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Computer Aided Drafting

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COMPUTER - AIDED DRAFTING

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This Independent Study submitted by Lou, Shi- Jer in partial fulfillment of the requirements for the degree of Master of Education in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.

(Chairperson)

(Advisor)

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CHAPTER I

INTRODUCTION

It is our nature as human beings to build tools that extend the capabilities of our bodies and minds. We strive to design these tools to meet our needs and mold them to match our skills. Computer technology has enabled us to create tools that are more sophisticated, more powerful, and more useful than ever before. In itself the computer is simply a machine, in creative hands it becomes a companion, assistant, and communication medium. And as technology pushes beyond today's limits, computer graphics is often playing a leading role.

Computers communicate with the "real world" through various devices designed for the input and output of data. Many sophisticated techniques are employed which foster greater sensitivity of the machine to its environment and synergism with human users. Computer graphics extends our eyes with new image-making capabilities, our hands with interactive design tools, and our minds through non-verbal communication.

No technological advance in the past three decades has impacted so profoundly on the occupation of drafting as the advent of computer-aided drafting / design (CAD). Computer-aided drafting can be done in all drafting fields,

from the architectural to mechanical drafting. Therefore, the coming age of computer-aided drafting represents a serious challenge in the area of occupational skills required for updating Technology Education instructors.

One of the major goals of Technology Education is to expand students knowledge and understanding of industry and the technology it uses. Thus, the use of computer-aided drafting in Technology Education classes should rapidly expand. If we provide the opportunity for Technology Education instructors to learn the CAD. Then they will realize that CAD can be integrated into many Technology Education classes as an aid to teaching and learning. In some cases, it will be used to reinforce conventional educational methods, and it will be a completely new tool in teaching and experience in learning.

Statement of the Problem

The problem of this independent study is to develop course materials on the fundamentals of computer-aided drafting that may be used to assist secondary school Technology Education instructors in updating their computer-aided drafting knowledge.

Objectives

1. Review literature and computer- aided drafting system applicable for teaching CAD concept in Technology Education.
2. Identified and structured content into fifteen units.
3. Developed and tested labortary experiments for the fifteen content units.
4. Develop a model computer program that will aid the technology teacher with computer- aided drafting.

Purpose of the Study

The purpose is to develop a teacher manual that will include:

1. General computer information.
2. Computer- aided drafting systems.
3. The basic mathematical and programming techniques of computer- aided drafting.

The need for this has become evident because many secondary Technology Education instructors have a difficult time grasping new concepts used in the modern day computer-aided drafting system.

The study was designed to assist teachers by providing material, resources, and alternatives, and guidance necessary to CAD courses directed towards the future.

Limitation of the Study

This study is limited to:

1. The available computer- aided drafting equipment in the Industrial Technology Department at the University of North Dakota.
2. The course material was designed on the basis of an Apple-IIe microcomputer for introducing the mathematical and programming techniques of computer- aided drafting.

It was assumed that the Technology Education instructors possess an understanding of BASIC language, microcomputer and mathematical concepts that are involved in the course materials.

Definition of Terms

The following terms are defined for use in this independent study:

Microcomputer. A CPU within a single integrated circuit, coupled to some memory and input / output interfaces.

Program. A series of computer instructions that cause a specific task or group of tasks to be performed.

Hardware. The acutual computer itself and peripheral devices or machines.

Software. All non-mechanical computer-aided drafting components.

CRT. Cathode ray tube. Visual display device on which drawings may be called up from memory and displayed on the screen. Drafters interact with the CRT through its keyboard or with a digitizer.

CPU. Central Processing Unit. The part of a computer where instructions are decoded and executed.

Plotter. A hardware device resembling a drafting table that actually plots the drawings based on commands from the computer.

Digitizer. A hardware device that allows drafters to electronically trace sketches or drawings and commit them on the computer's memory.

Printer. A device that prints computer output on paper.

Graphics Processor. A central processing unit used for computer-aided drafting system.

Hard Copy Unit. A special device designed to make copies of drawings and printed matter.

Turnkey System. Computer hardware and instructions integrated to complete a specific task or application, sold to the user as an integrated system.

CHAPTER II

Review of Literature

What is " Computer graphics ?" The term is widely used, yet it has a variety of meanings. The computer's ability to draw or to display information certainly falls within the domain of computer graphics. " Computer graphics is the use of computers to produce pictorial representations of information " (Scott 1984 P.10). " The computer is a kind of drafting tool or time saving device to help drafters perform their jobs more rapidly and effectively" (Goetsch 1981 P.2)." Computer graphics allows communication through pictures, charts, and diagrams " (Harrington 1983 P.1). Thus, computer graphics might best be defined as the communication of graphic data to or from the computer.

For an effective dialogue to occur between the human and the computer, the communication media must be fast, comprehensive, and comfortable to use. Computer graphics provides this communication language. It is much easier to understand a picture than a verbal or numerical description of the same information. We live in a visual world. We take in most of our information through our eyes. The

amount of information obtained visually far surpasses the amounts obtained by our other senses. For Donald Greenberg stated: " A picture is worth 1024 words " (Greenberg 1982 P.1).

The use of computers to draw pictures is not new. ENIAC, the first digital computer, began operating in 1946. Early applications in computer- aided design (CAD) were primarily computational, with no graphic output. Solutions to differential equations were being displayed at MIT's Lincoln Laboratory on a cathode ray oscilloscope in the early fifties. The impetus for interactive computer graphics can be traced to Ivan Sutherland's SKETCHPAD system, developed at MIT in 1962 (Greenberg 1982). By the mid-sixties there were several CAD systems in use at large companies such as General Motors and Boeing, but there were no standard graphics programs. Each system was a specialized design and required a large " mainframe " computer to support it.

These early systems were used for sophisticated design and analysis as well as for generating graphic imagines and drawings. Several industries, began to develop and use interactive computer graphics as part of their computer-aided design systems. Significant advances in computer technology made minicomputer-based CAD systems possible. Vendors began offering " Turnkey " systems.

The systems allowed companies without large data processing departments to install a system and be assured of support.

Turnkey systems gave CAD a new meaning- computer-aided drafting. The minicomputer CAD systems could not perform the sophisticated design and analysis of a mainframe system, but they could speed up the design and drafting process and increase the productivity of drafting departments.

Soon companies using computer-aided drafting systems began to realize the wealth of information contained in a set of architectural plans or an engineering drawing. It didn't take long before computer- aided design and drafting became the new phase with sophisticated graphics and analysis capabilities. (Scott 1984).

Since the 1970s, the microprocessor chip has increased incredibly in power. The newest sixteen and thirty-two bit microprocessors are equal in computational speed to the large minicomputers of a few years ago. This has made possible microcomputers with graphics capabilities that can run full- featured CAD software. Micro-based CAD is a relatively low-cost, high performace, mostly two-axis design and drafting technology that utilizes a personal computer with medium-to high resolution graphics for its CPU. The present-day use and future potential of micro-computer- based CAD technology is phenomenal. Close to

25,000 systems have been installed in just the last two and one-half years (Wohlers 1985).

The future also promises " intelligent " machines, or artificial intelligence (AI), rising from the study of knowledge and decision engineering. Recent Japanese and Western commitments toward the " 5th generation " of computing (the first four were tubes, transistors, LSI, and VLSI) will commercially apply AI techniques, producing intelligent machines that interact with people naturally. These machines will be easy to use, responding to our questions and instructions with informative graphics and in our own language. Computer graphics presentations will be automatically generated, showing the information we want, in the context we request.

Intelligent non-verbal communications between man and machine will utilize the computer graphics techniques developed today. Expert advice and problem-solving methods will be encoded and packaged into " knowledge-bases ", a future commodity that will be very big business. And computer graphics will be a primary vehicle through which information and knowledge are transferred (Scott 1984).

Computer- Aided Drafting in Industry

Applications for computer aided drafting (CAD) are growing constantly in industry. Computer displays provide a means for automating engineering drawings, architectural plans, or manufacturing processes. Drafting plans using CAD methods can produce an outline or rendering of a machine part from viewing angle by specifying the dimensions of the part to the computer graphics system. Using similar graphics methods, the manufacturing layouts for a part are drawn and displayed. These layouts can be used to show the path to be taken by machine tools over the part surfaces during the manufacturing of the part. Numerically controlled machine tools are then set up to produce parts according to the layout patterns.

Automobile, aircraft, and aeroapace design engineers use CAD techniques to help in designing surface contours. Wire frame drawings can be displayed on a video screen to test the appearance of body shapes for automobiles, airplanes, or spacecraft. These drawings can be created to display the entire surface outline or individual sections. More detail can be added to the computer- generated displays at each stage of the design process. A final, realistic rendering of the object allows the designer to see what the finished product will look like (Hearn 1983).

Electrical and electronic circuits are designed with CAD methods. Starting with pictorial symbols that represent the different components, an electronics designer can build up a circuit on the screen by adding components one at a time. With a video display of a building layout, an electrical designer can experiment with different arrangements for electrical outlets or fire warning systems.

CAD in architecture is more than presentation graphics. While the design of a building wins contracts and awards, The practical elements of architecture make a building serve its purpose. The computer provides new graphic and analytical tools for facility planning, environmental analysis, heat load calculations, and construction cost estimating. Architects can use the same three-dimensional shaded surface programs that show the exterior of buildings to create realistic images of office interiors, down to papers on the desk and plants in the corner. They can mix and match colors and light sources, and select from standard furniture and fixtures. Open design concepts give facility planners tremendous flexibility. With CAD, planners no longer have to move cardboard cutouts around blueprints; CAD allows them to rearrange entire floors graphically. They can give check points of various arrangements to their clients or, with a three-dimensional system present a simulated walk through

the building (Scott 1984).

Computer graphics in design and production is bringing about basic changes in how drawings are prepared in industry. The manual skills of drawing and lettering are being replaced by workstation operation and keyboard typing. As CAD systems became more powerful, engineers and architects will work directly with them. These changes will mean job displacement: A job dealing with the production and handling of engineering and architectural drawings will be replaced by information processing jobs.

CAD is certainly becoming more popular in industry. No recent breakthrough or scientific discovery has made this possible. It is simply that CAD expanded the tools we have available and provided mankind with the creative freedom we have never known before.

Computer- Aided Drafting in Education

The noticeable efforts of computer-aided drafting (CAD) will be in education. Educational applications like simulation, games always utilize computer graphics. Pictures and graphs are used to explain the operation of various systems.

Simulations enable a teacher to present artificial versions of real-life situations that are too costly, time-

consuming, dangerous, or complicated to recreate in a classroom. In this sort of instruction the computer is able to simulate the conditions of an experiment or situation. The student can set conditions and make decisions, and the computer will show or demostrate their implications. One well-known computer simulation, the flight simulator, has been used for years in training pilots to fly commercial and military aircraft. Flight simulators work quite well and provide valuable training before actual flights, without risking aircraft or life.

There is considerable flexibility regarding how computers can be used in simulations. They can control mechanical movement, or graphics displays, or text shown on CRT screens. To help convey an idea of the range of possibilities for computer simulations, some applications listed as illustrating chemistry, biology, physics experiements, designing manufacturing processes etc, are all instructional simulations (Bramble 1985).

There is one area of CAD with which everyone is familiar video games. Their fascination lies in a mixture of bright changing colors, simple electronic sounds, and an instant response to buttoms, joysticks, and trackballs. While these games may be entertaining, their educational value is doubtful. However, a number of attempts have been made to harness the motivational powers

of games for educational purposes by presenting instructional problems in game format. The student performs a task of educational value in order to do well in the game. According to Bramble, (1985), there are several benefits of computerized educational games which would apply in most situations:

1. Educational games motivate students.
2. Educational games can help increase a student's attention span.
3. Games can provide drill and pratice painlessly.
4. Educational games may be designed to foster the higher congnitive levels of instruction.

Educational simulations and games can work best when they are integrated into a planned sequence of learning, which includes textbooks, writing exercises, various media, and teaching strategies. As the quality of educational programming for microcomputers improves, educational simulations and games have great potential for enchancing instruction in complex intellectual tasks.

Computer- Aided Drafting in Technical Education

Computer-aided drafting (CAD) has been widely adopted by industry. More and more industries are turning to CAD for its potential to increase productivity, quality

and promote standardization.

Businesses, industries, and educational institutions are responding to the need for CAD education and training. Several companies have initiated in-house training programs for their employees, but there seems to be no people knowledgeable enough to develop and conduct training on a wide scale. And although a few experts in industry and education are acting as consultants to organizations seeking information and formal training, there are not enough of them either.

Fortunately, many schools are offering formal instruction. Two-year vocational / technical schools are beginning to conduct courses for the purpose of developing qualified operators. Public schools are slow in responding to this need, however, primarily due to a lack of teachers and computer lab facilities. Micro-based CAD in lower schools is desperately needed to meet the future demands of industry, and high school graduates should be made aware of career opportunities in CAD.

As Forrest John, head of Oklahoma State Tech's Drafting Technology Department, predicts that " drafting technology educators in the 1980s will have two choices: make the transition to CAD or abolish their programs ". Thus, the Technology Education instructors must cope with the rapid changes and introduce the new technologies into

the classroom.

