LUM BACKGROUND when using MODE 1 is "01". Use the value you like the most.)

MODE/SCREENS Register (3-D MENUS): Changing the Number of Display Screens

Type " → " (Out) to return to 3-D MENU #1 and load "11" (instead of "12") into the MODE/SCREENS register of 3-D MENU #1. Do not change the values in the other registers. Type the "R" (Redisplay Scene) key to view the SPACE SCREENS.

Notice that only one screen is now being displayed. Two screens have been plotted, but only one of the two screens is being displayed.

Type " → " (Out) to return to 3-D MENU #1 again. This time load "18" into the MODE/SCREENS register and then view the image in the SPACE SCREENS.

As you see, this produces an unsatisfactory result. You are instructing the display routines to display 8 screens but only 2

screens have been plotted. The display routines are flipping blank screens 6 out of 8 times. In the future, when you see this type of display, you will know the cause. (When you want 8 screens to be plotted, "8" must be loaded into the second digit of the MODE/SCREENS register at the time the image is plotted.) The second digit of the MODE/SCREENS register (the SCREENS digit) can hold any of 5 values. These values are: 1, 2, 4, 6 and 8.

Change the values in the MODE/SCREENS and COL/LUM registers and then use the "R" (Redisplay Scene) key to observe the effect of the changes on the currently plotted image. Practice viewing the image using both MODE 1 and MODE 2 until you understand the use of the COL/LUM registers in both modes. There are no values that you can load into these registers that can result in an error. The worst that can happen is that you get an unsatisfactory display of the model.

Note: The pre-loaded (default) values set up 3-D MENU #1 to display models in MODE 1, MENU #2 to display models in MODE 2, MENU #3 in MODE 3 and MENU #4 in MODE 4. You can, of course, always change these values as desired.

If a scene was plotted in MODE 1 or MODE 2 and MENU #1 and MENU #2 register values contain the default values, you need only go to MENU #1 to redisplay the scene in MODE 1 or MENU #2 to redisplay the scene in MODE 2.

COL/LUM Registers (3-D MENUS): Setting MODE 3 Color Assignments

The next mode to be covered is MODE 3. This is a high-resolution (192x320), 2-color mode (one color for the image, a second color for border). Since MODE 3 uses high-resolution plotting routines that are different than those that were used to plot the current image, the image must be replotted using MODE 3 routines.

Change the register values, where necessary, of 3-D MENU #1 to the values listed on the following page (Unless other register values have been changed since the last exercise, only the registers printed in bold may need to be changed. The COL/LUM 3 register is not used in MODE 3, therefore, it can contain any value.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....18
PITCH ANGLE = ...45
YAW ANGLE = ...*-40*
ROLL ANGLE =.....0
DISTANCE = ...160
X OFFSET =.....*-75*
Y OFFSET =.....*-25*
Z OFFSET =.....0

ANGLE OF VIEW =.....90
MODE/SCREENS =.....32
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 =.....000
TONES/CONTRAST-456 =.....000
MI HI IN NE =.....0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ..000
COL/LUM 1 =.....007
COL/LUM 2 =.....023
COL/LUM 3 = ...XXX

Type "L" to access the LIGHT MENU. Make sure the LIGHT MENU contains the following values. (Only the LIGHT 1 PITCH register should need to be changed.)

LIGHT 1 PITCH =..... 45
LIGHT 1 YAW =..... *-40*
LT1 INTENSITIES-123 =..... 999
LT1 INTENSITIES-456 =..... 000
LIGHT 2 PITCH =..... 0
LIGHT 2 YAW =..... 0
LT2 INTENSITIES-123 =..... 900
LT2 INTENSITIES-456 =..... 000
LIGHT 3 PITCH =..... 0
LIGHT 3 YAW =..... 0
LT3 INTENSITIES-123 =..... 000
LT3 INTENSITIES-456 =..... 000

The same viewing angles that were used to plot the "C" model in MODE 2 will also be used to plot the "C" model in MODE 3. This time, however, the light from LIGHT 1 will be directed toward the model using the same angles that the model will be viewed from.

One quick, easy way to set up lights is to load the PITCH and YAW registers of one of the lights with the same PITCH and YAW values that are used for the viewing angles (orientation registers). This produces a simple, direct lighting, as if the viewer shined light on the model from the viewer's point of view. This is a convenient way to light a model because it usually provides at least some light for all of the visible surfaces of the model.

Return to 3-D MENU #1 and type "V" (View) to plot and display the model in MODE 3 (requires about 3-3/4 minutes). (Remember, typing "V" (View) while viewing a 3-D MENU calls for a plot and display. Typing "R" (Redisplay Scene) calls only for a display of the currently plotted image.) Refer to the screen display when reading the following material:

In MODE 3 the color-code number loaded into the first two digits of the COL/LUM BACKGROUND register assigns the same color to all model surface paint numbers. In this case, "00" assigned "grey" to all paint numbers. The "0" loaded in the 3rd digit of COL/LUM BACKGROUND assigned the background brightness. The "7" loaded in the 3rd digit of COL/LUM 1 assigned the same paint brightness to all model surface paint numbers.

The first two digits of COL/LUM 1 were unused. As in MODE 1, the value loaded in COL/LUM 2 assigned both the color (1st two digits) and brightness (last digit) to the border. In MODE 3, if the background brightness (3rd digit of COL/LUM BACKGROUND) has a higher value than the paint numbers brightness (3rd digit of COL/LUM 1) a negative image will be produced.

For MODE 3, use the "MODE 3 COL/LUM DIGIT GUIDE" below:

MODE 3 COL/LUM DIGIT GUIDE

COL/LUM BACKGROUND = CCB

"CC" assigns the same paint color to all model surface paint numbers (use COLOR TABLE).

"B" assigns brightness (0 to 7) to background.

COL/LUM 1 = XXB ("7" recommended for "B")

"XX" is not accessed and can contain any value.

"B" assigns the same paint brightness (0 to 7) to all model surface paint numbers.

COL/LUM 2 = CCB

"CC" assigns color to border (use COLOR TABLE).

"B" assigns brightness (0 to 7) to border.

COL/LUM 3 is not accessed by MODE 3 and can contain any value.

