APX ATARI® PROGRAM EXCHANGE

Clyde Spencer

STEREO 3-D GRAPHICS PACKAGE

Produce wire-frame stereograms (teens and up)

Diskette: 32K (APX-20087)

User-Written Software for ATARI Home Computers

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by

Clyde Spencer

Distributed By

The ATARI Program Exchange
P.O. Box 3705
Santa Clara, CA 95055

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INTRODUCTION

OVERVIEW

Computer programs that transform 3-dimensional coordinates into a 2-dimensional screen display have been around for several years. Some, written in assembly language and using integer arithmetic, even operate at blazing speed and allow real time animation and flight simulation.

This package of programs will, however, introduce you to the world of REAL 3D, albeit with moderately slow plotting speed. But, as with many things in life, compromises are necessary; in trade for speed you get much more precise calculations, with decimal fraction input and no upper or lower limit on the range of coordinates input. You also get the only example of its kind on the market - computer generated stereograms that allow you to learn to see a wire-frame stereomodel in true 3-dimensions.

STEREO3D also has some other features that distinguish it from similar products on the market. It employs a simplified approach to the conventional coordinate system. You build your object data base around the center of the "universe". That is, the center of the TV screen has the X,Y,Z (Cartesian) coordinates of (0,0,0). You then imagine that you are in a balloon or aircraft looking down toward the ground and are free to move instaneously, at will, anywhere you want in the "universe". You define that viewing position with the appropriate X,Y,Z-coordinates (e.g. 100,250.5,399) and the program automatically calculates the necessary parameters (YAW and PITCH) to place the center of the "universe" in the center of the screen for viewing. You are only required to pick an appropriate SEPARATION for the two stereoviews.

The usual stereogram drawing mode is the ATARI 800 high-resolution mode (320H x 160V). However, another interesting feature that this program offers is the ability to draw a red and green stereopair in the medium-resolution mode (160H x 80V); this allows people who do not have a stereoscope or the ability for direct-stereoviewing to use inexpensive anaglyphic viewing glasses to learn direct on-screen stereoviewing.

You may input FIELD OF VIEW values from 2 to 179 degrees, varying the viewing perspective from that of a "telephoto-lens" to "normal" to "wide-angle". Very small angles, corresponding to an extreme "telephoto" view are useful for orthographic-like projections (such as are used in Engineering Drawings) when used with the MONO3D.BAS program.

The MONO3D program is a modified version of STEREO3D and only provides for single views with each run. It has advantages of running slightly faster and allowing the input of slightly larger data bases. Also, when using larger scenes, if you do not wish to introduce the distortion inherent in "wide-angle" views, it allows you to alter YAW, PITCH and BANK parameters to look at selected portions of a scene.

It is also useful for becoming familiar with the Cartesian coordinate system. In both these implementations of 3D graphics, the positive Y-axis extends straight up on the screen; the +X-axis extends to the right and the +Z-axis extends out from the screen. Hence, with MONO3D, to initially view an object from a position of say, X=0, Y=0 and Z=500, you would enter viewing parameters of YAW=0, PITCH=0 and BANK=0. If you wished to view the object properly centered from a position of X=500, Y=0 and Z=0, you should enter viewing parameters of YAW=-90, PITCH=0 and BANK=0. Figure 1 below illustrates the coordinate system.

It is possible to view objects from anywhere: above, below, behind, from any distance and even inside. The program automatically clips and pushes line segments ouside the field of view in order to provide an image that does not exceed the screen cursor limits.

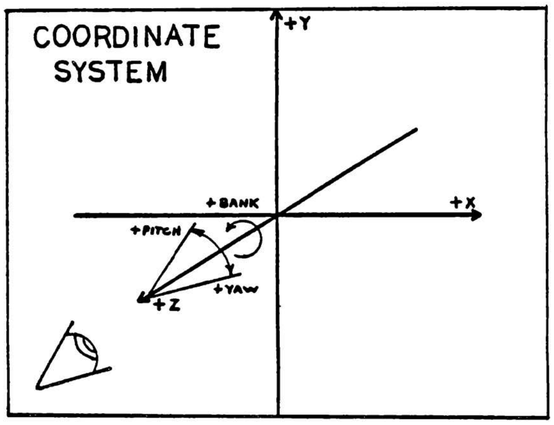

Figure 1 The Coordinate System

REQUIRED ACCESSORIES

32K RAM
ATARI BASIC Language Cartridge
ATARI 810 Disk Drive

OPTIONAL ACCESSORIES

Pocket (folding) Stereoscope
Anaglyphic Glasses (red & green lenses)
Polaroid (TM) Camera
ATARI Paddle Controllers