New competition and continuous technological advances are rapidly making CAD education and training in schools an affordable reality. The time to start preparing students for CAD is now.

Summary

Nothing in the last half-century has affected our lives and the world we live in more than two inventions: the television and the computer. Computer graphics is the artful and scientific fusion of these two. Computer graphics has been applied to industry, business, medicine, education, scientific research, engineering and so forth. It is the most important and useful tool in the modern society.

Computer- aided drafting (CAD) as parts of computer graphics has also grown at a phenomenal rate. The result of a 1983 study on CAD uses in Houston, Texas revealed that 57.1 percent of the corporations surveyed were using CAD at the present and another 58.3 percent of the corporations that were not using CAD at the present plan to do so in 3 to 5 years. Also 64.3 percent thought that CAD should be taught at the secondary level of education (Becker 1985, P.16).

With these statistics in mind it seems reasonable and

necessary that Technology Education instructors should familiarize students with CAD. CAD should be implemented into the industrial technology education programs since it is becoming more demanded by industries of all sizes.

CHAPTER III

PROCEDURES

Development of Research Materials

The following materials were used:

A. Library resource materials

1. Text books:
   a. Computer Graphia
   b. Microcomputer Graphics for The Apple Computer
   c. Microcomputer Graphics
   d. Computer Graphics and Applications
   e. Computers in Schools
   f. other related books

2. Related periodicals:
   a. School Shop
   b. The Technology Teacher
   c. Computer Graphics World
   d. Educational Technology
   e. Industrial Education
   f. other related periodicals

3. Government documents on computer-aided drafting systems.

B.Review related literature and analyze information.

C.Develop course material that can be integrated into a computer- aided drafting class.

Design of Instructional Materials

The computer-aided drafting manual on the following pages was written in a form that related to the inservice Technology Education instructors and is explained for easy understanding language. The elements identified for the manual included: (1) title, (2) objective(s), (3) content(s): related information of each experiment, (4) procedures: activity steps in each experiment, (5) program list: necessary programs for each experiment, (6) exercise.

The computer-aided drafting system used for the study is the APPLE IIe microcomputer which is made by APPLE Computer,Inc, California. Each experimental set-up is actually run and tested by the researcher. Procedures are listed in each experiment.

In addition to this manual, the following instructional tools can also be used to reinforce the information being cover: Super Pilot lesson disk

Overhead transparencies

Film strips and records

Demonstration mock- ups

Video tape presentations

Periodically throughout this manual the student will have specific duties to perform in the order of job sheets. These job sheets will reinforce the material covered and also let the instructor know if the student is understanding the computer- aided drafting. At the end of the course a comprehensive test will be given.

CHAPTER IV

PRESENTATION

General Introduction

This chapter is a presentation of each experiment. The fifteen laboratory experiments were selected and grouped in a sequential order based on the library resource materials, related literature and information. The components for each experiment are: (1) title, (2) objective(s), (3) content(s), (4) procedures, (5) program list, (6) exercise.

List of Laborary Experiments

This chapter consists of fifteen laborary experiments as listed:

1. Fundamental Low Resolution Commands.
2. Fundamental High Resolution Commands.
3. Mixed and Full Screen on Page 1.
4. Drawing on Page 1 and Page 2.
5. Switching between Text and the Graphics Screen.
6. Draw a Circle.

7. Draw a Rectangle.
8. Draw a Ellipse.
9. Draw a Parabola.
10. Draw a Hyperbola.
11. Making a Shape using a Shape Table.
12. Manipulate the Shapes.
13. Matrix Representation of Transformations.
14. Matrix Shear and Rotation.
15. Animating Pictures.

Experiment 1

Title: Fundamental Low Resolution Commands

Objectives:

At the completion of this unit you will be able to:

1. Explain the functions of low resolution commands and use them properly.
2. Write a simple graphic program using the low resolution commands.

Contents:

1. GR: The GR commands converts the screen to low resolution mixed graphics mode. The display consists of a 40 * 40 graphics matrix with four lines of text at the bottom of the screen illustrated in Figure 1.1.
2. COLOR = expr.: The COLOR command sets the color for low resolution graphics that specified by the value of expression (expr.). Expr. = 0 through 15 are used to obtain the various hues illustrated in Table 1.1.
3. PLOT expr. 1, expr. 2 : The plot command displays a rectangular " brick " of a specified color on the screen at a particular column and row whose X coordinate is (expr.1) and whose Y coordinate is (expr.2).
4. HLIN : The HLIN command is used to draw horizontal lines on the screen in low resolution graphics.
5. VLIN : The VLIN command is used to draw vertical lines

on the screen in low resolution graphics.

6. TEXT : The TEXT command can return the screen to full screen text mode from graphics mode.

7. HOME : The HOME command can clear the text window, removing the typing of the RUN command.

Table 1.1. Color Numeral

COLOR	NUMERAL
Black	0
Magenta	1
Dark blue	2
Purple	3
Dark green	4
Gray 1	5
Medium blue	6
Light blue	7
Brown	8
Orange	9
Gray 2	10
Pink	11
Light green	12
Yellow	13
Aqua	14
White	15

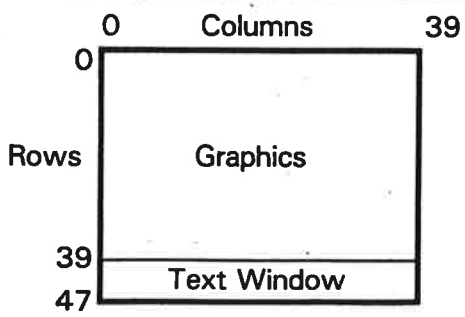

Figure 1.1. Low Resolution Screen

Procedures:

1. In program 1.1.-- draw some lines with HLIN and VLIN commands to display the boundary of the low resolution mixed graphics screen.
2. In program 1.2.-- draw fifteen vertical lines with different colors to show the varied colors for low resolution graphics.

Program List:

Program 1.1.

```
5  REM :The layout and boundary l
     imits of the mixed graphics
     screen
10  GR
18  ON
20  COLOR= 10
30  HLIN 0,39 AT 20
40  VLIN 0,39 AT 20
45  COLOR= 14
50  HLIN 0,39 AT 0
60  VLIN 0,39 AT 39
70  HLIN 0,39 AT 39
80  VLIN 0,39 AT 0
90  PRINT " THE BOUNDARY OF THE M
     IXED GRAPHICS SCREEN "
```

Program 1.2.

```
5  REM :The colors of low resolut
     ion graphics "
8 OMN
10  GR
20  COLOR= 0: VLIN 0,30 AT 2
30  COLOR= 1: VLIN 0,30 AT 4
40  COLOR= 2: VLIN 0,30 AT 6
50  COLOR= 3: VLIN 0,30 AT 8
60  COLOR= 4: VLIN 0,30 AT 10
70  COLOR= 5: VLIN 0,30 AT 12
80  COLOR= 6: VLIN 0,30 AT 14
90  COLOR= 7: VLIN 0,30 AT 16
100  COLOR= 8: VLIN 0,30 AT 18
110  COLOR= 9: VLIN 0,30 AT 20
120  COLOR= 10: VLIN 0,30 AT 22
130  COLOR= 11: VLIN 0,30 AT 24
140  COLOR= 12: VLIN 0,30 AT 26
150  COLOR= 13: VLIN 0,30 AT 28
160  COLOR= 14: VLIN 0,30 AT 30
170  COLOR= 15: VLIN 0,30 AT 32
180  PRINT " THE COLOR FOR LOW RE
     SOLUTION GRAPHIGS "
```

Exercise: Write a program to draw a rectangle with different colors in the low resolution screen, also writing the message " GR TEST " in the text window.

Experiment 2

Title: Fundamental High Resolution Commands

Objective:

At the completion of this unit you will be able to:

1. Explain the meanings and functions of high resolution commands.
2. Identify the differences between low and high resolution commands.
3. Write a simple graphic program using the high resolution commands.

Contents:

1. HGR : The HGR command converts the screen to high resolution mixed graphics mode. Figure 2.1. displays the layout and boundary limits of the mixed graphics screen. When HGR is executed, the graphics portion of PAGE 1 is cleared to black, with a four text window at the bottom of the page.
2. HCOLOR = expr. : Set color. Sets the high- resolution graphics color to that specified by the value of expression (expr.), which must be in the range 0 to 7. Table 2.1. defines the available color codes. Notice the use of H in HGR and HCOLOR for high resolution mode, in contrast to the use of GR and COLOR for low resolution mode.

3. HPLOT expr. 1, expr. 2 : Plot a dot. Plots a high-resolution dot whose X coordinate is (expr.1) and whose Y coordinate is (expr.2). The color of the dot is determined by the most recently executed HCOLOR statement. Expression expr.1 must be in the range of 0 through 279 while expression expr.2 must be in the range of 0 through 191.
4. TEXT : The TEXT command can return the screen to full screen text mode from graphics mode.
5. HOME : The HOME command can clear the text window, removing the typing of the RUN command.

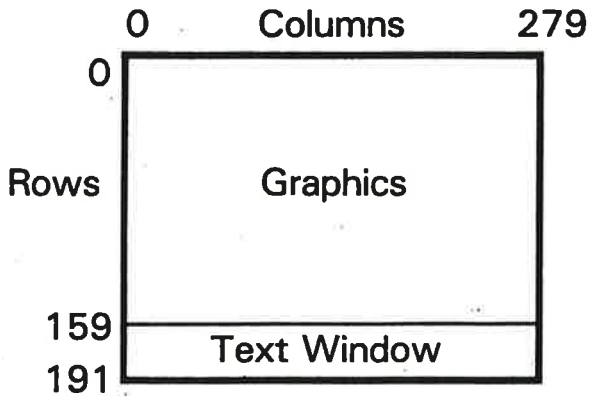

Figure 2.1. High Resolution Screen

Table 2.1. Color Numeral

COLOR	NUMERAL
Black 1	0
Green	1
Violet	2
White 1	3
Black 2	4
Orange	5
Blue	6
White 2	7

Procedures:

1. In program 2.1.-- draw a rectangle within the high resolution screen with HPLOT TO commands to show the boundary and limitation of screen. Also display text window, a VTAB X (where X = 21, 22, 23, 24) is necessary for messages from PRINT statement to appear on the screen illustrated in Figure 2.2.
2. In program 2.2.-- draw several lines with different colors while background color is black to show the varied colors for high resolution graphics illustrated in Figure 2.3.

Program List:

Program 2.1.

```
10  REM :The layout and boundary
     limits of the high resolutio
     n mixed graphics screen
15  HGR
20  HCOLOR= 3
30  HPLOT 0,80 TO 279,80
40  HPLOT 140,0 TO 140,159
50  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
60  PRINT "THE BOUNDARY OF THE HI
     GH RESOLUTION MIXED GRAPHICS
      SCREEN "
```

Program 2.2.

```
5   REM :Background color=0,The va
      ried colors for drawing
8 OMN
10  HGR
20  HCOLOR= 0: HPLOT 30,0 TO 30,1
     50
30  HCOLOR= 1: HPLOT 60,0 TO 60,1
     50
40  HCOLOR= 2: HPLOT 90,0 TO 90,1
     50
50  HCOLOR= 3: HPLOT 120,0 TO 120
     ,150
60  HCOLOR= 4: HPLOT 150,0 TO 150
     ,150
70  HCOLOR= 5: HPLOT 180,0 TO 180
     ,150
80  HCOLOR= 6: HPLOT 210,0 TO 210
     ,150
90  HCOLOR= 7: HPLOT 240,0 TO 240
     ,150
100  PRINT "BACKGROUND COLOR=0 ,T
     HE VARIED COLORS FOR DRAWING
      "
```

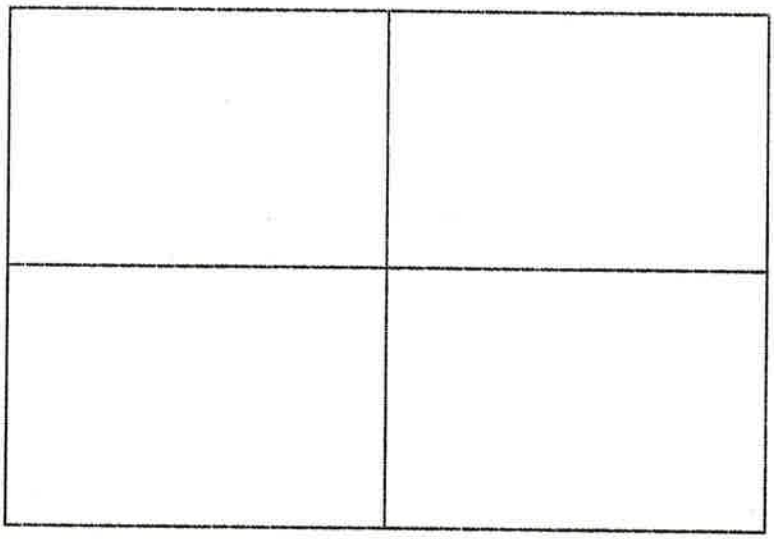

Figure 2.2. The Boundary Limits of High Resolution Screen

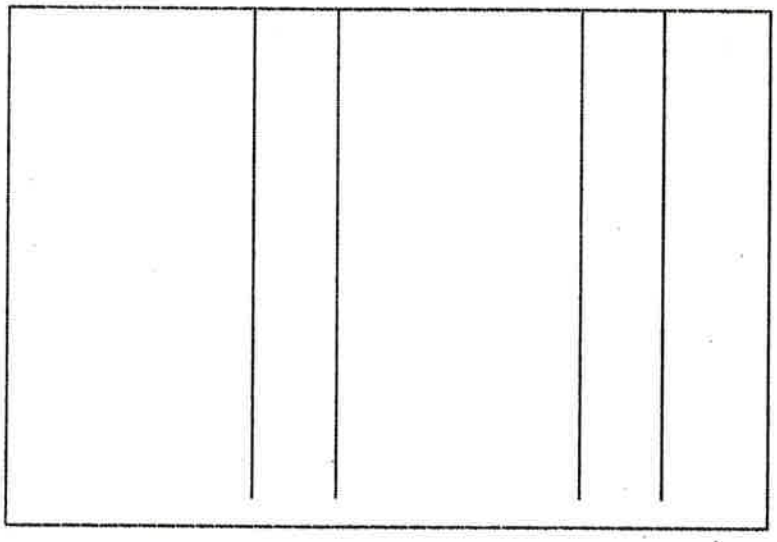

Figure 2.3. Varied Colors on The High Resolution Screen

Exercise: Write a program to draw a triangle with different colors on the high resolution screen, also write the message " HGR TEST " displaying in the text window.