Change the values in the MODE/SCREENS and COL/LUM registers and then use the "R" (Redisplay Scene) key to observe the effect of the changes. Practice until you understand the use of the registers in MODE 3. Try producing a negative image. Try viewing the MODE 3 plotted image with a MODE 1 or MODE 2 display.

COL/LUM Registers (3-D MENUS): Setting MODE 4 Color Assignments

The last mode is MODE 4, the 3-D stereo mode that produces stereo images of models viewable with stereo anaglyphic glasses provided with the program. For this exercise, it's best to darken the room as much as possible or to wait until after dark when the lights can be turned down or out. Low pixel illumination values produce better color separation for stereo viewing. Reducing surrounding light as much as possible will permit a lower illumination value to be used comfortably. In addition, annoying screen reflections will be minimized.

MODE 4 plots 4 high-resolution (192x320) screens in red to be viewed by the left eye and 4 high-resolution screens in blue to be viewed by the right eye. The program interlaces the screens on display — first a red then a blue then a red, etc. Each screen is displayed for 1/60 second. The glasses separate the images for each eye to produce a 3-D stereo effect. MODE 4 ignores the second digit loaded in the MODE/SCREENS register — 8 screens are always plotted regardless of what value is loaded in the 2nd digit.

Go to 3-D MENU #1 and change the register values, where necessary, of 3-D MENU #1 to the following values. (Only the registers printed in bold may need to be changed. COL/LUM 3 is not used in MODE 4.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....18
PITCH ANGLE = ...45
YAW ANGLE = ...*-40*
ROLL ANGLE =.....0
DISTANCE = ...160
X OFFSET =.....*-75*
Y OFFSET =.....*-25*
Z OFFSET =.....0

ANGLE OF VIEW =.....90
MODE/SCREENS = ...42
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 =.....000
TONES/CONTRAST-456 =.....000
MI HI IN NE =.....0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ...000
COL/LUM 1 =.....003
COL/LUM 2 =.....000
COL/LUM 3 = ...XXX

Type "L" to access the LIGHT MENU. Make sure the LIGHT MENU contains the following values. (No change should be necessary.)

LIGHT 1 PITCH = ... 45
LIGHT 1 YAW = ... *-40*
LT1 INTENSITIES-123 = ... 999
LT1 INTENSITIES-456 = ... 000
LIGHT 2 PITCH = ... 0
LIGHT 2 YAW = ... 0
LT2 INTENSITIES-123 = ... 900
LT2 INTENSITIES-456 = ... 000
LIGHT 3 PITCH = ... 0
LIGHT 3 YAW = ... 0
LT3 INTENSITIES-123 = ... 000
LT3 INTENSITIES-456 = ... 000

Here again, one light is directed toward the model from the observer's point of view and a second light is used to illuminate the top surface of the model. Other lighting arrangements can be used equally effectively in MODE 4.

Return to 3-D MENU #1 and type the "V" (View) key to plot a MODE 4 image of the "C" in the SPACE SCREENS (requires about 10-1/2 minutes). Refer to the screen display when reading the following material.

MODE 4 requires the most time to plot because two separate high-resolution images must be constructed and all 8 screens must always be plotted. The use of the color registers is similar to the use of the registers in MODE 3. Both MODE 4 and MODE 3 use the same 320x192 2-color high-resolution plot routines.

In MODE 4, the first two digits (the color digits) of COL/LUM BACKGROUND are ignored because alternating red/blue colors are automatically chosen for the SPACE SCREENS by the program. The 3rd digit of COL/LUM BACKGROUND assigns the background brightness (0 to 7). The 3rd digit of COL/LUM 1 assigns the same paint brightness (0 to 7) to all model surface paint numbers. The first two digits of COL/LUM 1 are unused. The low brightness value of "3" used here for COL/LUM 1 is recommended because colors produced by most T.V.'s or monitors have better color saturation or "richness" at lower illumination values. This makes it easier for the

stereo glasses to separate the two images.

The value loaded in COL/LUM 2 assigns both the color (first two digits) and brightness (last digit) to the border. In this example, "000" (black) was chosen for COL/LUM 2 because some people feel that a border is distracting when viewing stereo images. This, however, is strictly a matter of personal preference. Color borders can be used if desired.

"<" (Left Shift) and ">" (Right Shift) keys (STEREO SPACE SCREENS): Adjusting Color Balance for Stereo Viewing

Type the ">" (Right Shift) key (located on the upper row of keys) once. Notice that the two images separate. Type the ">" (Right Shift) key one more time so that the two images are further apart. Fold the stereo glasses so that your right eye will be looking through the blue lens and your left eye though the red lens. Put on the stereo glasses and adjust the color balance and intensity settings on your T.V. or monitor until you get the maximum color separation possible. With most T.V.'s or monitors, you should turn the brightness level down for best results. Ideally, when you close your right eye, the blue image will almost disappear. Similarly, when you close your left eye, the red image will almost disappear.

When you have the best balance possible, shift the two images back to the starting position by typing the "<" (Left Shift) key twice to shift the images twice. The overlapping portions of the images should now be displayed in a purple hue. Make note of the monitor color knob settings so that you can easily return to them again when viewing other stereo images.

View the image with the stereo glasses until you see the stereo effect. This may take a little effort the first time until the two images fuse. If you have trouble seeing the stereo effect, try viewing the T.V. or monitor from different distances until the images fuse.

When loading COL/LUM registers for MODE 4, use the MODE 4 COL/LUM DIGIT GUIDE below:

MODE 4 COL/LUM DIGIT GUIDE

COL/LUM BACKGROUND = XXB

"XX" is not accessed and can contain any value.
"B" assigns brightness (0 to 7) to background.

COL/LUM 1 = XXB ("3" or "4" recommended for "B")

"XX" is not accessed and can contain any value.
"B" assigns the same paint brightness (0 to 7) to all model surface paint numbers.

COL/LUM 2 = CCB

"CC" assigns color to border (use COLOR TABLE).
"B" assigns brightness (0 to 7) to border.

COL/LUM 3 is not accessed by MODE 4 and can contain any value.

