THE 3-D DRAWING SYSTEM

for the Apple II

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Contents

I. INTRODUCTION

Overview

The 3-D Drawing System contains the 3-D modules from *The Complete Graphics System.* The options page includes choices for the other modules, which will allow you to easily use them if you decide to upgrade with the *100-Color Drawing System,* sold separately. The *100-Color Drawing System* and *3-D Drawing System* together give the equivalent of *The Complete Graphics System.*

The Complete Graphics System is a user-orientated set of graphics programs for the Apple II microcomputer. It offers almost every feature possible to aid in creation of multi-color graphic and text displays with your computer. With it you can, for example, design a house in three dimensions by drawing each of its faces on the screen. Then with the 3-D module you can assemble the pieces and present several different views of the house, in true three-dimensional perspective. Saving these views, you can use the Drawing Module to fill in the walls with your choice of over 100 colors and add any finishing touches to each picture. You can even add text descriptions to the pictures, anywhere on the screen. If you want, you can shrink your pictures so that four different views are shown at once.

Do not expect to sit down and master all of the capabilities of this system at once. Even though it is very user-orientated, there is a lot that it can do. There are actually six programs and several machine language subroutines in the system (although you won't really notice; once you boot the disk movement back and forth among the programs is handled totally by the system). You will most likely be discovering new tricks and ideas for a long time. We hope you enjoy it, and let us know if you have any comments or suggestions.

This software has been thoroughly tested prior to release. If you should have any problem with it, try to duplicate the situation leading to the problem. If it recurs, let us know the exact circumstances and we will act to correct the situation. Those who return their registration cards will be notified of updates, if any.

Data Disks and Backup Copies

Most of the information on the system master can be copied with a standard copy program. You will, however, have to boot with the original disk in order to load all the information necessary for the system. Although all data files (pictures, shape tables, text fonts, 3-D files) can be saved on any Apple formatted disk (of the matching DOS: 3.2 or 3.3), we suggest the following for the easiest use of the system, and for minimal wear on the system master:

1) Make back-up copies of the system master with any standard copy program.

2) When you use the graphics system, boot with the system master. When the menu page is displayed, put the master away and insert one of your back-up copies. Use this as your data disk so that you won't have to swap disks as you go from one graphics module to another. Your system master gets less wear this way, and you don't have to concern yourself with constantly swapping disks.

3) If you want one of your files (picture, shape table, etc.) transferred to a non-system disk, this is easily accomplished by loading the file, inserting the non-system disk, and saving from the appropriate module.

If anything goes wrong with your system master, return it, with $5.00 to cover a new disk and handling, and we'll promptly send a replacement. Be sure to return your registration card so we can notify you of updates and other graphics system compatible products. We are looking for user-generated text fonts, shape tables, and sets of 3-D files that we can make available to owners of the graphics system at a low cost. Write or call Co-op Software for information.

II. GETTING STARTED

First, be sure your paddles are plugged into your computer. Half of the modules allow or require use of the paddles. After you've booted the system master (and put in your back-up, if you've made one), you will be shown the main options page, hereafter called the "menu". On it are displayed the names of the six main modules: (D) Drawing, (T) Text, (3) 3-D Graphics, (S) Shape Tables, (P) Panel Drawing for 3-D files, and (K) Shrink utility. Below those are two other options: (C) Color Bars, and (I) Issue a Disk Command.

When you first boot it is a good idea to select the Color Bars option by typing 'C'. This displays and labels the six primary high-resolution colors: green, violet, white, black, orange, and blue. Adjust your set so that you are getting the proper colors and an intensity that does not distort the edges. Some of the original Apples only have four colors (lacking orange and blue). Some televisions may change the orange and blue. After making any adustments, pressing any key returns you to the menu.

The "I" command is the one you'll use if you want to CATALOG a disk, or DELETE a file. If at any point you forget a file name or run out of room on a disk, you can return to the menu and issue any disk command.

In the graphics system, anytime you are asked a question that has a yes or no answer, press the letter 'Y' or 'N'. If ever an error message appears, or if the computer seems to be waiting, you can usually press any key to go on. A list of error messages and probable causes appears in Appendix A.