GETTING STARTED

LOADING STEREO 3-D GRAPHICS INTO COMPUTER MEMORY

1. Insert the ATARI BASIC Language Cartridge in the (Left Cartridge) slot of your computer.

2. Turn on your disk drive.

3. When the BUSY light goes out, open the disk drive door and insert the program diskette with the label in the lower right-hand corner nearest to you. Close the door.

4. Turn on your computer and TV set.

5. When the READY prompt displays on your TV screen, type RUN "D1:MONO3D.BAS" or RUN "D1:STEREO3D.BAS" (depending on which program you want to use) and press the [RETURN] key. The program will load into computer memory and start.

THE FIRST DISPLAY SCREENS

The first display screen contains the title and copyright notice. The display lasts for 10-30 seconds (depending on the amount of resident memory) while all arrays are initialized.

The program then prompts for appropriate user input, as shown in Figure 2, which uses the STEREO3D.BAS program and contains sample responses. These parameters are explained in the section titled "Using the Programs".

```
        SCREEN RESOLUTION?
            X  ,  Y
      1) 320 X 160 HI-RES
      2) 160 X 80 MED-RES
?1
      DISK OR KEYBOARD INPUT?
?DISK
      INPUT FILENAME?
?CUBE.DAT
```

Figure 2 First Set of Input Parameters

(The screen then clears and the program asks for more parameters.)

```
DESIRED FIELD OF VIEW (2-179 DEG)
?70
VIEWER'S LOCATION (X,Y,Z)
?0,0,275
SEPARATION
?25
CLEAR SCREEN (Y OR N)
?NO
```

Figure 2 Second Set of Input Parameters

The program then draws a figure according to your specifications.

CUSTOMIZING THE PROGRAMS TO COMPENSATE FOR INDIVIDUAL TV OVERSCAN

Using MONO3D.BAS, enter the data file CUBE.DAT and from coordinates (0,0,250) plot the image with input parameters for YAW, PITCH and BANK of (0,0,0). Now, carefully measure the width and height of the cube. Divide the value of the width by the height; you should get a value between about 2.0 and 1.4. Press [SYSTEM RESET] and type LIST 1410 [RETURN]. Change the value of the variable OVSN from 1 to the width/height ratio you just calculated (for example, 1410 LET OVSN=1.576). Insert a DOS II-formatted diskette in the drive and type SAVE "D1:MONO3D.CUS" [RETURN]. Now repeat the procedure for STEREO3D.BAS.

You might want to go directly to the section titled "STEREO3D.BAS", for help with entering your viewing parameters.

USING THE PROGRAMS

A BRIEF DISCUSSION ABOUT STEREOVISION

Before further discussing using these programs, a few words about stereovision in general might be helpful.

Virtually all creatures, great and small, have one feature in common - two eyes! Each eye must, by necessity, see the surroundings from two different vantage points. Fortunately, we do not perceive a blurred image because our mind takes this position-shifted information from each eye and integrates it into a single image which we perceive as having depth or a third dimension. That is our reality - the world as seen from two distinctly different positions about 50 to 70 mm (2.4") apart. The consequences of this relatively close eye spacing is that we are able to perceive depth directly (without other cues) from our minimum focusing distance (lets say about 1/4 meter) up to tens of meters for moderate size objects or hundreds of meters for very large objects (mountains!). Beyond that, everything blends into the background. From the moon, the Earth looks like a large flat disk.

To regain the ability to perceive depth directly, at great distances, it would be necessary to increase the separation between our eyes. That is a physical impossibility for us since we are not built like some mythical Martian creature with our eyeballs on the end of extended moveable stalks (take a look at a snail sometime; not a bad design except for the vulnerability!). That's not to say that it can't be done, however. In fact, it has been done for decades, essentially since the camera was invented! It is routinely done today in the creation of aerial stereophotographs. These stereo-pairs, which are photographed from many tens of meters apart, are subsequently viewed with a separation of only tens of millimeters. Not surprisingly, these viewing conditions do not create the same image we are used to experiencing with our narrowly spaced eyes when in an aircraft. We would say the stereomodel exhibits "vertical exaggeration." That's just another way of saying that it doesn't look normal! Only very rarely will stereophotos or stereograms (drawings) look "normal." The "normal" view is usually lacking depth or at least sufficient depth to be informative. Hence our decision to make a stereophoto or, in our case, a computer generated stereogram.