Experiment 3

Title: Mixed and Full Screen on Page 1

Objectives:

At the completion of this unit you will be able to:

1. Describe the functions of mixed and full screen.
2. Switch the mixed and full screen with POKE command.

Contents:

1. HGR command causes PAGE 1 of the high resolution screen to be cleared to black and put into the mixed graphics mode. The screen defaults to an organization of 280h * 160v (280 horizontal columns by 160 vertical rows) with a four-line text scrolling window at the screen bottom.
2. The text window can be removed with a POKE command to become a full screen with an increased graphics format of 280h * 192v.
3. APPLE SOFT allows for full screen graphics by using a POKE -16302,0 command after the HGR command. The poke -16301,0 command switches the full screen graphics back to mixed screen.
4. The number -16301 is a symbol of memory location 49235 (i.e. -16301 = 49235-65536) which is used in integer BASIC and is often used in APPLE SOFT. Similarly, POKE -16302,0 and POKE 49234,0 are equivalent. POKE -16301

and POKE -16302 as " soft switches " illustrated in Table 3.1.

Table 3.1. Location of Memory

	MEMORY LOCATION	
	-16301	-16302
	49235	49234
	MIXED SCREEN	FULL SCREEN
STATUS OF SWITCH	ON	OFF
	OFF	ON

Procedures:

1. In program 3.1.-- draw a pair of white flags on mixed screen and black flags on full screen with HPLOT TO command. Then we use POKE -16301,0 command to display white flags on mixed screen and a text on the four-line text window as illustrated in Figure 3.1. Also use POKE -16302,0 command to change the mixed screen into full screen displaying the black flags as illustrated in Figure 3.2.

Program List:

Program 3.1.

```
5  REM :Switching MIXED and FULL
     screen
10  HOME
12  REM :Mixed Sreen
15  HGR
20  POKE  - 16301,0
30  HCOLOR= 3
35  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
40  HPLOT 80,80 TO 200,80 TO 200,
     120 TO 160,120 TO 160,80: HPLOT
     120,80 TO 120,40 TO 80,40 TO
     80,80
45  VTAB 22: PRINT "MIXED SCREEN
     DRAWING"
50  GET Q$
55  REM :Full Sreen
60  POKE  - 16302,0
70  HPLOT 80,80 TO 200,80 TO 200,
     40 TO 160,40 TO 160,80: HPLOT
     120,80 TO 120,120 TO 80,120 TO
     80,80
75  FOR Y = 40 TO 80: HPLOT 160,Y
      TO 200,Y: NEXT Y
80  FOR Z = 80 TO 120: HPLOT 80,Z
      TO 120,Z: NEXT Z
```

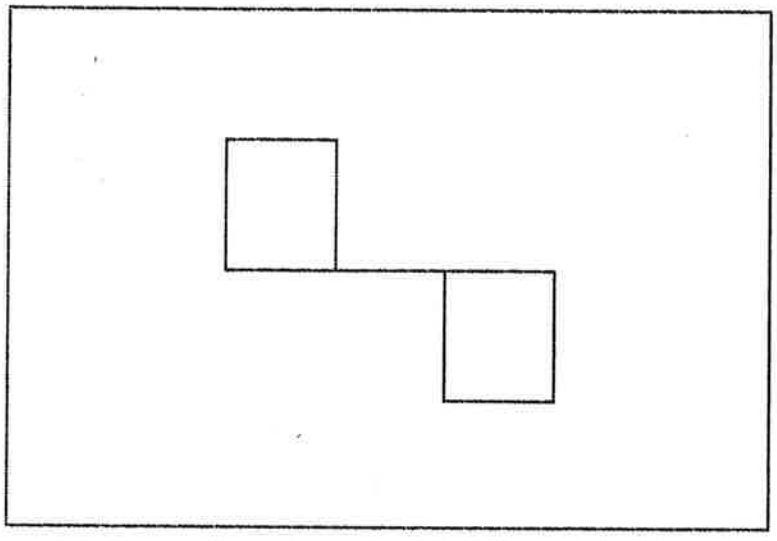

Figure 3.1. Flags on Mixed Screen

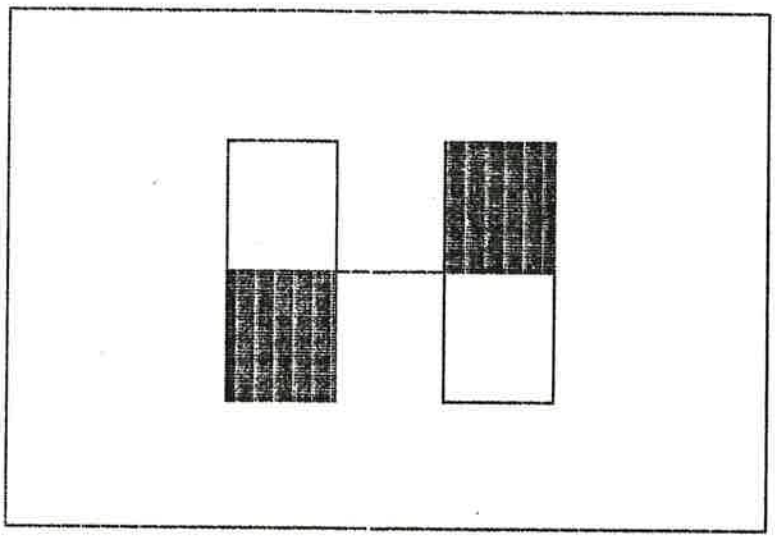

Figure 3.2. Flags on Full Screen

Exercise: Write a program which draws an outline of a diagram on the mixed and full screen and uses POKE command to switch them.

Experiment 4

Title: Drawing on Page 1 and Page 2

Objectives:

At the completion of this unit you will be able to:

1. Describe the function of PAGE 2.
2. Explain the differences between PAGE 1 and PAGE 2.
3. Switch the PAGE 1 and PAGE 2 with POKE command.

Contents:

1. HGR 2 command can clear the entire screen to black and switch to PAGE 2 of high resolution graphics. HGR 2 creates a full screen graphics mode, rather than a mixed graphics screen.
2. The POKE -16300,0 command sets screen for the display of PAGE 1. The POKE -16299,0 command displays PAGE 2 on the screen. Memory locations -16299 and -16300 coordinate as another one of several " soft switches " used to control the screen display in APPLE SOFT illustrated in Table 4.1.
3. The content of memory location 230 determines which graphics page is to be used for drawing. POKE 230,32 identifies PAGE 1 for drawing while POKE 230, 64 identifies PAGE 2. If the POKE 230,- command is not used, the page used for drawing is determined by the most recently used HGR or HGR 2 command.

Table 4.1. Location of Memory

	MEMORY	LOCATION
	-16300	-16299
	49236	49237
	PAGE 1	PAGE 2
STATUS OF SWITCH	ON	OFF
	OFF	ON

Procedures:

1. In program 4.1.-- draw a robot with closed eyes and mouth using HPLOT TO command on PAGE 1 illustrated in Figure 4.1.
2. Also draw a robot with closed eyes and opening mouth using the same command on PAGE 2 illustrated in figure 4.2.
3. Then, change PAGE 2 into PAGE 1 using POKE -16300,0 and POKE 230, 32 commands and draw a pair of left-watching eyes for robot illustrated in Figure 4.3.
4. Then, use POKE -16299,0 and POKE 230,64 commands to alter PAGE 1 to PAGE 2 and draw a pair of right-watching eyes for robot illustrated in Figure 4.4.

Program List:

Program 4.1.

```
5  REM :Continuous drawing on PAG
     E1$PAGE2
10  HOME
20  HGR : HCOLOR= 3
30  HPLOT 85,40 TO 115,40: HPLOT
     165,40 TO 195,40
35  HPLOT 120,60 TO 80,60 TO 80,8
     0 TO 120,80 TO 120,60
40  HPLOT 160,80 TO 200,80 TO 200
     ,60 TO 160,60 TO 160,80
50  HPLOT 140,80 TO 140,90: HPLOT
     135,90 TO 145,90
55  HPLOT 120,120 TO 160,120
60  FOR A = 1 TO 400: NEXT A
62  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
63  GET Q$
70  HGR2
80  HPLOT 85,40 TO 115,40: HPLOT
     165,40 TO 195,40
85  HPLOT 120,60 TO 80,60 TO 80,8
     0 TO 120,80 TO 120,60
90  HPLOT 140,80 TO 140,90: HPLOT
     135,90 TO 145,90
95  HPLOT 120,120 TO 120,125 TO 1
     60,125 TO 160,120 TO 120,120

100  HPLOT 200,60 TO 160,60 TO 16
     0,80 TO 200,80 TO 200,60
110  FOR A = 1 TO 400: NEXT A
112  HPLOT 0,0 TO 279,0 TO 279,19
     0 TO 0,190 TO 0,0
113  GET Q$
120  POKE  - 16300,0: POKE 230,32

130  FOR Y = 60 TO 80: HPLOT 80,Y
      TO 100,Y: NEXT Y
140  FOR Y = 60 TO 80: HPLOT 160,
     Y TO 180,Y: NEXT Y
150  FOR B = 1 TO 400: NEXT B
152  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
160  POKE  - 16299,0: POKE 230,64

170  FOR Z = 60 TO 80: HPLOT 100,
     Z TO 120,Z: NEXT Z
180  FOR Z = 60 TO 80: HPLOT 180,
     Z TO 200,Z: NEXT Z
190  FOR B = 1 TO 400: NEXT B
195  HPLOT 0,0 TO 279,0 TO 279,19
     0 TO 0,190 TO 0,0
200  GET Q$: GOTO 10
```