III. 3-D Graphics Module

To enter the 3-D module, type '3' from the menu page.

What is a 3-D Figure?

A 3-D figure, to the computer, is a set of numbered points, given in X,Y,Z coordinates, and a list of pairs of point numbers to connect with lines. When viewed, a figure appears as a set of interconnected lines in space. As an example, a cube would be stored as 8 points (numbered 0-7) with the coordinates of the 8 vertices of the cube. The definition of the cube would also include 12 lines (numbered 0-11). The information necessary for each line would be the starting point number, ending point number, and color. The color may be any of the primary Apple colors, although black is impractical. White gives the best results, as it has twice the resolution of the other colors. Figure 4 has a list of points and lines necessary to define a cube. The key feature of this 3-D module is that you don't have to use coordinates to create a figure if you use the Panel Utility described in the next chapter for building your figures.

If you are going to use X,Y,Z coordinates, the X, Y, and Z axes are orientated such that X goes from left to right across the screen, Y goes from bottom (negative) to top (positive) on the screen, and Z goes from where you sit toward the back of the monitor (negative to positive).

A figure may also be a group of other figures. Several figures may be loaded into memory at a time, composing one larger figure. This larger figure can now also be saved. When it is loaded back, all of the original, smaller figures may still be referred to by name and manipulated individually.

There is room in memory for up to 50 figure names (0-49), 512 points (0-511), and 512 lines (0-511).

Points				Lines	
#	X	Y	Z	From	To
0	0	0	0	0	1
1	5	0	0	1	2
2	5	5	0	2	3
3	0	5	0	3	0
4	0	0	5	4	5
5	5	0	5	5	6
6	5	5	5	6	7
7	0	5	5	7	4
				0	4
				1	5
				2	6
				3	7

Figure 4 - Coordinates and Lines for Creating a Cube

Using the 3-D Module

The options page for the module gives you nine choices, most of which we'll get back to later. The system master disk has two 3-D figures already stored on it: 'CUBE' and 'M'. (3-D figures have the suffix ".TD" appended to their names as identifiers.) Type 'L' to load one of the figures. Type 'M' when it asks for a name, then press RETURN. It will ask if you want to give it a new name. Press RETURN to keep the name 'M'. The new name option helps you distinguish between figures in case you load more than one copy of a single figure from disk; say two M's and a 'cube'. You could rename the M's 'M1' and 'M2'. There are other options for dealing with figures with the same name that we'll deal with later.

Viewing a Figure

After the figure is loaded from disk, choose option 'V' to view the figure. A 3-dimensional block letter 'M' will appear on the screen, and at the bottom will appear the information in figure 5. The current function will be 'rotate', the direction will be 'U/D' (up/down), and the constant will be zero. The figure name will be 'ALL'. A list of one-letter commands will appear at the bottom of the screen.

Manipulations

To manipulate the figure, there are four functions: rotate (R), move (M), scale (S), and distort (D). The direction and constant determine exactly how these manipulations will affect the object. The arrow keys (<-,->) execute the operation displayed under function, direction, and constant. To change direction, press the space bar; your choices will be displayed on the bottom line. In the case of a two-letter choice (such as U/D), either letter is acceptable. To change the constant, simply type the number you desire (any combination of the digits 0-9, a minus sign, and a decimal point). After typing the new constant, press RETURN.

Rotations

When rotating, the constant is the number of degrees each rotation will be. The directions for rotating are as follows:

U/D - up/down
L/R - left/right
C/C - clockwise/counterclockwise

In each case, the directions refer to the direction of movement of the part of the object closest to you. (This is necessary to know, because if the front is rotating upward, the back is moving downward.) On rotating, the left arrow causes rotations of down, left, or counterclockwise, depending on the direction setting. The right arrow causes a rotation of up, right, or clockwise. If you want a repeated movement with the same constant and direction, you may use the REPT key by holding it down simultaneously with one of the arrows.

```
FUNCTION      DIRECTION     CONSTANT
ROTATE            U/D           0
*FIGURE : ALL
R M S D P A E C O V SP ESC <- ->
```

Figure 5 - 3-D View Command Page

Moving a Figure

Moving a figure simply shifts an object, and the constant is the number of units the object will move. Directions for movement are:

U/D - up/down
L/R - left/right
F/B - forward/back

The right arrow moves the object up, right, and forward (towards you). The left arrow moves the object down, left, or back.