"CHROMACAD" Letter Models: Displaying the Models

The seven "CHROMACAD" letter models on MODEL DISK #1 that were used to make the face screen were all constructed to the same scale. The same 3-D MENU and LIGHT MENU register values that were used in the above demonstrations to display the "C" model can also be used, therefore, to successfully display the other "CHROMACAD" letter models. To do this, simply load the BASE LINE number of a desired letter model into the MODEL BASE LINE register of a 3-D MENU and use the same register values as were used in the demonstrations to display the model. The BASE LINE numbers for the letter models are:

C..18 H..23 R..28 O..33 M..38 A..13 D..43

Experiment with the letter models. Load up the registers of a 3-D MENU any way you like and plot and display the models. Change the viewing angles and distances. Try an extreme close-up. Try a few different lighting arrangements, etc.

TONES/CONTRAST-123 and TONES/CONTRAST-456 Registers (3-D MENUS): Setting the Number of Shading Tones Individually for Each Paint Number

Chromacad allows you to set the number of shading tones that the program will use individually for each surface paint number. Using a small number of shading tones produces "STEPPED-TONE" images. Each of the 6 digit locations of the two TONES/CONTRAST registers corresponds to a different surface paint number (this is similar to the INTENSITIES registers of the LIGHT MENU). If any digit location of a TONES/CONTRAST register contains a "0", model surfaces with paint number corresponding to that digit location will be shaded with up to 22 shading tones. This produces normal continuous-tone shading.

If any digit location of a TONES/CONTRAST register contains a value in the range of 1 to 8, model surfaces with the paint number corresponding to that digit location can only be shaded with a number of shading tones up to the loaded value. This produces STEPPED-TONE shading.

For example, if TONES/CONTRAST-123 is loaded with "308", all surfaces painted "1" can only be shaded with up to 3 shading tones ("3" loaded at the 1st digit location), surfaces painted "2" can be shaded with up to 22 tones ("0" loaded at the 2nd digit location) and surfaces painted "3" can only be shaded with up to 8 tones. (The actual number of tones used will, of course, depend on the surface contours of the model. Not all of the tones permitted will always be used.)

For this exercise we will use a different model -- a model of the block letter "O". (This model, however, was not constructed to the same scale as the previous letter models that were used to produce the "CHROMACAD" face screen.) The BASE LINE number of this model is "9".

The "O" model was constructed lying face up on the graph, with the center of the "O" at X = 0, Y = 0. The outside lateral-facing sides of the "O" were painted with paint number 2. The lateral-facing sides of the hole of the "O" were painted with paint number 3. The top surface was painted with paint number 1.

Go to 3-D MENU #1 and change the register values of 3-D MENU #1, where necessary, to the following values. (Unless the computer has been turned off or register values have been changed since the last exercise, only those registers printed in bold may need to be changed.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....9
PITCH ANGLE =.....70
YAW ANGLE =.....0
ROLL ANGLE =.....0
DISTANCE =.....1100
X OFFSET =.....0
Y OFFSET =.....0
Z OFFSET =.....0

ANGLE OF VIEW =.....25
MODE/SCREENS =.....22
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 =.....030
TONES/CONTRAST-456 =.....000
MI HI IN NE =.....0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ...000
COL/LUM 1 =.....043
COL/LUM 2 =.....103
COL/LUM 3 =.....014

Notice that, this time, we are taking a slant view directed toward the bottom of the letter (PITCH ANGLE = 70, YAW ANGLE = 0).

Type "L" (Lights) to access the LIGHT MENU. Make sure the LIGHT MENU contains the following values. (Only the registers printed in bold may need to be changed from the last exercise.)

LIGHT 1 PITCH =..... 70
LIGHT 1 YAW =..... *-90*
LT1 INTENSITIES-123 =..... 999
LT1 INTENSITIES-456 =..... 000
LIGHT 2 PITCH =..... 0
LIGHT 2 YAW =..... 0
LT2 INTENSITIES-123 =..... 900
LT2 INTENSITIES-456 =..... 000
LIGHT 3 PITCH =..... 0
LIGHT 3 YAW =..... 0
LT3 INTENSITIES-123 =..... 000
LT3 INTENSITIES-456 =..... 000

Notice that we are swinging LIGHT #1 around so that it will illuminate only the right side of the model (LIGHT 1 YAW = *-90*). This will leave the left side unilluminated. MODE 2 was used for this demonstration although any of the other graphic modes could have been used.

Return to 3-D MENU #1 and type the "Q" (Quick) key to see how the present orientation register values plot the test figure.

Return to 3-D MENU #1 and type the "V" (View) key to plot and display a STEPPED-TONE rendering of the "O" model (requires about 2-3/4 minutes). Refer to the screen display when reading the following material.

The outside lateral-facing sides of the "O" model were painted with paint no. 2. The lateral-facing sides of the hole were painted with paint number 3. "030" was loaded in TONES/CONTRAST-123 at the time of plotting. The "3" loaded in the 2nd digit of TONES/CONTRAST-123 caused surfaces painted "2" (the outside lateral-facing sides) to be shaded with only three tones. This produced a STEPPED-TONE effect. The "0" loaded in the 3rd digit caused surfaces painted "3" (the lateral-facing sides of the hole) to be shaded with the normal number of up to 22 shading tones.

TONES/CONTRAST-123 and TONES/CONTRAST-456 Registers (3-D MENUS): Setting the HIGH CONTRAST Plotting Mode for Any Paint Number

As mentioned before, if a digit location of a TONES/CONTRAST register contains a value in the range of 1 to 8, the paint number corresponding to the digit location will be shaded in a number of shading tones up to that value. If a "9" is loaded in any digit location, a completely different effect is produced.

If any digit location of a TONES/CONTRAST register is loaded with "9", the model surface with paint number corresponding to that digit location will be plotted in HIGH CONTRAST with up to 22 shading tones. For example, if TONES/CONTRAST-456 is loaded with "290" at the time of plotting, all surfaces painted "4" will be STEP-TONE shaded with up to 2 tones in normal contrast. Surfaces painted "5" will be shaded with 22 tones in HIGH CONTRAST and surfaces painted "6" will be shaded with 22 tones in normal contrast.

The "O" model can be used again to demonstrate HIGH CONTRAST shading.