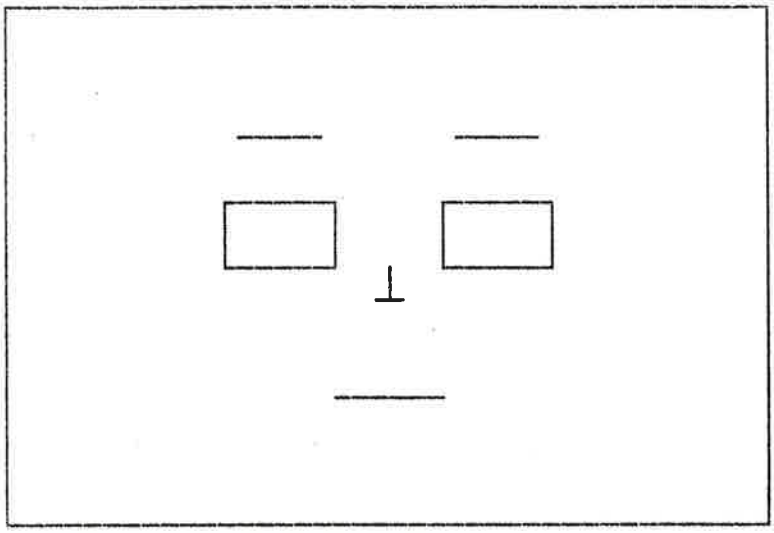

Figure 4.1. Plot of Robot on Page 1

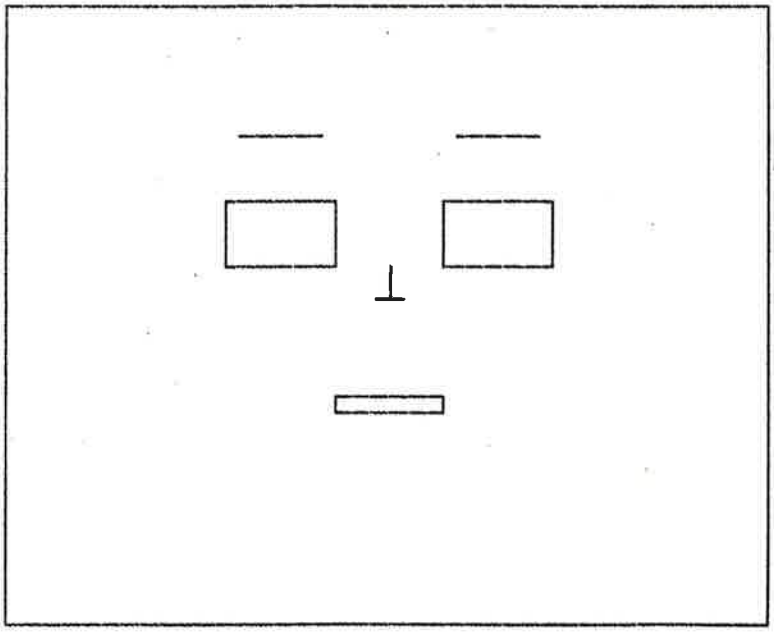

Figure 4.2. Plot of Robot on Page2

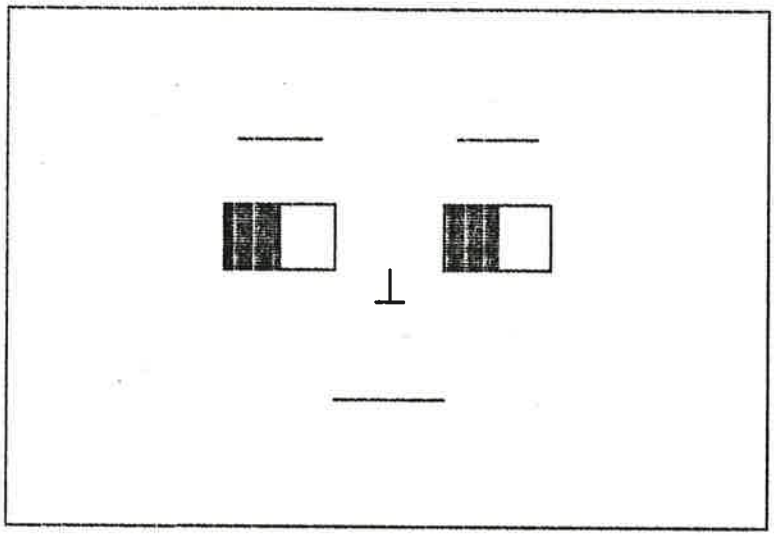

Figure 4.3. Plot of Robot on Page 1 Changed from Page 2

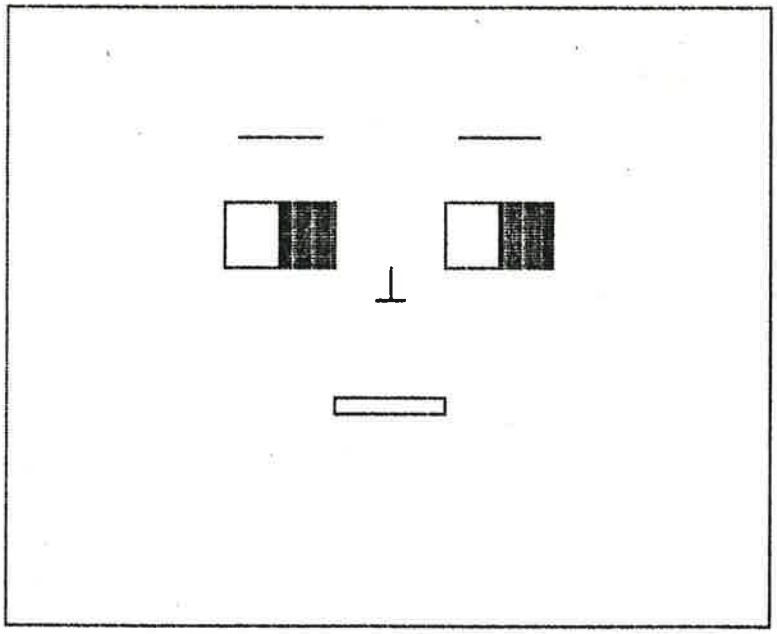

Figure 4.4. Plot of Robot on Page 2 Changed from Page 1

Exercise: Write a program to draw some diagrams on PAGE 1 and PAGE 2. Then, try to switch back and forth between pages with POKE commands.

Experiment 5

Title: Switching between Text and Graphics Screen

Objectives:

At the completion of this unit you will be able to:

1. Describe the function of text page.
2. Coordinate the alternate viewing of the text page and the high resolution pages

Contents:

1. Text and low resolution graphics share the same memory locations. Both of these modes can not be functioning at the same time, except for mixed screen.
2. HGR established a mixed screen, high resolution graphics mode. The text window for the high resolution PAGE 1 also resides in the bottom four lines of low resolution. While the HGR 2 command establishes a full screen graphics on high resolution PAGE 2.
3. The POKE -16304,0 command sets screen for the display of graphics screen. The POKE -16303,0 can clear the entire screen to text, losing the picture altogether illustrated in Table 5.1.

Table 5.1. Location of Memory

	MEMORY LOCATIONS	
	-16303	-16304
	49233	49232
	TEXT	GRAPHICS
STATUS OF SWITCH	ON	OFF
	OFF	ON

Procedures:

1. In program 5.1.-- draw a camera on PAGE 1 and print a text " GRAPHICS SCREEN " in the bottom text window area illustrated in Figure 5.1.
2. Then, use TEXT or POKE -16303,0 command to clear the whole screen to text screen. In this case, print a text " TEXT SCREEN " at the center of text screen illustrated in Figure 5.2.

Program List:

Program 5.1.

```
5  REM :Switching between TEXT an
     d GRAPHICS screen
10  HOME
15  REM  GRAPHICS SCREEN
20  HGR
30  HCOLOR= 3
35  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
40  HPLOT 120,55 TO 120,75 TO 160
     ,75 TO 160,55 TO 120,55
45  FOR Y = 55 TO 75: HPLOT 120,Y
      TO 160,Y: NEXT Y
50  HPLOT 160,60 TO 175,60 TO 175
     ,70 TO 160,70 TO 160,60
60  HPLOT 138,75 TO 142,75 TO 142
     ,80 TO 138,80 TO 138,75
70  HPLOT 140,80 TO 100,120: HPLOT
     140,80 TO 140,120: HPLOT 140
     ,80 TO 180,120
80  VTAB 21: PRINT " GRAPHICS SCR
     EEN"
90  GET Q$
95  REM  TEXT SCREEN
100  TEXT
110  HOME : VTAB 12: HTAB 14
120  PRINT " TEXT SCREEN "
130  GET Q$
140  GOTO 10
```

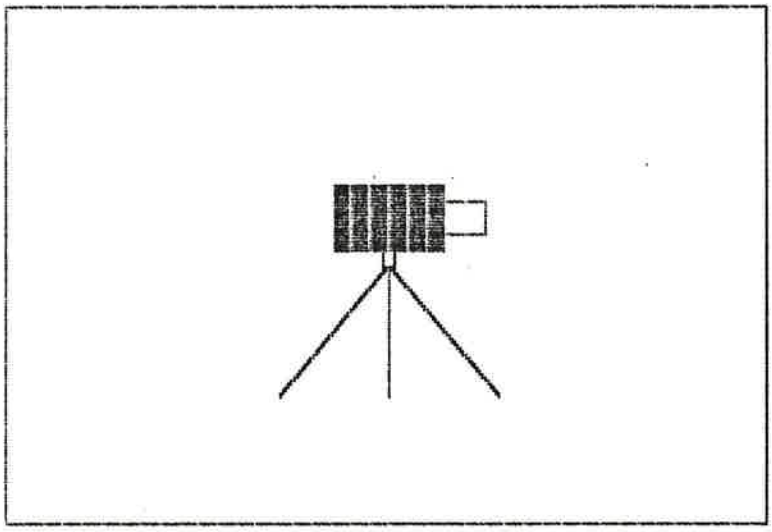

Figure 5.1. Diagram on Graphics Screen

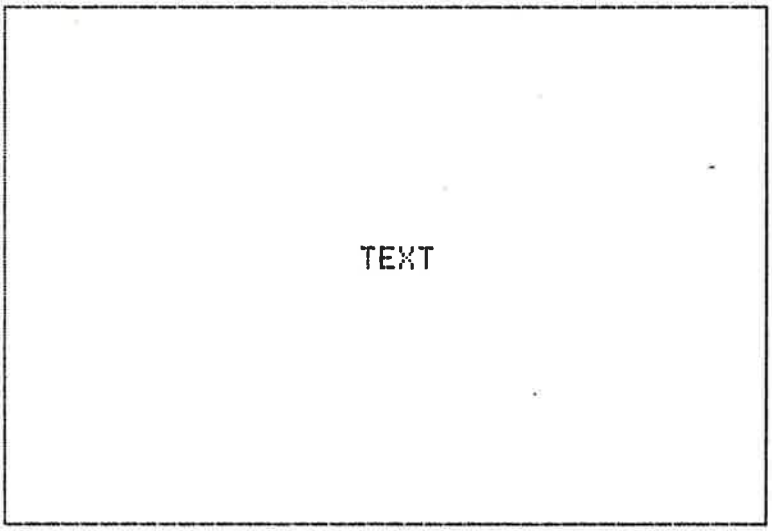

Figure 5.2. Diagram on Text Screen

Exercise: Write a menu program which permits you to view diagrams that are to be displayed on high resolution pages.

Experiment 6

Title: Draw a Circle

Objectives:

At the completion of this unit you will be able to:

1. Describe the geometric concept of a circle.
2. Write a graphic program to draw a circle.

Contents:

1. A circle is described as the set of all points (x,y) at a fixed distance (R) from the center (H,K). Algebraically, we have (X - H)^2 + (Y - K)^2 = R^2. For a circle with its center at (0,0), the equation becomes X^2 + Y^2 = R^2.
2. The relation X^2 + Y^2 = R^2 may be decomposed into the two functions Y1 = SQR (R^2 - X^2) and Y2 = - SQR (R^2 - X^2) which can be used in graphic program.
3. From trigonometry, the relation X^2 + Y^2 = R^2 may be changed into X = R * COS (θ) and Y = R * SIN (θ) while a point (X, Y) is on the circle illustrated in Figure 6.1.

4. In the degree system, a straight angle is defined as having measure 180 degrees. In the radian system, a straight angle is defined as having measure PI = 3.1416 radians, which is precisely one half the circumference length of a circle of radius one. In most computer languages the COS and SIN must be evaluated for the radian measure of the angle.

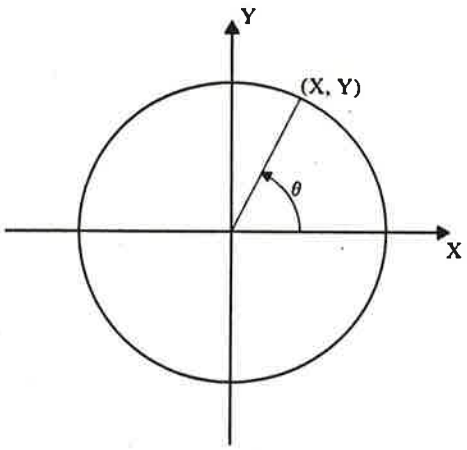

Figure 6.1. Circle Measure

Procedures:

1. In program 6.1.-- input the radius and the center point and determine the radians and increment, then use HPLOT command draw a circle, as shown in Figure 6.2.

Program List:

Program 6.1.

```
10  REM :DRAW A CIRCLE
15  HGR : HCOLOR= 3
20 R = 60
30 X1 = 130:Y1 = 80
40 PI = 3.1416
50 A1 = 0:A2 = 2 * PI
55 N = 100
60 INC = (A2 - A1) / N
70  FOR I = A1 TO A2 STEP INC
80 X = R *  SIN (I):Y = R *  COS
     (I)
90 M = X1 + X:N = Y1 + Y
100  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
140  HPLOT M,N
150  NEXT I
160  GOTO 20
```

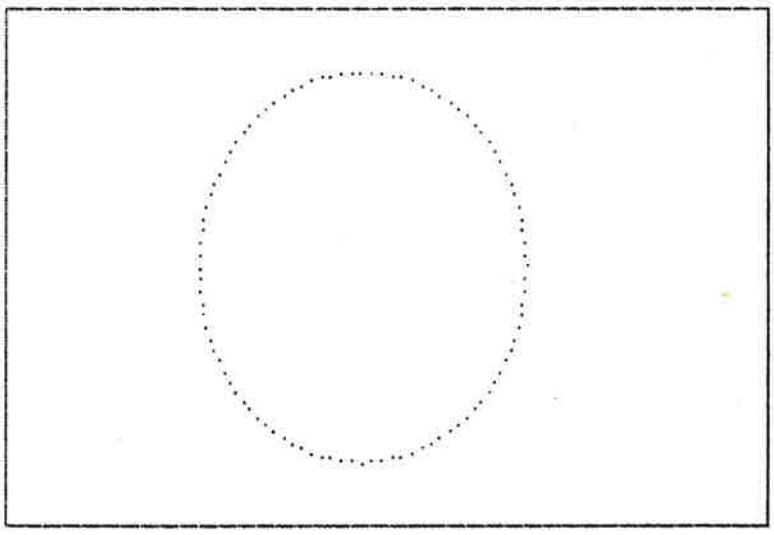

Figure 6.2. Plot of a circle

Exercise: Write a program using FOR NEXT loop to draw several circles with different radiuses as shown in Figure 6.3.