Scaling a Figure

Scaling a figure changes its actual size. The constant is the number to multiply the size by. Direction is unneccesary, as the object expands (or diminishes) in all directions. The right arrow multiplies the size by the constant. The left arrow divides the size by the constant. For example, using a constant of 2, the right arrow would double the dimensions, and the left arrow would halve the dimensions.

Distorting A Figure

Distorting is actually scaling on one dimension. Direction does matter here, and may be as follows:

H - height
W - width
D - depth

The arrow keys work the same as with scaling. Distorting has the effect of stretching or compressing the object in the specified direction. By distorting a cube you can create a rectangular box of any size, for example.

Editing while Viewing

You may move individual points of a figure around while you are looking at an object, changing the object's actual shape. To do so, use the 'E' command while the object is on the screen. A flashing cursor will appear over one of the points. Press the space bar until the cursor is on the point you want to move, then press RETURN. You may now move that point just as you would move the entire figure, using the directions, a constant, and the arrow keys.

Changing the Center

When an object is rotated or scaled, it is necessary to use a center. Rotations turn the object around the center point. Scaling operations expand the object out from the center, so that the center point is the only one that remains stationary. When you choose to view a figure, the center is computed to be the average of the high and low X values, the high and low Y values, and the high and low Z values. You may want a particular point to remain stationary in a rotate/scale operation. This may be accomplished with the 'C' command, making that point the center. The point is selected in the same manner as with the edit function above. The normal center is re-computed after use of the 'P', 'A', or 'O' commands.

Full Screen Graphics

As with the other modules, the ESC key allows you to switch to viewing the entire screen of graphics. Any subsequent command restores the text at the bottom.

Viewing More than One Figure

After you've tried all the options that allow you to manipulate a figure, you're ready to try using two figures in memory. Go back to the options page using the 'O' command, and using the 'L' option as before, load the CUBE from the master disk. Then go back and view what you have with the 'V' option. You should see both the 'M' and a cube.

Try a couple of commands manipulating the figures. Both the 'M' and the cube should be affected. Now use the 'P' command, which allows you to manipulate part of what's in memory. You will be asked "WHICH FIGURE :". At this point type the name of either figure and press RETURN. Any manipulations will now affect only the figure you specified. To go back to manipulating everything, use the 'A' command, for "all".

When you were asked "WHICH FIGURE :", you also could have pressed RETURN first, and the name of the first figure in memory would have been displayed, and the matching figure on the screen would have flashed. By using the arrow keys at that point, you can step forward or backward through the list of figure names until the one you want is displayed, upon which you press RETURN to select it.

Scaling the View, but not the Objects

The last view command is 'V', which is similar to scale, except the actual size of the figures is not changed. With all the other commands, the actual stored coordinates are changed, thus, with scaling, the object is changed. The 'V' command scales your view, and is more like using a pair of binoculars or a telescope. What you see changes size, but the object doesn't.

This command is also helpful when you want more or less "perspective" in your view of an object. The closer an object is to you, the more pronounced the perspective on the object will be. This is similar to holding something directly in front of your eye, as opposed to seeing it at a distance. To get less "perspective" move the object father away, and magnify it with the 'V' command. To get more "perspective", move it closer and reduce it with the 'V' command.

Saving Figures and Images

From the options page, there are several other commands affecting the figures stored in memory. The 'S' option saves all of the figures currently in memory. You must enter a name under which it will be saved. When the figures in memory are stored on disk, the names of all the figures are also stored as part of the one large figure being saved. When you load this large figure later, you will still be able to manipulate each of the smaller figures of which it was originally made.