Several things govern the amount of perceived depth exaggeration. The most important one is the ratio between viewing distance and separation of viewpoints; for a given distance, the greater the separation, the greater the exaggeration. Also, except for simple objects that occupy a small portion of the available view, you will find that increasing the separation decreases the area of overlap as seen by the two viewpoints. Only in the area of overlap is stereovision possible.

While most of us have natural stereovision, the ability to view a stereogram and see a three-dimensional model is something that must be learned; that is why this package is listed in the catalog under education. Like anything that is learned, some people will pick it up almost immediately. Others will have to work at it. But everyone will get better with practice. By better, I mean increasing the speed with which you can "fuse" the two images (it doesn't happen instantaneously!) and the ability to "fuse" images that have a separation equal to your interpupillary distance. Finally, after lots of practice you will probably get good enough to be able to "fuse" the images without the aid of a stereoscope or anaglyphic glasses. At that stage of development you will be able to directly see a three-dimensional model that appears to be floating inside your TV. For an introduction to stereoviewing and an extended treatment of the theory of stereovision see chapters 2 & 4 in Avery (1977) or chapter 2 in Miller (1961). For complete references on the cited articles or books, please refer to the bibliography at the end of the documentation.

IMPORTANT INFORMATION. Some people seem to be unable to learn to see stereomodels. Most commonly, these people wear corrective eye-glasses. That's not to be interpreted that if you wear glasses you won't be able to see "stereo". Most people can! But people who have a "lazy eye" or a significant difference in the acuity of their eyes often cannot see "stereo", or only with great difficulty.

The "trick" to stereoviewing is to learn to look straight ahead with very little eye convergence, as though you were looking at a distant object. At the same time you must train your eyes' lenses to focus at the actual distance. When doing it properly, you should be aware of three separate images. Ignore the ones on both sides and concentrate on the central composite image; that is the stereomodel! The anaglyphic glasses help with this by suppressing the side images. Unfortunately, they do not entirely eliminate them. So, if the actual images overlap, you may find the scene too confusing to view in 3D. The preferred method is to photograph the scene and use a stereoscope.

This package of programs also can be a powerful tool in investigating the various relationships between viewing angle, distance, separation, image spacing and exaggeration. Also, see the articles by Johnson and Richter (1979) and Cubit and Celenk (1976) to see how stereograms can be used to convey information other than terrain models.

HOW STEREO3D AND MONO3D OPERATE

Since these two 3-D graphics programs are modifications and extensions of current state-of-the-art 3-D to 2-D transformation software, only a brief description of their logical operation is given here. For a more detailed and theorectical treatment of their functioning, see "Mathematical Elements for Computer Graphics" by Rogers and Adams (1976) or "Principles of Interactive Computer Graphics" by Newman and Sproull (1979). The bibliogaphy at the end of this document has a more extensive treatment of these and other references for additional information.

The program operates as follows.

(1) The graphics mode is set.

(2) The data base is input either from diskette or the keyboard.

(3) Viewing parameters are input.

(4) Data points of the scene are translated and/or rotated as appropriate.

(5) The 3-D coordinates are converted to 2-D screen-coordinates for the corresponding perspective view.

(6) Lines outside the cone-of-view are "clipped" and "pushed" to keep the image on the screen.

(7) Steps 4, 5, and 6 are repeated for the second stereo-view.

The most time consuming operation in the above procedure is the "clipping" and "pushing" operation, which is essential for proper viewing of the scene.

STEREO3D.BAS

Assuming that you have already prepared a data base (or more likely are initially using one of the example data bases provided with the package) the first thing you have to do is provide the program with the required input information.

After typing RUN "D1:STEREO3D.CUS" [RETURN] the program will prompt you to input the desired screen resolution. The high-resolution (1) will give you the greatest detail and hence most realistic view. It however, requires that you either have the ability to fuse the images directly on the screen, or to photograph the images and use a stereoscope for viewing. The medium-resolution (2) is a trade-off of detail for the ability to plot two colors. This mode will plot a red and a green (complementary colors) image and allow you to use glasses with red and green lenses to directly view the stereo images on the TV screen; this is known as the anaglyphic method of stereoviewing. Proper viewing requires that the red lens be placed in front of the left eye and the green or blue lens be in front of the right eye.