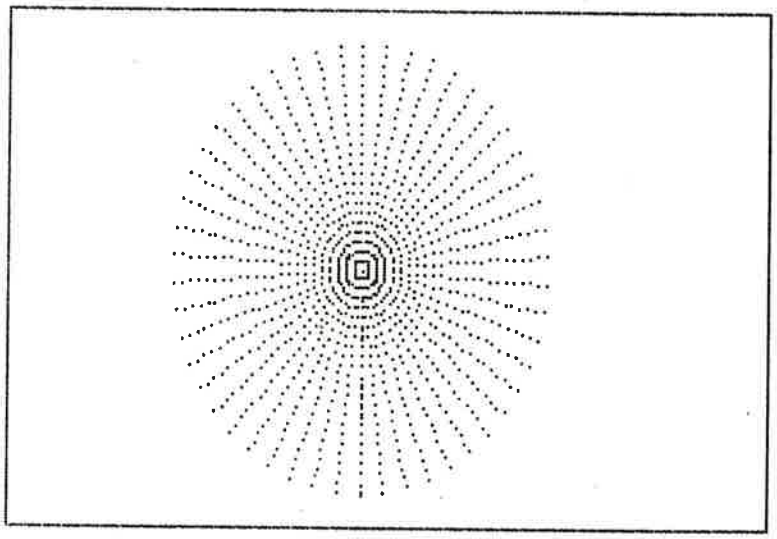

Figure 6.3. Plot of several Circles

Experiment 7

Title: Draw a Rectangle

Objectives:

At the completion of this unit you will be able to:

1. Describe the geometric concept of the rectangle.
2. Write a graphic program to draw a rectangle.

Contents:

1. Drawing rectangles requires that we pick the four corners and place them in a HPLOT TO statement.
2. As shown in Figure 7.1, can find that this is not a true square, that is, the sides do not look equal on the screen even though we know they are. The reason is that an increment on the X axis is not the same as an increment on the Y axis.
3. Take out a ruler and measure the sides of the squre. If X = P inches and Y = Q inches. We can divide Y by X to get the ratio, Y / X = F. This ratio says that one step in Y gives about F times the same step in the X. The trick is to adjust our program by multiplying X by F before we do the actual plotting.

Procedures:

1. In program 7.1.-- draw a square 100 * 100 units on the screen using a correction factor of 1.212 to remove

distortion and make the shape size and the start corner variable as shown in figure 7.2.

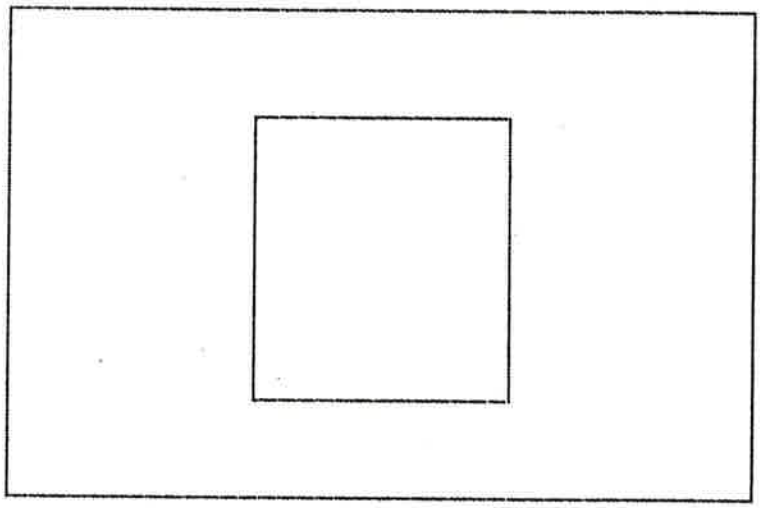

Figure 7.1. Plot of Square

Program List:

Program 7.1.

```
10  HGR : HCOLOR= 3
15 F = 1.212
20 XS = 100 * F
30 YS = 100
40 X = XS / 2:Y = YS / 2
50 I = 140:J = 80
60  HPLOT I - X,J - Y TO I + X,J -
     Y TO I + X,J + Y TO I - X,J +
     Y TO I - X,J - Y
65  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
70  END
```

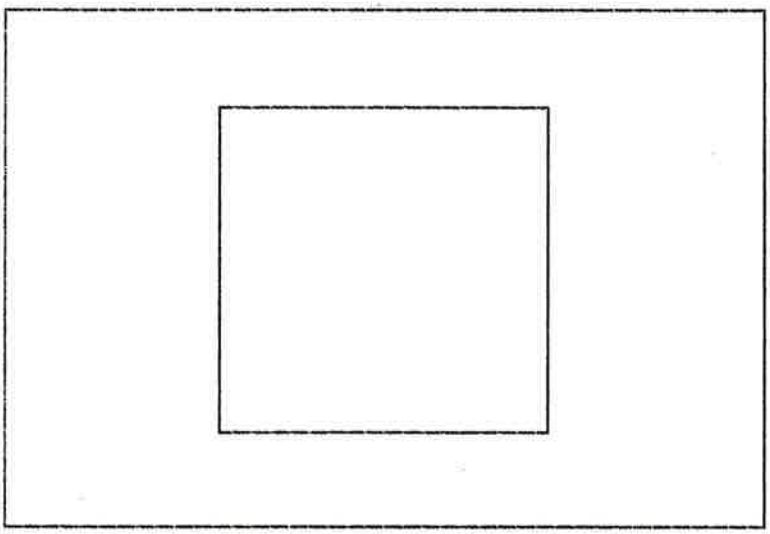

Figure 7.2. Plot of Square with Correction Factor Included

Exercise: Write a program using FOR NEXT loop to draw 5 rectangles with differents sides.

Experiment 8

Title: Draw an Ellipse

Objective:

At the completion of this unit you will be able to:

1. Explain the concept and function of the ellipse.
2. Write a graphic program to draw an ellipse.

Contents:

1. An ellipse is the set of points for which the sum of the distances from two fixed points (the thumbtacks) is a constant (the length of the string). Each of the fixed points is called a focus of the ellipse.
2. In the ellipse as shown in Figure 8.1, it is conventional to identify the coordinates of point C (the center) as (H,K); the distance AC (=BC) is usually designated by A; and the distance EC (= CD) is usually identified as B. With the motion, the ellipse is represented algebraically by (X-H)^2 / A^2 + (Y-K)^2 / B^2 = 1.
3. We may simplify the algebra by working with ellipse centered at the point (H,K). Equation then becomes X= A* COS(θ) + H and Y= B* SIN(θ) + K.

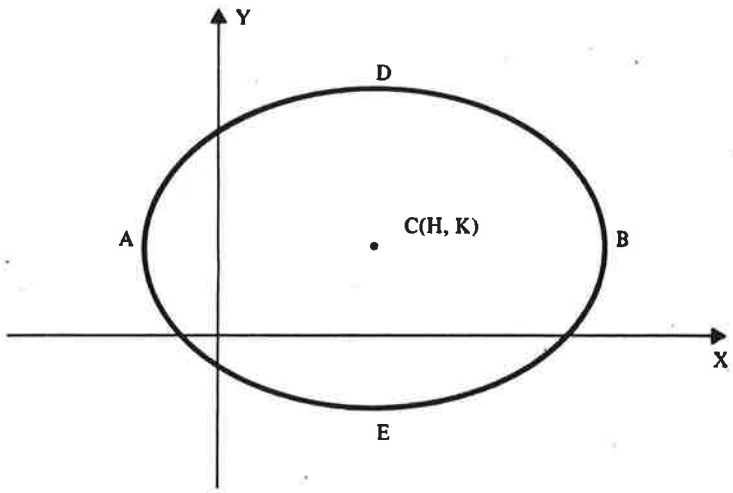

Figure 8.1. Plot of Ellipse

Procedures:

1. In program 8.1.-- draw an ellipse with the equation X= A * COS(θ) + H and Y= B * SIN(θ) + K while centere at the point (140 ,90); the distance A is 100; and the distance B is 60, as shown in Figure 8.2.

Program List:

Program 8.1.

```
10  HGR : HCOLOR= 3
20 H = 140:K = 90
30  FOR TH = 0 TO 6.28 STEP 0.01
40 A = 100:B = 60
50 X = A *  COS (TH) + 140:Y = B *
     SIN (TH) + 90
60  HPLOT X,Y
70  NEXT TH
75  HPLOT 0,0 TO 279,0 TO 279,159
     TO 0,159 TO 0,0
80  END
```

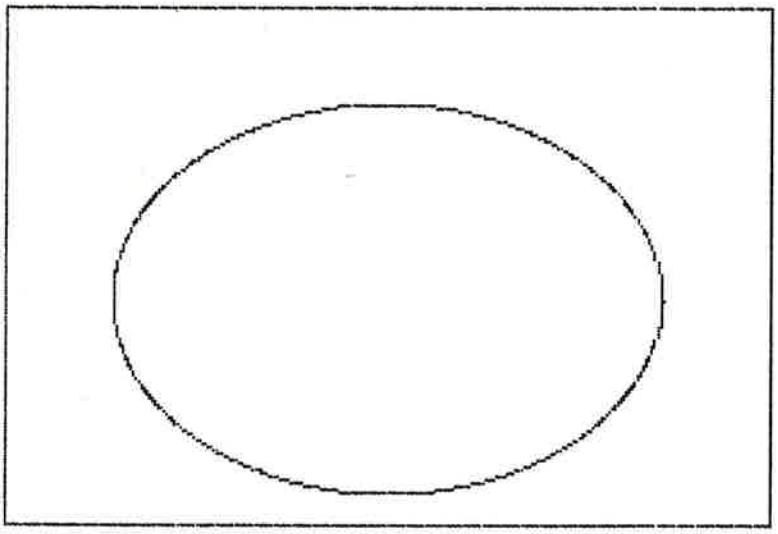

Figure 8.2. Diagram of Ellipse

Exercise: Write a program to draw an ellipse at the point (100, 100) with A= 80 and B= 120.

Experiment 9

Title: Draw a Parabola

Objectives:

At the completion of this unit you will be able to:

1. Explain the concept of the parabola.
2. Write a graphic program to draw a parabola.

Contents:

1. The parabola is a curve which has many physical applications. The equation Y = (X^2) / (4*P) identifies points of the parabola as shown in Figure 9.1. The origin (0,0) is the vertex of the parabola; the focus is at the point (0,P). The line containing the focus and the vertex is refered to as the axis of the parabola. The value of P determined the relative position of the focus and the vertex, and the shape of the parabola. The line segment AB, which contents the focus and is perpendicular to the axis of the parabola, has length 4* P.
2. The equation Y=(X^2)/ (4*P) will identify the points of a parabola, a formulation is the set of parametric equation X= 2 * P * T and Y= P * T^2.

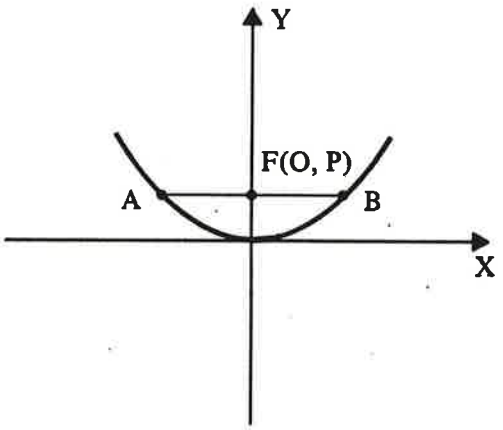

Figure 9.1. The Shape of Parabola

Procedures:

1. In program 9.1.-- draw a parabola with the equation X = 2 * P * T and Y = P * T^ 2. The vertex is at the point (125,180) and the value of P is 20, as shown in Figure 9.2.

Program List:

Program 9.1.

```
5  REM :Draw a Parabola
10  HGR : HCOLOR= 3
20  HPLOT 60,80 TO 200,80: HPLOT
     130,10 TO 130,150
30  FOR T =  - 3 TO 3 STEP 0.01
40 P = 6
50 X = 2 * P * T + 130:Y =  - P *
     T * T + 80
60  HPLOT X,Y
70  NEXT T
80  END
```

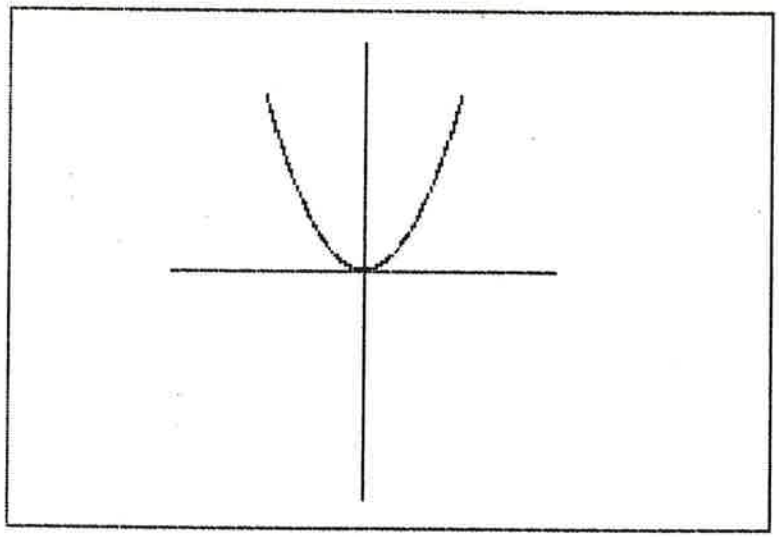

Figure 9.2. Diagram of Parabola

Exercise: Write a program to draw a parabola with P = 40 and the vertex is at the point (140,80).