Go to 3-D MENU #1 and change the register values, where necessary, of 3-D MENU #1 to the values listed on the following page. (Unless register values have been changed, only the register printed in bold should need to be changed.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....9
PITCH ANGLE = ...70
YAW ANGLE = ...0
ROLL ANGLE =.....0
DISTANCE = ...1100
X OFFSET =.....0
Y OFFSET =.....0
Z OFFSET =.....0

ANGLE OF VIEW =.....25
MODE/SCREENS = ...22
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 =.....009
TONES/CONTRAST-456 =.....000
MI HI IN NE =.....0000
AMBIENT LIGHT =.....0
COL/LUM BACKGROUND = ...000
COL/LUM 1 = ...043
COL/LUM 2 = ...103
COL/LUM 3 = ...014

Type "L" (Lights) to access the LIGHT MENU. Make sure the LIGHT MENU contains the following values. (Only the register printed in bold should need to be changed.)

LIGHT 1 PITCH =..... 70
LIGHT 1 YAW =..... 0
LT1 INTENSITIES-123 =..... 999
LT1 INTENSITIES-456 =..... 000
LIGHT 2 PITCH =..... 0
LIGHT 2 YAW =..... 0
LT2 INTENSITIES-123 =..... 900
LT2 INTENSITIES-456 =..... 000
LIGHT 3 PITCH =..... 0
LIGHT 3 YAW =..... 0
LT3 INTENSITIES-123 =..... 000
LT3 INTENSITIES-456 =..... 000

This time, we are swinging LIGHT #1 back to illuminate the model from the observers point of view again (LIGHT 1 YAW = 0).

Return to 3-D MENU #1 and type the "V" (View) key to plot and display a HIGH CONTRAST rendering of the model (requires about 2-3/4 minutes). Refer to the screen display while reading the following material:

"009" was loaded in the TONES/CONTRAST 123 register at the time of plotting. The "0" in the 2nd digit location caused model surfaces painted "2" (the outside lateral-facing sides of the model) to be shaded in continuous-tone normal contrast. The "9" in the 3rd digit location caused model surfaces painted "3" (the lateral-facing sides of the hole) to be shaded in continuous-tone HIGH CONTRAST.

AMBIENT LIGHT Register (3-D MENUS): Setting the Illumination Level of Non-directional Light

Real objects are usually illuminated by a combination of random, diffused, non-directional light that evenly fills the space around the object (called "ambient" light) and directional (non-ambient) light from specific directional sources such as windows, floodlights, etc. The AMBIENT LIGHT register will accept values from 0 to 100 (percent).

If you load "0" in AMBIENT LIGHT the model will receive light only from the three directional light sources. If you load "100" in AMBIENT LIGHT, the model will be flooded with so much ambient light that all visible surfaces of the model will be lit to the maximum extent possible. This produces a simple unshaded "cartoon" effect. A small amount of ambient light (like 15, 20 or 25) is often helpful to make sure that all visible surfaces of the model get at least some light.

MI HI IN NE Register (3-D MENUS): Turning on Special Features

This register holds four digits. Each digit location can contain either a "1" or "0". A "1" at a digit location turns on the feature corresponding to that digit location and a "0" turns the corresponding feature off. The four features are:

1. MI = MIRROR IMAGE
2. HI = HIGHLIGHT ENHANCEMENT
3. IN = INSIDE VIEW
4. NE = NEGATIVE IMAGE

For example, if you load the MI HI IN NE register with "1000" (MI turned on; all others turned off), a MIRROR image will be rendered. If you load the register with 1001 (both MI and NE turned on) a NEGATIVE MIRROR image will be rendered.

When you turn on the INSIDE VIEW feature, the inside-facing surfaces of the models become visible and the outside-facing surfaces invisible. This produces an interior view of the model. If you select a camera point of view that lies inside the model, the entire screen will be filled with the interior view. This produces the effect of viewing the model from the inside.

NOTE: The SURFACE SHADER XE will not shade a model surface triangle if, from the current point of view, one or more points of the triangle falls outside of a 90-degree angle-of-view. If some model surfaces around the outside edges of the SPACE SCREENS are not shaded, move the current point of view back by using a larger value in DISTANCE. (If you want to maintain the same image size, decrease the value in ANGLE OF VIEW at the same time.)

For inside views, for the above reason, it's best to use ANGLE OF VIEW values of less than "50".

HIGHLIGHT ENHANCEMENT Feature (MI HI IN NE Register): Creating a Shiny Surface Effect

The HIGHLIGHT ENHANCEMENT feature, when turned on, turns LIGHT #3 into a highlight-only light. Normally, when HIGHLIGHT ENHANCEMENT is turned off, LIGHT #3 acts exactly like LIGHT #1 and LIGHT #2. If you turn the HIGHLIGHT ENHANCEMENT feature on, however, only those model surfaces that would normally be illuminated to the maximum by LIGHT #3 are illuminated by LIGHT #3 at all. In other words, with HIGHLIGHT ENHANCEMENT turned on, LIGHT #3 only casts highlights. These highlights can be used to simulate a shiny, reflective surface.

When the HIGHLIGHT ENHANCEMENT feature is turned on, the INTENSITIES registers of LIGHT #3 are used to set the size of the highlight within the highlight area. The higher the intensity number at a digit location, the larger will be the highlight for the corresponding surface paint number.

For example, if HIGHLIGHT ENHANCEMENT is turned on and 3 INTENSITIES-456 contains "419", the highlight will be largest for surfaces painted "6" ("9" loaded at the 6 location) and smallest for surfaces painted "5" ("1" loaded at the 5 location). The HIGHLIGHT ENHANCEMENT feature provides some control over the glossiness of individual surface paints.

For the last demonstration, the HIGHLIGHT ENHANCEMENT feature will be illustrated with another plot and display of the "O" model.

Change the register values, where necessary, of 3-D MENU #1 to the values listed below. (Unless the computer has been turned off or the the register values have been changed since the last exercise, only the registers printed in bold should need to be changed.)