Next, the program will prompt for the type of input device, KEYBOARD or floppy DISK. If you respond with DISK then the program will ask you for the name of the data file. If you respond with KEYBOARD, the program will immediately request the X,Y, & Z-coordinates of each consecutive data point to draw until you type in -999,-999,-999. That will terminate your keyboard input. It is recommended that you use the KEYBOARD input only for simple objects with few data points. Also, small simple objects work best for direct viewing on the screen.

Next, the program will request the desired viewing parameters, starting with the DESIRED FIELD OF VIEW. The FIELD OF VIEW can vary from about 1.2 degrees to about 179.9 degrees. A very narrow field (2 degrees) is equivalent to an extreme "telephoto" camera lens in perspective and area covered. A wide field (i.e. 179 degrees) is similar to an extreme wide-angle or "fish-eye" lens. The image has extreme convergence and generally is quite unnatural looking. You will probably find that viewing angles of 50 to 70 degrees give the most natural appearance.

The program will next ask for VIEWERS LOCATION or the X,Y,Z coordinates of your viewing position. This input will largely be dependent on your desire as to where to view the object or scene from. Until you become familiar with the operations and coordinate system, I would suggest that for a scene that is 100 units wide (such as CUBE.DAT) at least one of your three coordinates should be 300 or greater. Increasing the Y-coordinate value will have the effect of causing you to look down on the object; increasing the X-coordinate value will cause you to view the object from the right side; increasing the Z-coordinate as well as either of the other two will have the result of viewing the object from a greater distance.

Next, the program will ask for the SEPARATION; it is the distance between viewing positions. Separation, as used here, is equivalent to what photo-interpreters call "photo-base" or the distance between principal (center) points on the photographs. As a rule of thumb, enter a value about 1/10 the viewing distance. The best value will be dependent on a number of factors, principally the viewing angle. Experiment to see what looks most natural for you.

The program will next draw the left-hand view and ask if you wish to CLEAR SCREEN. If you are photographing the screen, take your photos ("bracket" your exposures!) and then type YES [RETURN]. If you wish to view the scene directly on the screen, type NO [RETURN]. Finally, the right-hand view will be drawn.

The program will now again prompt for the FIELD OF VIEW. If you wish to continue, then repeat the steps given above. If not then press the [SYSTEM RESET] key, or enter 0 (zero).

MONO3D.BAS

The operation of MONO3D.BAS is very similar to STEREO3D.BAS. However, it draws only a single view with each run. Moreover, it allows you to enter additional viewing parameters of YAW, PITCH, and BANK.

YAW measures the angular deviation, left or right, from the initial straight-ahead (0 degree) viewing line. To view to your right side, enter +90 (or some intermediate value, as appropriate).

PITCH measures the angular deviation, above or below, from the initial viewing line. To view directly overhead enter +90.

BANK is a measure of the angular rotation around the line of sight, and like the other viewing parameters, is measured in degrees. To view the object as seen from a rotation of 1/8 of full clockwise rotation, enter -45.

These are the standard terms used by pilots to describe the motion of an aircraft about a set of three mutually perpendicular axes passing through the body of an aircraft. The roll or bank axis runs the length of the fuselage. The pitch axis is parallel to the wings, and the yaw axis is perpendicular to the other two and is parallel to the spine of the sitting pilot. What is unconventional is that the initial position is defined as a "nose down" attitude pointing at the ground with your pitch axis (or wings) parallel to the X-axis. Don't worry, since your speed is zero you won't crash into the ground unless you want to!

Since this program does not automatically draw stereoviews, there is no request for a SEPARATION input. The major use of this program is to allow you to view a portion of a large scene from arbitrary perspectives; it is not necessary always to look directly at the center of a scene. However, it can also be used to generate stereograms, providing the correct YAW and PITCH values are entered manually.

GFILEGEN.BAS

GFILEGEN is a graphics-file generating program to assist you in building up data files. It is specifically designed to build subfiles that consist of points with the same Z-value and with consecutively plotted points. This is particularly useful for building a data file of isopleth models, such as a topographic map. The subfiles generated with this program are then later appended or merged together with FMERGE. All subfiles are terminated with X,Y,Z-coordinates of -999,-999,-999, which serves as a flag to tell STEREO3D or MONO3D not to connect the points immediately preceeding and following the flags.