Experiment 10

Title: Draw a Hyperbola

Objective:

At the completion of this unit you will be able to:

1. Describe the concept of the hyperbola.
2. Write a graphic program to draw a hyperbola.

Contents:

1. The circle, the ellipse, parabola, and hyperbola are called conic sections because they are curves formed by the intersection of a cone and a plane.
2. The hyperbola is represented by the equation (X^2 / A^2) - (Y^2 / B^2) = 1. The shape of the hyperbola obviously is controlled by the choice of values for A and B. The parametric equations of the hyperbola is X = A* SEC (θ) and Y = B* TAN (θ) as shown in Figure 10.1.

Procedures:

1. In program 10.1.-- sketch a hyperbola with the equation X= A* SEC (θ) and Y = B* TAN (θ) while the center point is at (140,95) and A= 50, B= 30, as shown in Figure 10.2.

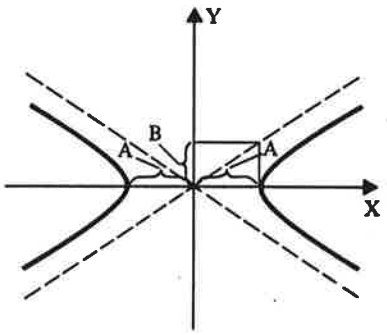

Figure 10.1 The Shape of the Hyperbola

Program List:

Program 10.1.

```
10  HGR
20  HCOLOR= 3
30  FOR T =  - 1 TO 1 STEP 0.01
40 A = 50:B = 30
45 X = A /  COS (T):Y = B *  TAN
     (T)
50  HPLOT 140 + X,95 + Y
60  HPLOT 140 - X,95 + Y: NEXT T
70  HPLOT 140,0 TO 140,159: HPLOT
     0,95 TO 279,95
80 MN
90  HPLOT 0,0 TO 279,0 TO 279,159
      TO 0,159 TO 0,0
100  END
```

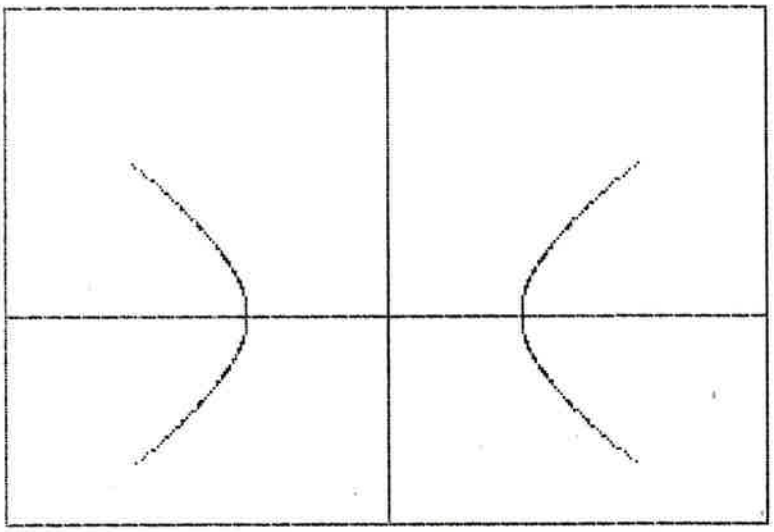

Figure 10.2 Diagram of Hyperbola

Exercise: Describe the differences of equations among the circle, the ellipse, the parabola and the hyperbola.

Experiment 11

Title: Making a Shape Using a Shape Table

Objective:

At the completion of this unit you will be able to:

1. Describe the steps for creating a shape table for a shape figure.
2. Write a program to design and create a shape in high resolution graphics mode.

Contents:

1. The use of shapes provides another alternative for drawing diagrams on the high resolution screen rather than using HPLOT commands. A high resolution shape is created by executing a sequence of instruction codes known as " plotting vectors ". each vector indicates movement either up, down, right, or left. Vectors can either be " plotted " or " not plotted ", which gives a combination of eight vector outcomes or actions.
2. Each vector action is represented symbolically in binary code as a 3 bit entity. The left most bit is used to define whether the vector is to be plotted or not. The remaining two bits are used to indicate direction. Table 11.1. summarizes these vectors by indicating the vector symbol, its resulting action and its corresponding binary code. The heavily dot at the tail of the

arrow to indicate a plotting vector and the absence of the dot to indicate a non-plotting vector.

3. These vectors are assembled into a sequence of bytes, converted to equivalent decimal numbers, and finally POKE into designated memory locations as DATA in coordination with a READ statement. Table 11.2. illustrated the byte configuration, where at the most three vectors can define a byte. Section A is used to represent the first vector, section B the second, and the section C the third.

Table 11.1. Action of Symbol

Symbol	Action	Binary Code
↑	Move up without plotting	000
→	Move right without plotting	001
↓	Move down without plotting	010
←	Move left without plotting	011
↑	Move up with plotting	100
→	Move right with plotting	101
↓	Move down with plotting	110
←	Move left with plotting	111

Table 11.2. Shape Table Byte

Bit	Section C		Section B			Section A		
	7	6	5	4	3	2	1	0
D = Direction bit P = Plot/No plot bit	D	D	P	D	D	P	D	D

DD = 00 move up
DD = 01 move right
DD = 10 move down
DD = 11 move left

P = 0 do not plot
P = 1 do plot

Procedures:

1. Design the shape: The grid paper was used to draw the outline of the figure as illustrated in Figure 11.1. This drawing is translated into a series of plotting vectors as illustrated in Figure 11.2.
2. Convert vectors to hex: Using the key shown in Table 11.3, convert the vectors into a table of binary bytes and then convert these to hex values as shown in Table 11.4.
3. Add the header: Since up to 255 shapes can be placed in a single shape table a header must be added to indicate how many shapes are stored and where the first

shape begins. This header indicates there is one shape and it starts four bytes from the table beginning (See Program 11.1. Line 50,60). We also must add a zero byte to the end of the shape to indicate the end of the shape.

4. Load the table into memory: There are 17 pieces of data to be entered from lines 50 and 60 by poking memory locations 37888 to 37904. The data in line 60 are the decimal numbers from Table 11.4. Line 300 contains data to set initial conditions for the shape as shown in Figure 11.3.

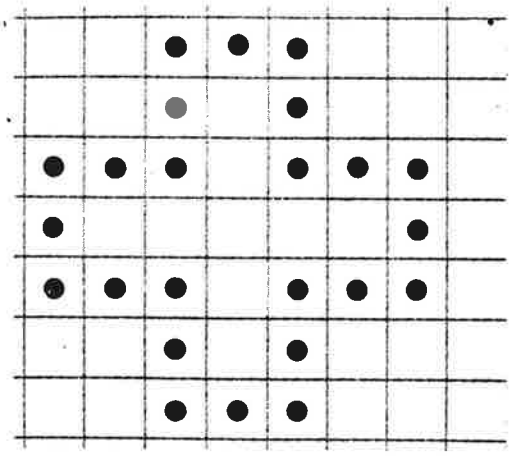

Figure 11.1. Design the Shape

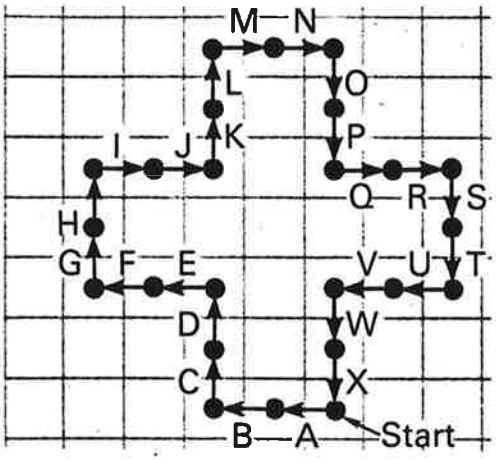

Figure 11.2. Design the Vectors

Table 11.3. Convert the Binary

Vector	Action	Binary Rep.	Vector	Action	Binary Rep.
A	←	111	M	→	101
B	←	111	N	→	101
C	↑	100	O	↓	110
D	↑	100	P	↓	110
E	←	111	Q	→	101
F	←	111	R	→	101
G	↑	100	S	↓	110
H	↑	100	T	↓	110
I	→	101	U	←	111
J	→	101	V	←	111
K	↑	100	W	↓	110
L	↑	100	X	↓	110

Table 11.4. Byte Configuration of the Shape

Byte #	Section C	Section B	Section A	Bin. Rep.	Hex. Rep.	Dec. Rep.
1	—	B	A	00111111	3F	63
2	—	D	C	00100100	24	36
3	—	F	E	00111111	3F	63
4	—	H	G	00100100	24	36
5	—	J	I	00101101	2D	45
6	—	L	K	00100100	24	36
7	—	N	M	00101101	2D	45
8	—	P	O	00110110	36	54
9	—	R	Q	00101101	2D	45
10	—	T	S	00110110	36	54
11	—	V	U	00111111	3F	63
12	—	X	W	00110110	36	54

Program List:

Program 11.1.

```
5  REM :Making a Shape
10  POKE 233,148: POKE 232,0
20  FOR I = 37888 TO 37903
30  READ J
40  POKE I,J
50  DATA  1,0,4,0
60  DATA  63,36,63,36,45,36,45,54
     ,45,54,63,54
70  NEXT I
80 MN
90 X = 140:Y = 80
100  SCALE= 1
110  ROT= 1
120  XDRAW 1 AT X,Y
130  END
```

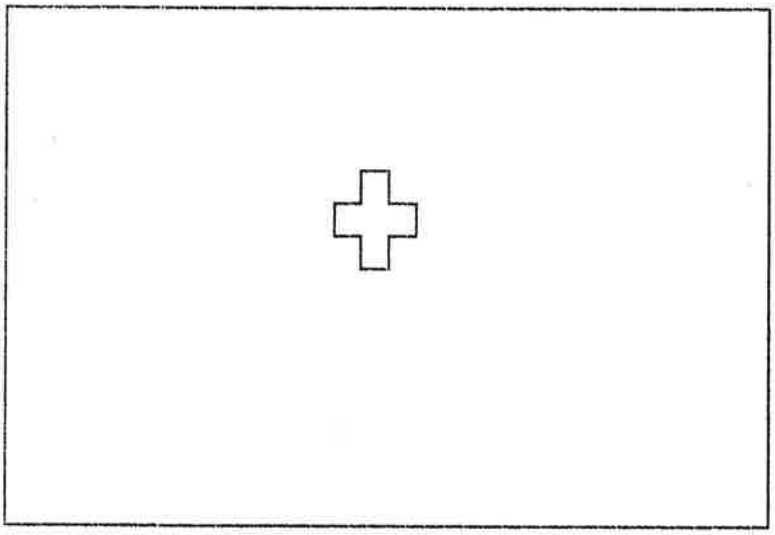

Figure 11.3. Diagram of the Shape

Exercise: Write a program that draws a shape using vectors which determine the DATA for Program 11.1. line 60 to obtain the shape.

Experiment 12

Title: Manipulate the Shapes

Objectives:

At the completion of this unit you will be able to:

1. Explain how shapes can be enlarged and rotated in a variety of positions.
2. Write a program to display and manipulate the shape.

Contents:

1. Shapes are drawn on the screen by using either the DRAW or XDRAW command. Both commands require a high resolution page color be established first, as well as values for a SCALE and ROT command. The parameters for DRAW and XDRAW include a number for the shape to be displayed and a (X,Y) coordinate for its location on the screen.
2. The primary distinction between the DRAW and XDRAW commands is that DRAW plots the shape in the last defined color, while XDRAW plots the shape in the complement of the color found.
3. The SCALE command controls the size of the shape. SCALE = 1 draws the shape in the same size in which it was created. If SCALE = 2 is used, the size of the shape is doubled. Possible values for the SCALE command extend to 255.
4. The ROT command has the effect of rotating the shape

in a clockwise direction but usually distorts the shape to some degree. The acceptable values for ROT = depend on the value used in the SCALE command. Table 12.1. lists the possible ROT values for various SCALE values.

Procedures:

1. In Program 12.1.-- draw the shape at the center of screen first,then use FOR NEXT loop to change the value of SCALE and ROT to enlarge and rotate the shape as shown in Figure 12.1.
2. In line 120 and 130, use two XDRAW commands. The first XDRAW command plots the shape, while the second XDRAW command has the effect of erasing the shape.