THIS MENU NO = ...1
MENU DISPLAY ORDER =....0
MODEL BASE LINE =.....9
PITCH ANGLE = ...70
YAW ANGLE = ...0
ROLL ANGLE =.....0
DISTANCE = ...1100
X OFFSET =.....0
Y OFFSET =.....0
Z OFFSET =.....0

ANGLE OF VIEW =.....25
MODE/SCREENS = ...22
SECTIONS/AUTO =.....10
TONES/CONTRAST-123 =.....000
TONES/CONTRAST-456 = ...000
MI HI IN NE =.....0100
AMBIENT LIGHT =.....18
COL/LUM BACKGROUND = ...000
COL/LUM 1 = ...043
COL/LUM 2 = ...103
COL/LUM 3 = ...014

Type "L" (Lights) to access the LIGHT MENU and make sure the following values are loaded in the registers of the 3-D MENU #1 LIGHT MENU:

LIGHT 1 PITCH =..... 90
LIGHT 1 YAW =..... 80
LT1 INTENSITIES-123 =..... 999
LT1 INTENSITIES-456 =..... 000
LIGHT 2 PITCH =..... 0
LIGHT 2 YAW =..... 0
LT2 INTENSITIES-123 =..... 900
LT2 INTENSITIES-456 =..... 000
LIGHT 3 PITCH =..... 90
LIGHT 3 YAW =..... 40
LT3 INTENSITIES-123 =..... 020
LT3 INTENSITIES-456 =..... 000

Notice that we are swinging LIGHT #1 around to illuminate the left side of the model (LIGHT 1 YAW = 80). This time, however, we are adding a little ambient light to illuminate the right side (AMBIENT LIGHT = 18%).

Return to 3-D MENU #1 and type the V (View) key to plot and display the model (requires about 2-3/4 minutes). Read the following material while viewing the display:

LIGHT #1 was set to illuminate the left side of the model. LIGHT #2 was set to illuminate the top surface. No light was set to illuminate the right side; therefore, a small amount of ambient light (18%) was added to illuminate and define the right side.

The HI (HIGHLIGHT ENHANCEMENT) digit of the MI HI IN NE register was turned on. LIGHT #3 was set, therefore, for highlight casting for the purpose of creating a shiny surface effect. If the model has a shiny surface, LIGHT #1 would normally cast a bright reflective highlight on the lit side of the model. LIGHT #3 was set, therefore, to create this highlight.

With the present model viewing angle and the present incoming angle of LIGHT #1, the highlight would be cast by LIGHT #1 on those surfaces of the model that are facing out at angles at or near PITCH = 80, YAW = 40. These are angles that are midway between the PITCH and YAW of the viewing angle and the PITCH and YAW of the incoming light of LIGHT #1.

No surface of the "O" model faces out at an angle of PITCH = 80, YAW = 40. Some surfaces on the side of the model, however, do face out at approximately PITCH = 90, YAW = 40. LIGHT #3 was set, therefore, to PITCH = 90, YAW = 40. This setting causes light from LIGHT #3 to shine perpendicularly on and cast a highlight on model surfaces facing out at angles at or near PITCH = 90, YAW = 40. This reflective highlight appears as a vertical band on the left side of the "O" model in the display.

"020" was loaded into the LT3 INTENSITIES-123 register. Since only the 2nd digit contains a non-zero value, only model surfaces painted "2" can receive the highlight. If a larger value had been loaded in the 2nd digit (such as "040") a wider highlight would have been produced.

When using the HIGHLIGHT ENHANCEMENT feature, try to select main light angles and viewing angles that will permit the in-between angles of LIGHT #3 to strike at least one surface facet of the model at a perpendicular angle (or as close to the perpendicular as possible). If light from LIGHT #3 does not strike any surface of the model at an angle close to perpendicular, you may not get any highlight at all.

In many cases, it's easiest to: (1) decide what surface of the model

is to receive the highlight and first set the PITCH and YAW angles for LIGHT #3 to shine perpendicularly on that surface and then (2) set the viewing angles and main light angles so that the highlight cast by LIGHT #3 falls about halfway between the viewing angle and the incoming main light angle. In other words, set LIGHT #3 PITCH/YAW highlight angles first and the PITCH/YAW of the viewing and main light angles second. HIGHLIGHT ENHANCEMENT and HIGH CONTRAST often work well together to create a shiny surface effect.

NOTE: A highlight cast on the right side of a model using a negative YAW angle may not always be cast in exactly the same place on the left side using the same value positive YAW angle. Don't try to be too mathematical when it comes to placing highlights. Highlight casting is more of an art than a science. Use your own eye to size and place highlights. There is a limit to how large you can make a highlight. The maximum highlight size is a function of the compound curve of the particular surface that is being highlighted. Use "9" to highlight large flat surface areas.

"CONTROL V" Key-combination (3-D MENUS) and the MENU DISPLAY ORDER Registers (3-D MENUS): Displaying Multiple Views of Models on One Screen

You can use the "CONTROL V" key-combination to display multiple views of models in a similar manner as the "CONTROL Q" key-combination was used to display multiple views of the test pattern.

Important rule when using the "CONTROL V" key-combination: The values loaded in the ANGLE OF VIEW, MODE/SCREENS, SECTIONS/AUTO and COL/LUM registers of 3-D MENU #0 are used for all models called for plotting by the "CONTROL V" key-combination.

Always make sure that a model base line number is loaded in any 3-D MENU called for display by the "CONTROL V" key-combination. It's a good idea to always make this a two-step process: First, check to make sure the desired model base line number is loaded in the MODEL BASE LINE register and only then load the menu display order number in the MENU DISPLAY ORDER register.

The "CONTROL V" key-combination is not functional in MODE 4. In MODE 4, only one model can be viewed at a time. If you attempt to

use "CONTROL V" when the MODE/SCREENS register of 3-D MENU #0 calls for MODE 4, you will get a "NO MULTI-MODEL IN MODE 4" error message.

NOTE: It's much faster to set up multi-model scenes with the contour-line model display mode of the MODEL BUILDER program. The MODEL BUILDER program is fast enough to draw models in contour-line form in the SPACE SCREEN as you watch. In addition, you can use the "Delete" key to stop the drawing process of any particular model as soon as you have determined the placement and orientation of that model. (Usually only the first few lines of each model need to be drawn in order to "fit" a group of models together to produce a multi-model scene.)