You may also save exactly what is displayed on the screen as a two-dimensional picture using the 'I' option. This type of picture can later be loaded with the drawing module, text module, and others.

Deleting Figure Names

Occasionally you will load several figures from disk, assemble them in some manner, and then wish to address the newly created figure with only one name, forgetting the names of all its parts. The 'D' option allows you to delete a figure name from memory, but keeps all the points and lines intact as part of a larger figure. If you are working with large figures that are combinations of several smaller figures, you may want to "house-clean" this way occasionally. When you are asked for a figure name, you may respond in either of the ways explained under the 'P' (manipulate part) command above.

Clearing Memory

If you wish to start over and delete all of the figures from memory, use the 'C' option. You will be asked to verify that you really want to delete everything, then returned to the options page.

Editing a Figure

The 'E' option lets you go in and change the actual coordinates of a point, change endpoints of lines, add points and lines, delete points and lines, and change colors. When you choose 'E', you will again be asked "WHICH FIGURE :", to which you can give the same types of responses as before. After you select a figure, the coordinates of the first 21 points of that figure will be displayed. At the top of the page you will see the available commands:

"L P D O SP <– –>"

The X coordinate of the first point will be shown in inverse. This is your cursor. At the lower left corner you'll see a '!' or '-'. This denotes the direction of movement for your cursor (up/down or left/right).

To move the cursor, use the arrow keys. To change the direction that the cursor moves, press the space bar; the sign in the lower left will change.

If you want to change a coordinate, type the number you want at the cursor position, followed by RETURN. That number will now be entered.

If you want to delete a point from the figure, position the cursor over any of the coordinates of that point and press 'D'. After you verify that you want that point deleted, all the subsequent points will be pushed up one and the lines will be adjusted.

To add a new point to a figure, move the cursor past the last point, and a new point with coordinates 0,0,0 will be added. Change the coordinates to whatever you wish.

The 'L' and 'P' commands let you switch between editing lines and points. The edit commands for lines are the same as those for points. Instead of coordinates, for lines you will be shown the color (0-7), the starting point number, and the ending point number.

'O' returns you to the options page.

Adding a Figure

Using 'A' from the options page allows you to add a figure by entering its coordinates and line endpoints. You will first have to give the figure a name, and from then it will be the same as using edit mode.

There is another way to add figures that is much easier and doesn't require use of coordinates: the panel utility described in the next chapter. With it you can draw the flat surfaces of an object, then use the 3-D module to assemble the pieces into a 3-D figure. Adding by coordinates is more precise, however, and will usually take fewer points and lines, so if you want to use this method there are advantages.

Returning to the Master Menu

As usual, the 'M' command from the options page will return you to the master menu. Anything that you haven't saved while using this module, except for the image currently on the hi-res screen, will be lost.

IV. The Panel Utility

The panel utility is a short module with the single purpose of allowing one to draw 2-dimensional surfaces that can be used with the 3-D module. The panel utility is run by selecting 'P' from the menu page. The three options given by this module are to create a panel (C), save a panel (S), and return to the menu (M).

A panel is a single 2-dimensional figure which is stored on disk with 3-dimensional coordinates. The Z coordinate, or the depth, is assigned a value of zero. To create a panel, press 'C', and you will be asked whether you want the screen cleared. With the first panel you create, the screen will be clear anyway, so it doesn't matter. With subsequent panels you may want to use earlier panels for reference, for matching sides and sizes so that when they are assembled the parts will fit.

The next question asked will allow you to set the scale of the screen. You will first be asked if you want to change the scale. If you answer 'Y', then two points will be displayed, and you'll be asked to assign a number to the distance between them. The actual screen distance between them is 20 points, and the default distance assigned is 5 units (making the distance from one point to the next ¼ unit). Unless you want to design a panel that is supposed to be much larger or much smaller than other figures you've designed, press RETURN to select the default. Otherwise, type the number you want, then press RETURN.

After you select the scale, the text at the bottom will list your panel drawing commands (see figure 6). Also listed will be the X and Y coordinates of the two cursors on the screen, the distance between them according to your scale, the current color, and the point number, if any, of each of the cursor locations. If a cursor is not on a previously used point, '-' will be displayed for the point number.