Table 12.1. Table of ROT and SCALE

ROT = / SCALE =	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64
1	0°		45°		90°		135°		180°		225°		270°		315°		360°
2	0°	22.5°	45°	67.5°	90°	112.5°	135°	157.5°	180°	202.5°	225°	247.5°	270°	292.5°	315°	337.5°	360°
3	ROT can be assigned any value divisible by 2																
4	ROT can be assigned any integer value 0 through 64																

Program List:

Program 12.1.

```
5  REM :ROT$SCALE
10  POKE 233,148: POKE 232,0
20  FOR I = 37888 TO 37903
30  READ J
40  POKE I,J
50  DATA  1,0,4,0
60  DATA  63,36,63,36,45,36,45,54
     ,45,54,63,54
70  NEXT I
80  HGR : HCOLOR= 3
90 X = 140:Y = 80
100  SCALE= 1
105  FOR B = 1 TO 10
110  FOR A = 1 TO 64
115  SCALE= B
117  ROT= A
120  XDRAW 1 AT X,Y
130  XDRAW 1 AT X,Y
140  NEXT A
145  NEXT B
150  GOTO 80
```

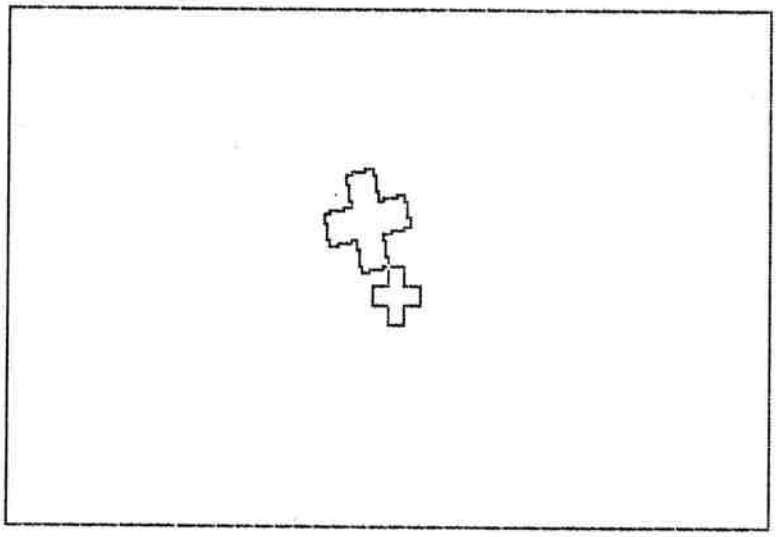

Figure 12.1. Manipulating Shape

Exercise: Write a program to display 4 shapes while ROT = 0, 16, 48,and 64 on the high resolution screen.

Experiment 13

Title: Matrix Representation of Transformations

Objectives:

At the completion of this unit you will be able to:

1. Describe the functions of matrix for transformation of points in a two dimensional plane.
2. Describe the concepts of scaling and reflection.
3. Write a program to scale and reflect the figure.

Contents:

1. Transformations of points in a two dimensional plane may be represented as products of points with 2 * 2 matrices. May transform a point (X,Y) to a new point (X1,Y1) as follows: (X,Y) (A / C , B / D) = (A * X + C * Y , B * X + D * Y) = (X1, Y1) Thus, for each point (X,Y), identify a transformed point (X1,Y1) = (A * X + C * Y ,B * X + D * Y). The effect of a transformation is determined by the choice of values for A, B, C, and D.
2. Scaling may be controlled by a diagonal matrix. (X,Y) (A / 0 , 0 / D) = (A * X , D * Y) The diagonal entries of the matrix may be used to provide independent scaling in the direction of each of the coordinate axes.
3. Reflection of an object through the Y axis or X axis

refers to the process of generating a mirror image of the object on the opposite side of the respective axis. Transformation through the origin (0,0) is represented by the matrix (X,Y) (-1 / 0 , 0 / -1) = (-A , -D).

Procedures:

1. In Program 13.1.-- draw a four- leaf figure, then in line 90 keep C = 5 and D = 5 to enlarge the figure, as shown in Figure 13.1.
2. In program 13.2.-- draw a heart curve, then in line 70 keep A = 1 and D = -1 to reflect the object through X axis, as shown in Figure 13.2.

Program List:

Program 13.1.

```
5  REM :Scaling a Four-leaf Curve

10  HGR : HCOLOR= 3:PI = 3.1416
20 A1 = 0:A2 = 2 * PI
30 N = 90:A = 10
40 INC = (A2 - A1) / N
50  FOR I = A1 TO A2 STEP INC
60 R = A *  COS (2 * I)
70 X = R *  SIN (I):Y = R *  COS
     (I)
80  HPLOT 140 + X,80 + Y
85  REM :Scaling the Curve
90 C = 5:D = 5
100 X1 = C * X:Y1 = D * Y
110  HPLOT 140 + X1,80 + Y1
120  NEXT I
125  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
130  END
```

Program 13.2.

```
5  REM :Reflecting the Heart Curv
     e
10  HGR : HCOLOR= 3
20  HPLOT 60,80 TO 200,80: HPLOT
     130,10 TO 130,150
30  FOR I = 0 TO 6.28 STEP 0.01
40 X = 20 * (1 +  SIN (I)) *  COS
     (I):Y = 20 * (1 +  SIN (I)) *
      SIN (I)
50  HPLOT 130 + X,80 + Y
60  REM :Reflecting the Curve
70 A = 1:D =  - 1
80 X1 = A * X:Y1 = D * Y
90  HPLOT 130 + X1,80 + Y1
100  NEXT I
105  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
110  END
```

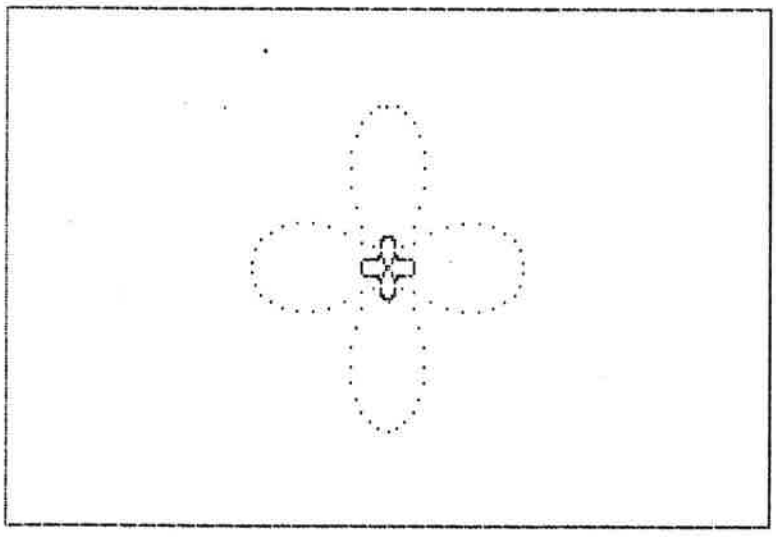

Figure 13.1 Scaling the Four- Leaf Curve

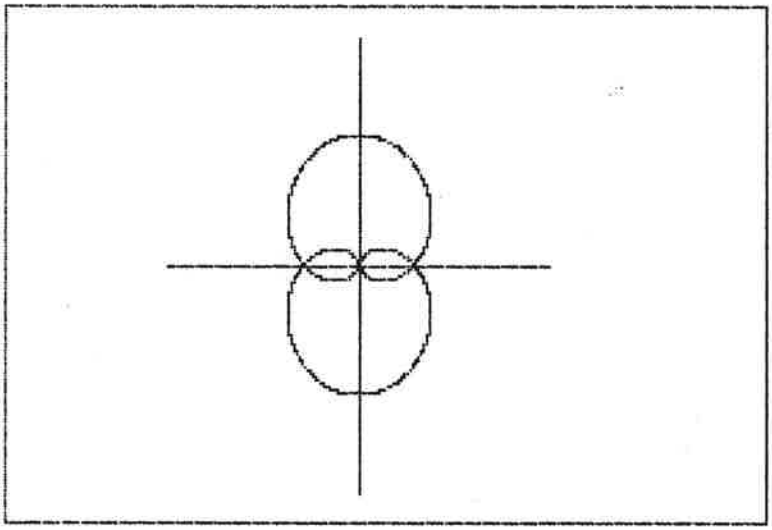

Figure 13.2. Reflecting the Heart Curve

Exercise: Write a program to scale and reflect a ellipse figure.

Experiment 14

Title: Matrix Shear and Rotation

Objectives:

At the completion of this unit you will be able to:

1. Describe the functions and concepts of shear and rotation.
2. Write a program to shear and rotate a figure.

Contents:

1. The effect of the matrix (1 / 0, B / 1) on the points of the figure can be used to shear. Algebraically, (X1,Y1) = (X,Y)(1 / 0, B / 1) = (X, B * X + Y). The transformation is refered to as a Y shear. An X shear is represented by matrices of the form: (1 / C, 0 / 1).
2. The points of an image may be rotated counter clockwise by multiplying the points by the matrix:
   (COS(θ) / - SIN(θ) , SIN(θ) / COS(θ)).
   (X1,Y1) = (X,Y)(COS(θ)/ - SIN(θ), SIN(θ)/ COS(θ))
   = (X * COS(θ) - Y * SIN(θ), X * SIN(θ) + Y * COS(θ)).

Procedures:

1. In Program 14.1.-- draw a three- leaf curve first, then use the equation X1= X and Y1= B * X + Y while keeping B = 5 to shear the curve in the direction of Y axis, as

shown in Figure 14.1.

2. In Program 14.2.-- also draw a three- leaf curve first, then in line 80 and 90 multiply the points by the matrix (COS(θ) / -SIN(θ) , SIN(θ) / COS(θ)) to rotate the curve 60 degrees, as shown in Figure 14.2.

Program List:

Program 14.1.

```
5  REM :Shear the Three-Leaf Curv
     e
10  HGR
20  HCOLOR= 3
30  HPLOT 60,80 TO 200,80: HPLOT
     130,10 TO 130,150
40  FOR I = 0 TO 3.15 STEP 0.01
50 X = 20 *  COS (3 * I) *  COS (
     I):Y = 20 *  COS (3 * I) *  SIN
     (I)
60  HPLOT 130 + X,80 + Y
70  REM :Y Shear
80 MN
90 X1 = X:Y1 = B * X + Y
100  HPLOT 130 + X1,80 + Y1
110  NEXT I
115  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
120  END
```

Program 14.2.

```
5  REM :Rotate the Three-Leaf Cur
     ve
10  HGR
20  HCOLOR= 3
30  HPLOT 60,80 TO 200,80: HPLOT
     130,10 TO 130,150
40  FOR I = 0 TO 3.15 STEP 0.01
50 X = 40 *  COS (3 * I) *  COS (
     I):Y = 40 *  COS (3 * I) *  SIN
     (I)
60  HPLOT 130 + X,80 + Y
70  REM :Rotating the Curve 60 De
     grees
80 A = 1.05
90 X1 = X *  COS (A) - Y *  SIN (
     A):Y1 = X *  SIN (A) + Y *  COS
     (A)
100  HPLOT 130 + X1,80 + Y1
110  NEXT I
115  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
120  END
```

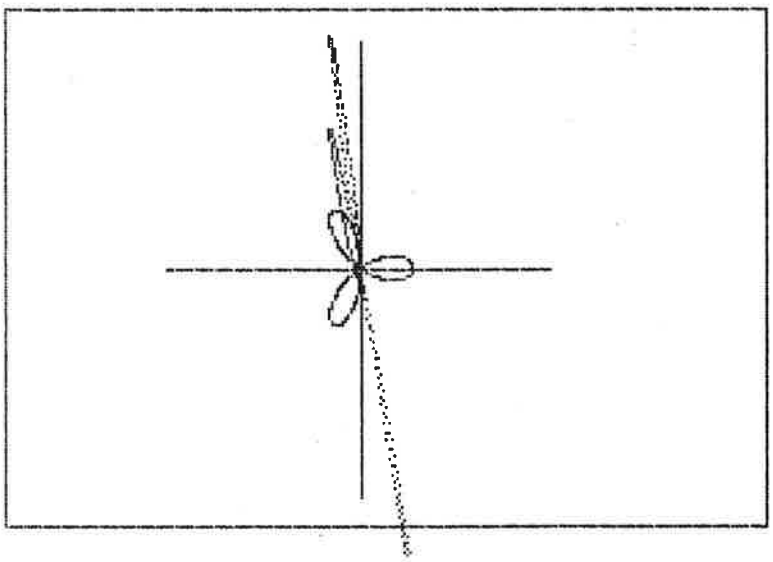

Figure 14.1. Shear the Three- Leaf Curve

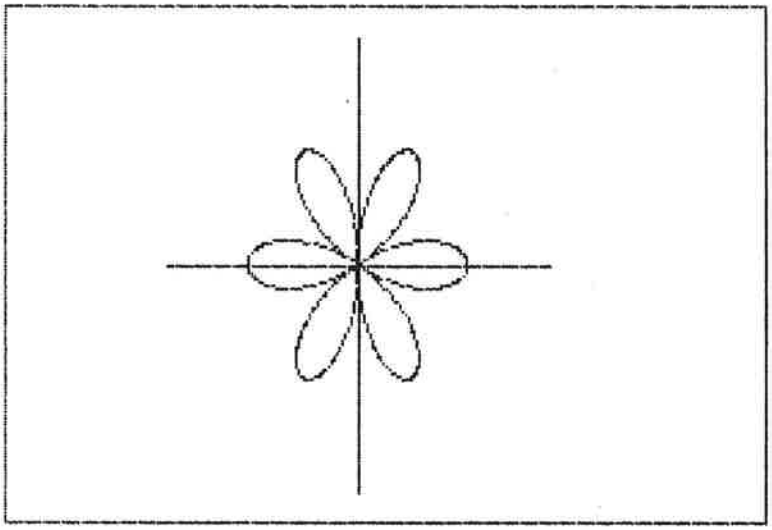

Figure 14.2. Rotate the Three- Leaf Curve

Exercise: Write a program to rotate a hyperbola figure 90 degrees and shear the curve in the direction of X axis.