The "Control V" key-combination is used exactly the same way by the MODEL BUILDER program to display multi-model scenes in contour-line form as it is used by the SURFACE SHADER XE program to display multi-model scenes in surface-shaded format. In addition, the 3-D MENUS of model disks are booted the same way, loaded the same way and saved the same way in both programs. At this point, no extra instructions are necessary; therefore, for you to use the MODEL BUILDER program to set up and display multi-model scenes in contour-line form.

Once a multi-model scene is set up in contour-line form with the MODEL BUILDER program, the 3-D MENUS can be saved to disk where they can be used later by the SURFACE SHADER XE program to display models in surface-shaded format.

SECTION 6 — HIGH-RESOLUTION PHOTOGRAPHIC PRINTS, 2-D MODELS, SHADOW CASTING

SECTIONS/AUTO Register, Sections Digit (3-D MENUS): Creating Large High-resolution Photographic Prints

Chromacad has a special feature of interest to amateur photographers. You can use this feature to create large, high-resolution pictures of any single or multi-model display produced by MODES 1, 2 or 3. One of the problems of photographing the T.V. or monitor display is that the highest resolution multi-color display possible is only 160x192 pixels.

Theoretically, Chromacad 3-D models (or combinations of models) can be displayed in 127 colors at more than 48,000 shades per color on a 32767x32767 resolution screen. This includes the models you construct with Atari 8-bit computers. In practice, model displays are severely limited by the graphic modes of the computer/monitor. If higher resolution graphic modes with more colors were available, Chromacad model displays would be able to take full advantage of them.

You can use the SECTIONS/AUTO register to obtain larger, higher resolution graphics than could be obtained by simply photographing a single monitor or T.V. display of the scene. This is accomplished by displaying and photographing many overlapping sectional screen displays of the scene and then combining them to produce one high-resolution composite graphic.

For example, if a you load a "1" in the 1st digit (i.e., the SECTIONS digit) of SECTIONS/AUTO, the screen display will be normal. If you load a "2" in the first digit, the program will produce a series of 4 sectional displays of the scene. The first display will be of the upper left portion of the scene. The 2nd display will be of the upper right portion, the 3rd display will be of the lower left portion and the last display will be of the lower right portion. Photographs of the 4 sectional displays can be combined to produce a final 384x320 graphic in MODE 1 or 2 or a 384x640 graphic in MODE 3.

If "3" is loaded in the 1st digit, 9 displays will be produced, 3 displays across the top of the scene, 3 across the center and 3 across the bottom, for a 576x480 graphic in multi-color modes. The number of sectional displays produced will always be the square of

the value stored in the first digit of the SECTIONS/AUTO register. The sectional displays overlap slightly to facilitate aligning the pictures when mounting.

The maximum value that can be loaded into the 1st digit of SECTIONS/AUTO is "9". A maximum 9x9 graphic, composed of 81 separate pictures is possible. A more practical size is "6x6". This size fits conveniently on a 36 exposure roll of 35mm film and produces a 1152x960 color graphic about 2 feet wide (assuming individual 4x5 print sizes).

If the first sectional display (the upper left corner section) is being displayed on the T.V. or monitor, typing the " → " (Out) key will cause the program to begin plotting the 2nd section of the series. If the 2nd section is being displayed, typing the " → " (Out) key will cause the program to begin plotting the 3rd section, etc. until all sections have been displayed, in turn. Typing the " → " (Out) key when the last section of the series is being displayed will return the program to the MAIN MENU.

You can use the SECTION/AUTO register and the "CONTROL V" key-combination together to produce large multi-section multi-model high-resolution graphic prints. This is a good project to do while watching a football game or T.V. movie, because it often takes many hours for the computer to plot all of the sectional displays. (As mentioned earlier, the ANGLE OF VIEW, MODE/SCREENS, SECTIONS/AUTO and COL/LUM registers of 3-D MENU #0 are used for all models called for plotting by the "CONTROL V" multi-model key-combination.)

When photographing a T.V. or monitor display, a cable release is recommended. The camera should either be placed on a solid object like a book or mounted on a tripod. Most cameras have inaccurate shutter speeds at the slow speeds necessary for photographing a T.V. or monitor screen. To solve this problem, an option has been provided that you can use to produce a computer-timed 3/4 second exposure of the display. This option can be used to photograph any MODE 1, MODE 2 or MODE 3 display, including sectional displays.

"ESC", "START" Keys (SPACE SCREENS): Producing a Timed 3/4-second Exposure

When photographing any MODE 1, MODE 2 or MODE 3 display, follow the 3 steps below to produce a timed 3/4-second exposure:

1. While viewing the SPACE SCREENS, press the "ESC" key. The screens will go dark.

2. Press the "START" key. A timed 3/4-second exposure will be produced.

3. Press the "START" key again. The display will return to normal.

It's always best to do screen photography at night with the lights out to avoid unwanted screen reflections.

One problem with photographing sectional displays is that most monitors and T.V.'s tend to slightly boost the pixel illumination of those sectional displays that have fewer lit pixels. Since all sectional displays contain different numbers of lit pixels, the exposure is often slightly different from section to section, even though the same exposure was used to photograph each section.

This problem can be corrected by individually exposing each print during processing. For the above reason, we do not recommend using snap-shot film developing services for printing a series of sectional prints. If you do use a print service, specify that all prints of the series are to be made with identical color balance and exposure settings.

Large multi-color high-resolution graphics made with the above technique are impressive. If you use MODE 1 or MODE 3, the constant number of lit border pixels in each sectional display tends to help solve the above problem. In addition, it's easier to cut off borders after the prints are made if they are visible.

Use slant inward cuts when cutting off the borders so that the cut lines will disappear when the finished composite graphic is rephotographed after being pasted up. Rephotography should be done outside on an overcast day with no strong shadows.

Another suggestion that often helps the exposure variation problem mentioned above is to use a 2-D background model that contains fairly uniform shading tints to fill the entire screen prior to plotting the models. This tends to keep the number of lit pixels relatively constant from section to section.