GFILEGEN has TV overscan correction built in. For calculating the overscan correction coefficient, follow the previously given instructions and then divide the height by the width. Enter the new value for OVSN on line 320. The value should be greater than 1, but smaller than the value previously calculated for STEREO3D. Save the modified program as GFILEGEN.CUS.

Before you attempt to run this program, carefully draw out the object, select the consecutive points to be drawn to, and compile a table of X,Y,Z coordinates for input.

With the system up and running (DOS booted) type RUN "D1:GFILEGEN.CUS" [RETURN]. The first thing the program asks for is the screen resolution. Again you have a choice of high or medium resolution. After indicating the desired resolution by entering a 1 or a 2, the program prompts for whether you wish to use DISK or KEYBOARD input, as before. Use DISK input to modify an existing data file. Use KEYBOARD to create a new data file. The screen will display "POINT 1 (X,Y,Z)?". Respond with the desired coordinates (e.g. 1,2,3). When you have entered all your desired data points, enter -999,-999,-999 [RETURN].

The program next asks for the COORDINATES OF NEW ORIGIN. This allows you to move your object up, down, left or right. For example, if you wanted to move the object up and to the right, enter some small positive value for both the X and Y coordinates. Remember, though, that the screen coordinates have values between +160 and -160 along the X-axis and +80 and -80 along the Y-axis in the high resolution mode and half that in medium resolution. So be careful not to shift your object off the screen if you want to view it!

Next the program asks for ROTATION. This is used if you want to rotate the object within the range of +90 and -90 degrees. This not only rotates the view but the object in the data base saved.

Next you are asked for the SCALE-FACTOR. Use 1 as an input if you wish no change to your original data. Use a value between 0 and 1 to reduce it in size and a value greater than 1 to enlarge it. Bear in mind, however, that if you enlarge it too much, it may plot off the screen. This program does not incorporate clipping and pushing. Points beyond the screen boundary are set equal to the screen boundaries. Therefore, very large objects will simply plot as rectangles coincident with the screen boundaries. After the object has been plotted, the program will prompt you with OUTPUT SATISFACTORY (YES or NO)? If it is not satisfactory you may change individual data points and go back and repeat the previous steps. If the output is satisfactory, respond with YES [RETURN] and when prompted, enter the name of the file to be created. The program will then automatically end.

DIGITIZE.BAS

DIGITIZE is a program to allow you to digitize film-strips or objects drawn on clear acetate overlays such as are used with class room overhead projectors. Digitizing is a process whereby some continuous (analog) line is converted to a series of discrete (digital) points, with X,Y & Z-values, that represent the original line.

This program of course also has TV overscan correction. Use the value calculated for use in GFILEGEN.CUS. The OVSN variable is on line 40.

To use this program, place the drawing to be digitized on the TV screen. Usually electrostatic attraction will be sufficient to keep it firmly attached. However, if not, then use some small pieces of tape at the corners. Plug in a pair of game paddles in controller jack 1.

With the system up and running (DOS booted), type RUN "D1:DIGITIZE.CUS" [RETURN]. After presenting the title screen, the program will ask for the desired SCREEN RESOLUTION. Use the medium-resolution mode; the cursor is brighter and steadier. In the high-resolution mode, the cursor has a tendency to wander. The problem of wandering can be so bad with a TV with poor voltage regulation and/or poor power supply filtering as to make it impossible to practicably use the high-resolution mode.

The program will next ask for the OUTPUT FILENAME. This is the name of the data file you wish to create and does not include the device specification.

Use the cursor to trace the outline of the object to be digitized. Move it with the paddle controllers; paddle 0 controls the Y-direction and paddle 1 the X-direction movement. When the trigger on paddle 0 is pushed it will erase the path that the cursor has traced on the screen. The Paddle 1 trigger is used to digitize the current cursor position. The X and Y coordinates of the cursor are always shown on the bottom left of the screen. To write a point on the current file, press the trigger button and enter the desired Z-value on the keyboard and then press the [RETURN] key. If you change your mind and decide not to digitize that position, simply make no entry but press the [RETURN] key anyway; the program will continue as though you had not pressed the trigger.

When you are done entering the points that you wish to have plotted contiguously, move the cursor to the extreme upper left-hand corner and the file will be closed and the program terminated.