One of the two cursors will be flashing, and its point number will be shown in inverse at the bottom. This is the cursor that you can currently move. To move the other cursor press the space bar, which allows you to switch back and forth between the two. The I, J, K, and M keys allow you to move the cursor up, left, right, and down, respectively, in the same manner in which those keys are laid out on the keyboard. Any of those keys can be used with the REPT key to speed movement. To update the coordinates and distance, press 'D'.

When you have the cursors in position and you want to connect them with a line, press 'L'. A line will be drawn, and each endpoint will be assigned a number.

Lines will be entered and drawn with the color number that is displayed. To change colors, type 'C' and enter a number 1 through 7, excluding 4 (0 and 4 are black).

If you want to move a cursor back to a previous point, type 'P'. The flashing cursor will move to the first point. Press the space bar until it moves to the point you want, then press RETURN.

To view the full screen of graphics, press ESC.The next keystroke will return the text.

When done drawing a panel, press 'F', for finished. You will be returned to the options page, where you can give the panel a figure name and save it, then draw another panel or return to the master menu.

When assembling panels in the 3-D module, it is strongly recommended that you only use 90 degrees for rotations of your entire figure. Combinations of other angles of rotation are not as easy to reverse, and it is not difficult to lose your reference position. Using 90 degree rotations you can make sure your pieces are fitted properly, viewing it from any of six possible directions (front, back, top, bottom, left, and right), yet still easily return to any of those six views. Individual panels, of course, may be rotated however you want for positioning.

```
L P D C I J K M SP ESC F
POINT -                    POINT -
X:2.25   Y: – 3.75         X:2.27   Y: – 3.75
DISTANCE : 5               COLOR : 7
```

Figure 6 - Create Panel Command Page

V. Programmers' Notes

Creating Files for the 3-D Display Routine

For the more ambitious, it is possible to have your own programs generate files for the 3-D module. 3-D files are Apple text files with very specific information about the 3-D figures. To talk about this information, we have to define some variables. The following will be dimensioned as arrays of 512 elements (0-511):

X - the x coordinate of each point
Y - the y coordinate of each point
Z - the z coordinate of each point
P1% - starting point of each line
P2% - endpoint of each line
C% - color of each line (0-7)

This information requires the following dimension statement:

```
10 DIM X(511),Y(511),Z(511),P1%(511),P2%(511),C%(511)
```

We'll also use the variable NP for the number of the last point, and NL for the number of the last line. Note that if there are 8 points and 12 lines, NP = 7 and NL = 11 (the first point and line are numbered 0).

It will be up to your program and your ingenuity to assign values to the X, Y, and Z arrays. Each point 'I' will be a vertex of your figure, with coordinates X(I),Y(I),Z(I). You will also assign values to the P1%, P2%, and C% arrays. As an example, if line 'I' goes from point 0 to point 6, and its color is 5, P1%(I) = 0, P2%(I) = 6, and C%(I) = 5.

Once a program has assigned all the values necessary to create a figure, the only task is to save the information in the correct format. Use the following statements, substituting the name you want for 'name':

```
100 D$ = CHR$(4)
110 PRINT D$; "OPEN name.TD"
120 PRINT D$;"WRITE name.TD"
130 PRINT NP + 1:PRINT NL + 1:PRINT 1
140 FOR I = 0 TO NP
150 PRINT X(I): PRINT Y(I): PRINT Z(I)
160 NEXT
170 FOR I = 0 TO NL
180 PRINT P1%(I) + C%(I)*512: PRINT P2%(I)
190 NEXT
200PRINT D$; "CLOSE name.TD"
```

With the above information a good technical programmer should be able to use a program to create 3-dimensional models of, for instance, wiring and plumbing diagrams of buildings, any figures that can be generated mathematically, and any figures that involve repetitive patterns. These models, in turn, can be used fully with the 3-D module of the graphics system.

Appendix

Error Messages

Below are possible error messages you may receive and their probable causes. Press any key after an error occurs to continue.