SECTIONS/AUTO Register — AUTO Digit (3-D MENUS): Setting the Automatic Advance/Exposure Digit

The 2nd digit (AUTO digit) of the SECTIONS/AUTO register is an ON/OFF digit. This digit will only accept a "1" or "0". If a "1" is loaded in the 2nd digit, Chromacad's automatic advance/exposure feature will be turned on. With the automatic advance/exposure feature turned on, any image will be displayed for exactly 3/4 of a second. At the beginning of the display, pin 4 of CONTROLLER PORT #2 (joystick jack #2) will change states (to +5 volts). At the end of the display, pin 4 will revert to its original condition and the program will automatically either begin plotting the next sectional display or return to the MAIN MENU.

The purpose of the change of state at pin 4 is to trigger the camera shutter of a motor-driven camera. Many inexpensive 35mm cameras now have automatic motor-driven film transport mechanisms. With this feature, all exposures of a multi-panel display can be made without the necessity of manually making each exposure. Unless you have a camera cable release designed for this purpose, always leave the 2nd digit of the SECTIONS/AUTO register on "0" (Off).

2-D Models

2-D models are like "paintings" that can be moved around in 3-D space. They are easy to construct with the MODEL BUILDER program. 2-D models are usually constructed face up, on the BASE LINE GRAPH (the same surface that the "L" test pattern is plotted on).

Many 2-D models are rectangular background models designed to fill the entire screen area. Background models are always the first models plotted when using the "CONTROL V" multi-model key-combination. Other 2-D or 3-D models can be plotted directly on the background model in order to produce a multi-model scene that fills the entire screen.

To display 2-D models, you usually set the PITCH, YAW and ROLL ANGLE registers to "0" so that the line-of-view is straight down, perpendicular to the BASE LINE GRAPH. You can use the X OFFSET and Y OFFSET registers to move the model around on the BASE LINE GRAPH, much as moving a picture around on a table top.

You can use the DISTANCE register to scale a 2-D model of an individual object to a desired size and then use the X OFFSET and Y OFFSET registers to place the model anywhere in the foreground of a 3-D or 2-D background model.

You can also use the orientation registers to position 2-D models of logos, letters, numbers, words, etc. to appear as if they are painted on the slant surface of 3-D models. You can use 2-D lettering models as foreground captions. In addition, you can use 2-D models as shadow models (covered later in this section).

2-D model "paintings" have numerous advantages over graphics produced by most 2-D paint programs. Most of the options of the SURFACE SHADER XE that are used for displaying 3-D models can also be used to display 2-D models. Some of these options are: indirect color assignment, tone separation, negative imaging, mirror imaging, calling and using the graphic as a background or foreground scene with other 3-D or 2-D models, adding ambient light, zooming in on desired features, etc.

2-D models are displayed using the same procedure as is used in displaying 3-D models. The BASE LINE of the model is loaded in the MODEL BASE LINE register of a 3-D MENU and the model is displayed using the "V" (View) or "CONTROL V" multi-model key-combination.

SHADOW CASTING: Using a Combination of Models to Produce Shadows

Both 2-D and 3-D models can be used for shadow casting. There are always at least three models plotted for shadow effects. These are: the shadow receiving model, the shadow model and the shadow casting model. Follow the 5 steps on the following page to produce shadow effects.

1. Load one of the 3-D MENUS with the model on which the shadow will be cast. This will be the shadow receiving model and is often a 2-D background model or a 3-D landscape model. This shadow receiving model will be called and plotted first.

2. Load another 3-D MENU with the shadow casting model and use the "CONTROL V" multi-model option to plot both models on the same screen. Plot the shadow receiving model first. Observe the scene and decide the desired outline shape of the shadow as it would be cast on the shadow receiving model. This, of course, depends on the direction of the light as it strikes the shadow casting model and on the slant which the shadow falls on the shadow receiving model.

3. At this point, you can do one of two things: (1) If you have the MODEL BUILDER program, you can draw a 2-D model of the proper shape to use as the shadow model or, (2) you can often select a viewpoint of the shadow casting model that will provide an outline shape close enough to be used for a shadow model.

4. Load a 3rd 3-D MENU with the shadow model as determined above. Make sure all of the lights of the shadow model are turned off. This model must be plotted and displayed in black only. Use the OFFSET and DISTANCE registers to size the shadow model and place it at its proper location on the receiving model. (This step can be done much faster with the contour-line drawing mode of the MODEL BUILDER program.)

5. Use the "CONTROL V" multi-model option to plot and display all three models. Plot the shadow receiving model first, the shadow model second and the shadow casting model last.

BOOT MODULE PROGRAM Option (MAIN MENU)

The last option not yet covered is the BOOT MODULE PROGRAM option of the MAIN MENU. This option allows you to boot other Chromacad programs without disturbing a plotted image that may reside in the extended memory of the 130XE. Some future Chromacad module programs may take advantage of this feature.

There is only enough room in a 130XE to hold a surface-shading imaging program and an image file of up to 64K length. Once an image is created in extended memory by a Chromacad surface-

shading program, the BOOT MODULE PROGRAM option will permit other programs that may use the image file to be booted without disturbing the image file.

At this point, you know all of the options, registers, keys, beeps, bells and whistles of the SURFACE SHADER XE program. Sculptured-surface 3-D modeling is a powerful, new medium of artistic expression. Experience proves that the part requiring the most skill is not the skills learned in using the features of the program. Those you will learn in your first few efforts at building you own multi-model scenes. The skillful part lies in being able to combine models, both 2-D and 3-D, and choose color schemes and rendering effects to achieve a pleasing artistic effect. These skills require artistic ability — different perhaps than painting or drawing, but just as demanding. The user's personality and style is just as important in 3-D modeling as it is in other forms of artistic expression.

MODEL DISK #1 includes models not viewed in the course of this manual. The 3-D MENUS of MODEL DISK #1 were originally set up with register values useful for displaying some of these models. If these register values have not been changed while doing the exercises in this manual, you need only go to the corresponding 3-D MENU and type "V" (View) to plot and display the model. The best way to learn the program is to display the models once, using the supplied register values, and then practice displaying the models (or model combinations) using your own viewing angles, lighting conditions, and rendering options. (For a description of the models on any disk, see the corresponding MODEL DESCRIPTION SHEET.)