ZCHANGE.BAS

ZCHANGE is a program to change all the Z-values in a data file to the same new value. This would most commonly be used with isopleth subfiles created with DIGITIZE or GFILEGEN when it is desirable to change the vertical spacing between lines of equal values. Note! ALL Z-values get changed to the same value so be careful how you use it. Always give the OUTPUT-FILENAME a different name from the INPUT-FILENAME.

FMERGE.BAS

FMERGE is a program to allow you to conveniently append or merge together previously created data files. This can be used to create complex scenes of many objects or to create isopleth models, such as TOPOMAP.DAT.

The program will first ask for the MERGED-DATA FILENAME. This is the new file that will be created. Next it will prompt for the INPUT-DATA FILENAME. This is the first of the existing files to be merged. The program will next ask ARE THERE ADDITIONAL FILES? When you respond NO [RETURN] to this query, the program will close all files and terminate.

DATA FILES

The program diskette comes with several example data files for you to use and experiment with. These include both simple geometric solids and an example of an isopleth model, a topographic terrain model.

To see how the data files are constructed, you may wish to list them and examine them in detail. To do so, go into the Disk Operating System (DOS) menu by typing DOS [RETURN]. Then select option C (Copy File). Use the desired file specification for the "copy from" parameter and E: or P: for the "copy to" parameter. (E: sends the file listing to the screen and P: sends it to your printer.) A brief description of each of the sample data files follows.

CUBE.DAT
A simple cube 100 units on each side with its center at 0,0,0.

OCTAHEDN.DAT
An octahedron (two four-sided pyramids, base to base) with the center at 0,0,0.

ISOCOMB.DAT
A combination of the two preceeding isometric forms.

TETRAHED.DAT
A tetrahedron (a 3-sided pyramid with each of the three faces and the base being equilateral triangles) with the center at 0,0,0

TETRAGNP.DAT
A tetragonal prism (a six-sided parallelapiped with square ends and rectangular sides) with the center at 0,0,0 and the elongation parallel to the Z-axis

ORTHORHP.DAT
An orthorhombic prism (a six-sided parallelapiped with all faces being rectangles) with the center at 0,0,0 and the major elongation along the Z-axis.

MONOCLIP.DAT
A monoclinic prism (a six-sided form with 4 rectangular faces and 2 parallelograms) with the center at 0,0,0

HEXAGONP.DAT

A hexagonal prism (a form with 6 rectangular faces and 2 hexagonal faces) with the center at 0,0,0 and the six-sided faces parallel to the XY plane.

USAMAP.DAT

An outline map of the United States drawn at sea-level (Z=0).

TOPOMAP.DAT

A topographic terrain model (see Figure 3) of a hypothetical coast line that has been created by U.S. Geological Survey cartographers.

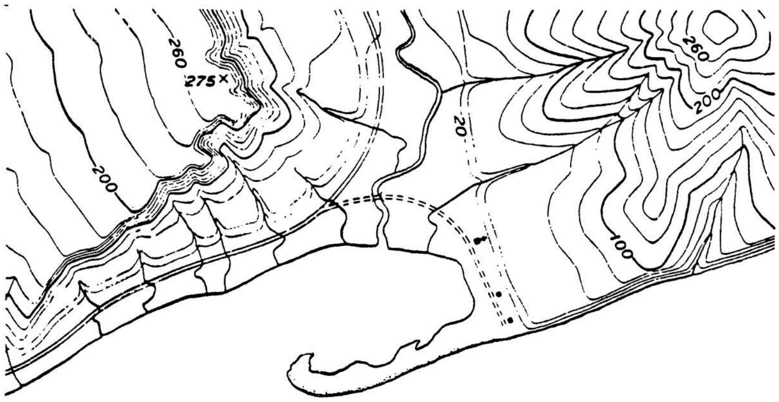

FIGURE 3

ADVANCED TECHNICAL INFORMATION

The high-resolution plotting mode is designed to give a very light green line on a light green background. However, because of a feature called "artifacting" that is always observed to a greater or lesser degree with televisions, you may experience lines of different colors on the screen. If you find this distracting, simply adjust the color intensity control on your TV until the color difference between lines is no longer objectionable. Ideally the tint control should be adjusted so that the high-res mode has a green background while the normal BASIC mode 0 has a blue background.