DISK ERROR - probable causes: disk full or write protected (possibly trying to save a file on the system master), no disk in drive, drive error.

NOT ON DISK - probable causes: wrong disk in drive (system master when you want to load one of your own files, or a non-system disk when loading a module), mistyped or wrong name.

INVALID COLOR - number outside of range 0-7 was entered for a color.

Reference Guide to Options

From the master menu:

D) Drawing module
3) 3-D module
T) Text module
S) Shape table module
P) Draw a 2-dimensional panel for the 3-D module
K) Shrink a picture
C) Display color bars for monitor adjustment
I) Issue a disk command

3-D Module

A - Add figure
enter name, then you are put in edit mode

E - Edit a figure
Select name: type name, or press RETURN without typing a name. With the latter, existing names are displayed on by one, using the arrow keys (<- ->), until you press RETURN to select the displayed name.
L : Display and edit lines.
Color, Point1, and Point2 are shown.
P : Display and edit points. X,Y,Z coordinates are shown.
D : Delete the line or point at the cursor position.
O : Return to options.
SPACE: change direction of cursor movement. Symbol in lower left corner shows direction (!,-).
<-,-> : Arrow keys move cursor left/right, or down/up. Moving down past the last point or line adds a new point or line.
0-9,.,- : Enter number at cursor position and press RETURN to replace current value.

V - View figures in memory
R : Rotate
M : Move
S : Scale
D : Distort (Scale one dimension)
P : Operate on a single Part. You will be asked for a figure name. Same input technique for name as in edit mode.

A : Operate on All figures in memory.
E : Edit a point by moving it only. Flashing cursor lets you select point by sight. Press RETURN to select point, any other key to move to next point.
C : Choose Center. Point is selected as in 'E' command.
'P' and 'A' commands re-compute center. Center is used in rotation and scaling.
ESC : Full screen graphics. Any other key returns to mixed.
O : Return to options.
V : Scale view on screen, but coordinates of figures remain unchanged.
SPACE : Change direction. Following options depend on mode (Rotate, Scale, Move or Distort).
U/D - Up/Down
L/R - Left/Right

C/C - Clockwise/Counterclockwise
W - Width
H - Height
D - Depth
For the first four, either letter in option has the same effect.
0-9,.,- : Number followed by RETURN selects constant to be used in Rotate, Move, Scale, and Distort modes.
<-,-> : Arrow keys effect an operation (rotate, scale, etc.) as per the displayed parameters. -> is right, up, forward, or larger; <- is left, down, back, or smaller, as per displayed.

S - Save set of figures in memory
L - Load a figure, you may give it a new name, in the case that more than one of that figure will be loaded for use in the current figure.

I - Save 2-dimensional image as a picture that can be used by the other modules.

D - Delete a figure name from memory.
C - Clear all figures from memory.
M - Return to master menu.

Panel Module

S - Save panel on disk as a 3-D figure
C - Create panel
You may clear the screen, or leave it displaying any previous panels for reference. You may also change the scale by which the points, and distances, are interpreted.
L : Draw a line connecting the points at the cursor positions.
P : Move the flashing cursor to one of the previously used points.
Any key moves the cursor to the next point in sequence, RETURN Selects that point.
D : Display the coordinates of the cursor points, and the distance between them.
C : Color; select 1,2,3,5,6, or 7.
Lines will be drawn in the most recently selected color.
I : Move cursor up
J : Move cursor left
K : Move cursor right
M : Move cursor down
SPACE : Switch cursors, so the other point will move.
ESC : Full screen switch.
F : finished; return to options.
M : Return to menu

Color Bars

Displays and labels the primary Apple colors for TV or monitor adjustment.

Issue a Disk Command

Allows you to CATALOG and DELETE
programs without leaving the graphics system.

A 3-D graphics module that lets you draw objects on the screen, then assemble them into 3-D figures. Complete viewing and editing functions allow you to easily manipulate objects in 3-D space.

Requires disk, 48K, and Applesoft firmware or the language system. Specify DOS 3.2 or 3.3.

CO-OP software

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