In addition to a brief description of each model, the MODEL DESCRIPTION SHEET provides the approximate XYZ center point coordinates, the suggested viewing distance and the approximate imaging time (in MODE 2 at the suggested distance) for each of the models on the corresponding model disk. The center point coordinates are usefull for positioning the model in the SPACE SCREENS. If you change the signs of the center point coordinates of a model and load them into the corresponding offset registers, the model will usually be centered in the SPACE SCREENS when viewed from any angle.

REGISTER RANGE APPENDIX

3-D MENUS

THIS MENU NO. 0 to 9
MENU DISPLAY ORDER 1 to 10
MODEL BASE LINE Any Current Model BASE LINE NUMBER
PITCH ANGLE -180 to +180
YAW ANGLE -180 to +180
ROLL ANGLE -180 to +180
DISTANCE -32767 to +32767
X OFFSET -32767 to +32767
Y OFFSET -32767 to +32767
Z OFFSET -32767 to +32767
ANGLE OF VIEW 10 to 90
MODE/SCREENS 1st Digit...1 to 4, 2nd Digit...1, 2, 4, 6 or 8
SECTIONS/AUTO 1st Digit...1 to 9, 2nd Digit...1 or 0
TONES/CONTRAST-123 Each Digit...1 to 9
TONES/CONTRAST-456 Each Digit...1 to 9
MI HI IN NE Each Digit...1 or 0
AMBIENT LIGHT 0 to 100
COL/LUM BACKGROUND 1st 2 Digits...00 to 15, 3rd Digit...0 to 7
COL/LUM 1 1st 2 Digits...00 to 15, 3rd Digit...0 to 7
COL/LUM 2 1st 2 Digits...00 to 15, 3rd Digit...0 to 7
COL/LUM 3 1st 2 Digits...00 to 15, 3rd Digit...0 to 7

LIGHT MENU

LIGHT 1 PITCH -180 TO +180
LIGHT 1 YAW -180 TO +180
LT1 INTENSITIES 123 Each Digit...0 to 9
LT1 INTENSITIES 456 Each Digit...0 to 9
LIGHT 2 PITCH -180 TO +180
LIGHT 2 YAW -180 TO +180
LT2 INTENSITIES 123 Each Digit...0 to 9
LT2 INTENSITIES 456 Each Digit...0 to 9
LIGHT 3 PITCH -180 TO +180
LIGHT 3 YAW -180 TO +180
LT3 INTENSITIES 123 Each Digit...0 to 9
LT3 INTENSITIES 456 Each Digit...0 to 9

"DANGER" zone coordinates outside -18918 to +18918

Disk Sectors Available

Chromacad contains its own built-in disk filing system. The number of disk sectors available for model storage depends on the disk drive and format used. All disks to be used for model storage should be formatted using the DOS provided with the disk drive. Disks formatted single density can utilize up to 720 sectors for model storage. Disks formatted enhanced density using the 1050 or XF551 drives can utilize up to 1040 sectors.

STORE LINE TO DISK Option (Main Menu)

When using the MODEL BUILDER program to store a model contour line to disk, always check the number displayed after the "STORE LINE TO DISK" option of the MAIN MENU. This number displays the total number of disk sectors that would be required if the current line in memory were saved to disk. (This includes the number of disk sectors already used plus the number of sectors that would be needed for the current line.) If this number would exceed your disk sector capacity (720 or 1040 depending on the format), do not attempt to store the line.

If an attempt would be made to store a line that would exceed the maximum capacity of the disk, no line storage would occur. For example, if only 3 disk sectors remained for storage and an attempt would be made to store a 5-sector line, no partial storage of the line would occur -- the attempted storage will be rejected and there would still be 3 disk sectors available for storage.

Colors and Shading Tints Available -- Atari Operating System

Users of the MODEL BUILDER program can "paint" up to 127 different surface paint numbers (1 to 127) on model surfaces at the time of construction. The Atari operating system, however, can only display three colors plus background color in highest resolution (192X160) color mode. (Chromacad "pushes" this a little by flipping screens to get six image colors plus separate background and border colors for a total of eight colors on the screen at once.)

When the SURFACE SHADER XE program is used to display a model, any of 16 actual colors can be assigned to surfaces painted "1", "2" or "3" (see the SURFACE SHADER XE program manual for

the exact colors). Surfaces painted "4" will automatically be colored with a blend of the colors assigned to surfaces painted "1" and "2". Surfaces painted "5" will be colored with a blend of the colors assigned to surfaces painted "1" and "3", and surfaces painted "6" will be a blend of the colors assigned to surfaces painted "2" and "3". For example, when red is assigned to surfaces painted "1", blue to surfaces painted "2", and yellow to surfaces painted "3" model surfaces painted "1" "2" and "3" will be displayed in red, blue and yellow respectively and model surfaces painted "4", "5" and "6" will be displayed in purple, orange and green respectively.

In addition, at the time of construction, users can directly shade model surfaces with any of 50 shading tints. (The SURFACE SHADER XE program automatically shades 3-D models when they are displayed. This direct user shading feature is primarily used when building 2-D models or placing shaded patterns directly on the surface of 3-D models.)

The SURFACE SHADER XE program uses up to 22 tonal values when displaying models on a monitor or T.V. (The 50 shading tints that are used when constructing 2-D models, are scaled down, at display time, to 22 values that are practical for the Atari operating system. 3-D models are calculated to more than 48,000 tonal values by the program before being scaled down to the 22 values.)

When the SURFACE SHADER XE program displays models that have surfaces painted with paint numbers higher than "6", the program divides the number by 6 and uses the remainder as the paint number unless the remainder is 0, in which case, "6" is substituted. The same 6 colors are, therefore, rotated when the model is displayed on a monitor or T.V.

Chromacad permits the use of paint numbers greater than "6" and user shading values greater than "22" because, in the future, other output devices (other computers, color printers, slide makers, "TIFF" files etc.) with a larger range of colors and shades may be supported. When other output devices are supported, 3-D models designed on the Atari will be capable of being displayed (or printed) with up to 127 colors and up to 48,000 shading tones.

EDIT 3-D MENUS Mode

APPENDICES