If, after you have used the programs for a while and become familiar with them, you would be willing to give up being able to watch the plotting being done in exchange for speed, enter the following two lines of code in the program:

```
705 POKE 559,34

815 TRAP 705:POKE 559,0
```

Change the "GOTO" in line 900 from 710 to 705. These changes will turn-off the ANTIC chip during plotting and clipping, freeing the 6502 CPU from display list interrupts, and will increase plotting speed by 30-40 percent.

A variable labeled SPNG in line 1410 of STEREO3D currently has an assigned value of 0.25. By increasing or decreasing this value, the spacing between plotted objects will be increased or decreased. The function of this variable is to allow you to customize the program so that the offset between centers of the objects plotted will be equal to or less than the distance between your eyes (interpupillary distance). You should adjust this value to give you the most comfortable viewing positions with the least eye strain. Exceeding your interpupillary distance will cause you severe eye strain and you will probably not be able to fuse the images in direct viewing.

A hint for photography - do not use a shutter speed faster than 1/60th of a second or you will not get a full screen; in fact unless syncronization is perfect even a 60th may not give satisfactory results. A 30th or slower is desirable. However, you will probably find it impossible to hand-hold the camera sufficiently steady below 1/15th second. Also, many televisions leave something to be desired in the way of adequate power supply filtering and voltage regulation. Consequently, a single point (or the points making up a line) will follow a sinusoidal path on the screen. This is seldom noticed by the eye, but long camera exposures will blur the line. So your best bet it to select film speed and aperture to give you proper exposure at 1/30th to 1/8th of a second. Most Polaroid (TM) cameras do not offer this flexibility, but there are a couple of models out of production that you may be able to purchase used. Most 35mm single-lens reflex cameras should be adequate, however.

Although a very large amount of time and effort has been expended in assuring that the programs will perform properly, the total number of combinations of input parameters is so large that it is impossible for any one individual to check all possible combinations. Therefore it is remotely possible that certain combinations of input may cause the program to "crash" or otherwise malfunction. If that should happen, please record the input parameters used, and write to the ATARI APX program, detailing as carefully as possible the conditions leading up to the "crash". If the system gives an error message and line number, give that information also.

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INSTRUCTIONS FOR MAKING

ANAGLYPH GLASSES

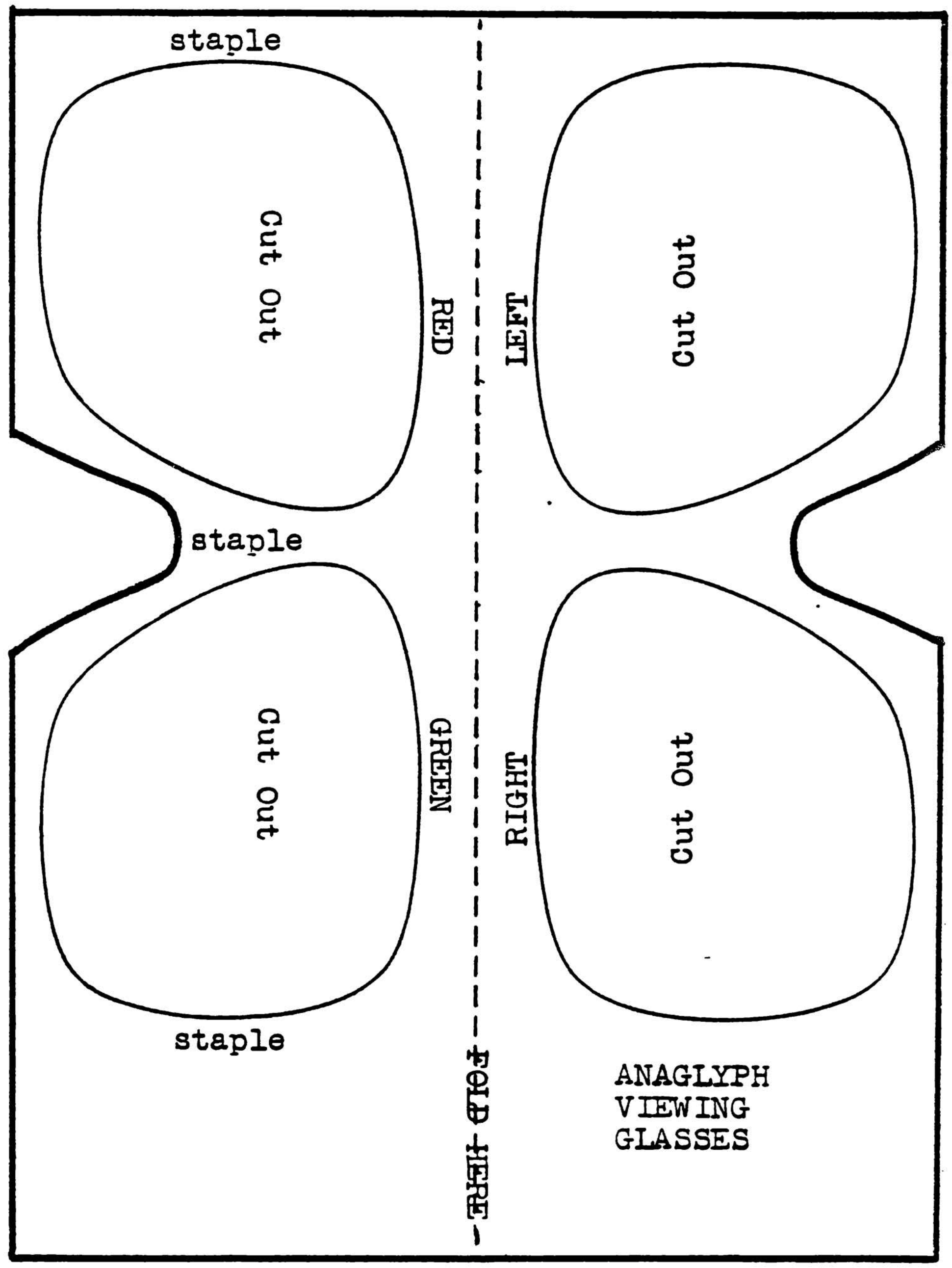
1. USING A SHARP KNIFE OR SINGLE-EDGE RAZOR BLADE, CAREFULLY CUT OUT THE PATTERN PROVIDED.

2. USING A PAIR OF SCISSORS, CUT 2 EACH RED AND GREEN PLASTIC FILTERS APPROXIMATELY 2 1/4 BY 2 1/2 INCHES. WHILE CUTTING THE MATERIAL, SANDWICH IT BETWEEN TWO CLEAN PIECES OF PAPER TO AVOID GETTING FINGERPRINTS ON IT.

3. FOLD THE PATTERN FOR THE GLASSES ALONG THE INDICATED FOLD LINE.

4. BEING PARTICULARLY CAREFUL NOT TO GET FINGERPRINTS ON THE INSIDE SURFACES OF THE FILTERS, PLACE THE 2 RED AND 2 GREEN FILTERS INSIDE THE FOLDED PATTERN. STAPLE THE PATTERN CLOSED IN SUCH A WAY AS TO PREVENT THE FILTERS FROM FALLING OUT OR MOVING AROUND.

5. YOU MAY FIND THAT YOU WILL MAKE A SLIGHTLY MORE DURABLE AND PROFESSIONAL LOOKING RESULT IF YOU USE SOME RUBBER CEMENT AS WELL AS STAPLES. BE PARTICULARLY CAREFUL NOT TO GET ANY CEMENT ON THE VIEWING PORTIONS OF THE FILTERS, HOWEVER.


staple
Cut Out
RED
LEFT
Cut Out
staple
Cut Out
GREEN
RIGHT
Cut Out
staple
FOLD HERE
ANAGLYPH
VIEWING
GLASSES

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1. Name and APX number of program.

___

___

2. If you have problems using the program, please describe them here.

___

___

___

3. What do you especially like about this program?

___

___

___

4. What do you think the program's weaknesses are?

___

___

___

łow can the catalog description be more accurate or comprehensive?

___

___

6. On a scale of 1 to 10, 1 being "poor" and 10 being "excellent", please rate the following aspects of this program:

_______ Easy to use
_______ User-oriented (e.g., menus, prompts, clear language)
_______ Enjoyable
_______ Self-instructive
_______ Useful (non-game programs)
_______ Imaginative graphics and sound

7. Describe any technical errors you found in the user instructions (please give page numbers).

8. What did you especially like about the user instructions?

9. What revisions or additions would improve these instructions?

10. On a scale of 1 to 10, 1 representing "poor" and 10 representing "excellent", how would you rate the user instructions and why?

11. Other comments about the program or user instructions:

From

STAMP

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[seal here]