Experiment 15

Title: Animating Pictures

Objectives:

At the completion of this unit you will be able to:

1. Describe the techniques for moving diagrams on the screen.
2. Write a graphic program for computer- aided instruction.

Contents:

1. Computer animation is the process of moving pictures around the screen either horizontally, vertically or diagonally.
2. The effect of animation is accomplished by successively drawing the picture , then removing it after some appropriate pause, and drawing it again in a new position by either incrementing or decrementing a variable designated for controlling the location of the object.
3. Using HGR or HGR 2 command can remove previous drawing, and then draw a new object on either of the two pages.
4 The effect of drawing an object in a color,then drawing it again in the background color in the same position after an appropriate delay, and looping this procedure offers a more satisfactory animation effect.
5. The quick display of complex diagrams occurs by drawing

the picture on page 1 while page 1 of text is being viewed. The combination of POKE -16304, 0 and POKE -16300,0 established a graphics mode and the viewing of page 1. The same function of POKE -16304, 0 , POKE -16299,0 and POKE -16302,0 established a graphics mode and the viewing of page 2.

Procedures:

1. In Program 15.1.-- the Pascal's Law can be displayed to show how fluids transmit power. In page 1 a cylinder is drawed filled with liquid and an input force working on the surface of piston, as shown in Figure 15.1. This is further illustrated on page 2 by drawing the force being applied throughout the container , as shown in Figure 15.2. Than on page 1, the figure can be changed to show the force acting on the large side of piston that produces a powerful output force, as shown in Figure 15.3.
2. In the program HGR and HGR 2 commands can be used to remove and redraw the force , fluid movement and cylinder, as listed in line 15, 140 and 257.

Program List:

Program 15.1.

```
5  REM :Moving figure
10  HOME
15  REM :PAGE 1
20  HGR : HCOLOR= 3
30 X = 140:Y = 120
40  GOSUB 250
50  HPLOT X - 50,Y - 94 TO X - 50
     ,Y - 84: HPLOT X - 46,Y - 84
      TO X - 54,Y - 84 TO X - 50,
     Y - 80 TO X - 46,Y - 84
60  HPLOT X - 60,Y - 35 TO X - 40
     ,Y - 35 TO X - 40,Y - 30 TO
     X - 60,Y - 30 TO X - 60,Y -
     35
70  HPLOT X - 52,Y - 70 TO X - 52
     ,Y - 35 TO X - 48,Y - 35 TO
     X - 48,Y - 70 TO X - 52,Y -
     70
80 MN
90  HPLOT X + 52,Y - 50 TO X + 58
     ,Y - 50 TO X + 58,Y - 15 TO
     X + 52,Y - 15 TO X + 52,Y -
     50
100  FOR Q = Y - 30 TO Y + 15: HPLOT
     X - 60,Q TO X - 40,Q: NEXT Q

110  FOR Q = X - 40 TO X + 40: HPLOT
     Q,Y TO Q,Y + 15: NEXT Q
120  FOR Q = Y + 15 TO Y - 10 STEP
      - 1: HPLOT X + 40,Q TO X +
     70,Q: NEXT Q
125  HPLOT X + 55,Y - 60 TO X + 5
     5,Y - 70: HPLOT X + 50,Y - 7
     0 TO X + 60,Y - 70 TO X + 55
     ,Y - 78 TO X + 50,Y - 70
130  FOR A = 1 TO 200: NEXT A
135  REM :PAGE 2
138  GET Q$
140  HGR2
150  GOSUB 250
```

```
155  HPLOT X - 50,Y - 84 TO X - 5
     0,Y - 74: HPLOT X - 46,Y - 7
     4 TO X - 54,Y - 74 TO X - 50
     ,Y - 70 TO X - 46,Y - 74
160  HPLOT X - 60,Y - 25 TO X - 4
     0,Y - 25 TO X - 40,Y - 20 TO
     X - 60,Y - 20 TO X - 60,Y -
     25
170  HPLOT X - 52,Y - 60 TO X - 5
     2,Y - 25 TO X - 48,Y - 25 TO
     X - 48,Y - 60 TO X - 52,Y -
     60
180  HPLOT X + 40,Y - 20 TO X + 7
     0,Y - 20 TO X + 70,Y - 15 TO
     X + 40,Y - 15 TO X + 40,Y -
     20
190  HPLOT X + 52,Y - 55 TO X + 5
     8,Y - 55 TO X + 58,Y - 20 TO
     X + 52,Y - 20 TO X + 52,Y -
     55
200  FOR Q = Y - 20 TO Y + 15: HPLOT
     X - 60,Q TO X - 40,Q: NEXT Q

210  FOR Q = X - 40 TO X + 40: HPLOT
     Q,Y TO Q,Y + 15: NEXT Q
220  FOR Q = Y + 15 TO Y - 15 STEP
      - 1: HPLOT X + 40,Q TO X +
     70,Q: NEXT Q
225  HPLOT X + 55,Y - 65 TO X + 5
     5,Y - 75: HPLOT X + 50,Y - 7
     5 TO X + 60,Y - 75 TO X + 55
     ,Y - 83 TO X + 50,Y - 75
230  FOR A = 1 TO 200: NEXT A: GOTO
     257
250  HPLOT X - 60,Y - 40 TO X - 4
     0,Y - 40 TO X - 40,Y TO X +
     40,Y TO X + 40,Y - 40 TO X +
     70,Y - 40 TO X + 70,Y + 15 TO
     X - 60,Y + 15 TO X - 60,Y -
     40
```

```
253  HPLOT 0,0 TO 279,0 TO 279,15
     9 TO 0,159 TO 0,0
255  RETURN
256  GET Q$
257  GET Q$: HGR : GOSUB 250
258  HPLOT X - 50,Y - 74 TO X - 5
     0,Y - 64: HPLOT X - 46,Y - 6
     4 TO X - 54,Y - 64 TO X - 50
     ,Y - 60 TO X - 46,Y - 64
260  HPLOT X - 60,Y - 15 TO X - 4
     0,Y - 15 TO X - 40,Y - 10 TO
     X - 60,Y - 10 TO X - 60,Y -
     15
270  HPLOT X - 52,Y - 50 TO X - 5
     2,Y - 15 TO X - 48,Y - 15 TO
     X - 48,Y - 50 TO X - 52,Y -
     50
280  HPLOT X + 40,Y - 30 TO X + 7
     0,Y - 30 TO X + 70,Y - 25 TO
     X + 40,Y - 25 TO X + 40,Y -
     30
290  HPLOT X + 52,Y - 65 TO X + 5
     8,Y - 65 TO X + 58,Y - 30 TO
     X + 52,Y - 30 TO X + 52,Y -
     65
300  FOR Q = Y - 10 TO Y + 15: HPLOT
     X - 60,Q TO X - 40,Q: NEXT Q

310  FOR Q = X - 40 TO X + 40: HPLOT
     Q,Y TO Q,Y + 15: NEXT Q
320  FOR Q = Y + 15 TO Y - 25 STEP
      - 1: HPLOT X + 40,Q TO X +
     70,Q: NEXT Q
325  HPLOT X + 55,Y - 75 TO X + 5
     5,Y - 85: HPLOT X + 50,Y - 8
     5 TO X + 60,Y - 85 TO X + 55
     ,Y - 93 TO X + 50,Y - 85
330  FOR A = 1 TO 150: NEXT A
340  GET Q$: GOTO 10
```

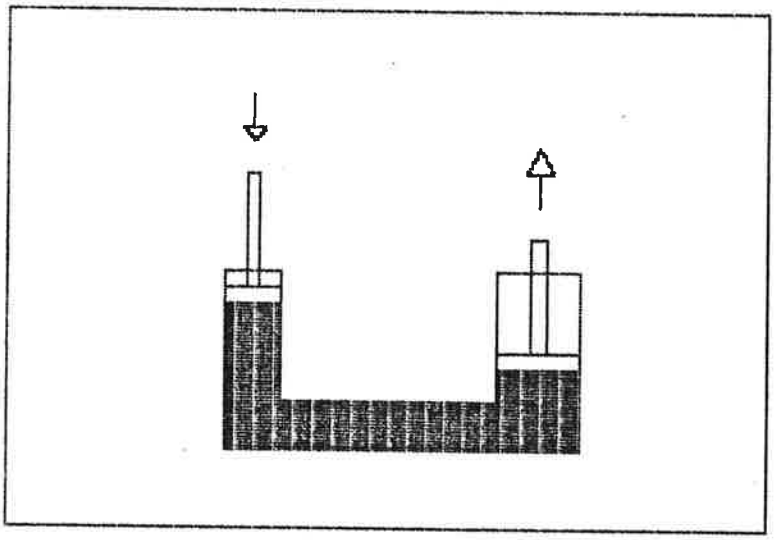

Figure 15.1 Plot of Cylinder 1

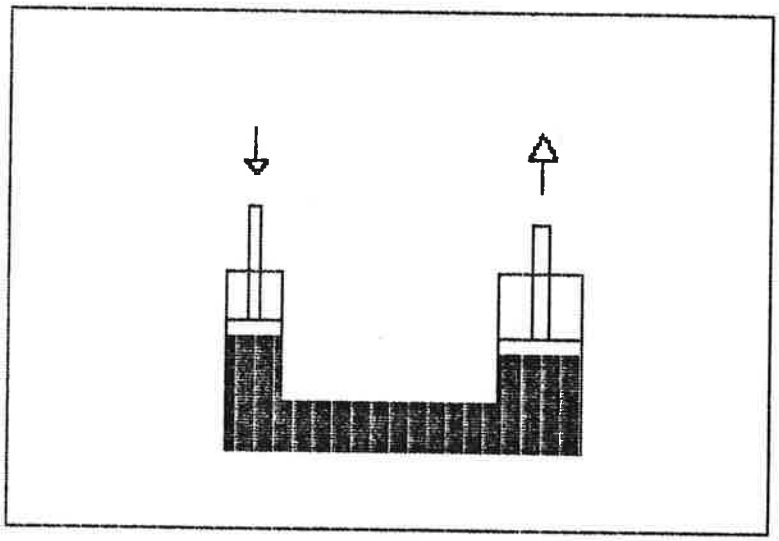

Figure 15.2. Plot of Cylinder 2

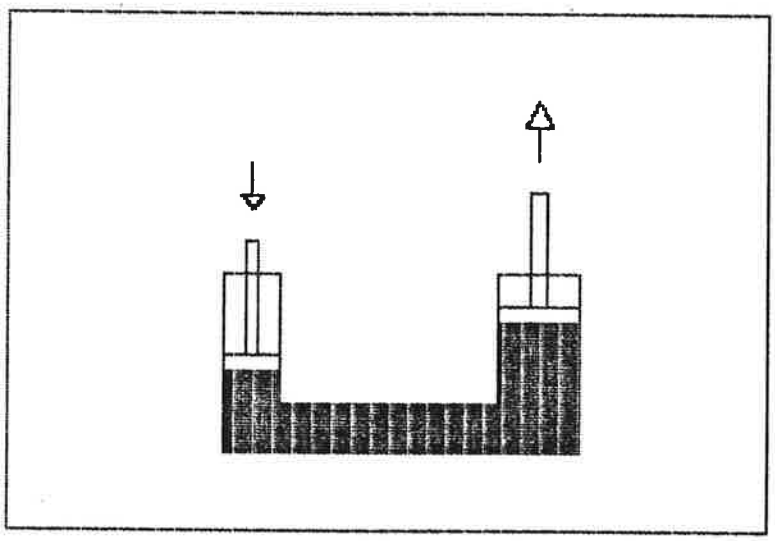

Figure 15.3. Plot of Cylinder 3

Exercise: Write a program to animate a simple electric circuit diagram for computer- aided instruction.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Restatement of the Objectives

The purpose of this study is to develop course materials that will assist secondary school Technology Education instructors in updating their computer- aided drafting knowledge. In order to fulfill this purpose, it was necessary to meet the following objectives:

1. Determine what content is important and easily understood by reviewing the library resource, related literature, and information.
2. Select content and develop fifteen laboratory experiments on the fundamentals of computer- aided drafting for the secondary school Technology Education instructors.
3. Develop a model computer program (CREATE) that will aid the Technology Education in the implementation of computer- aided drafting.

Summary

In the past few years computer- aided drafting (CAD) has grown at a phenomenal rate. No recent breakthrough

or scientific discovery has made this possible.

Applications are achieved to a large ranges. In industry, engineers, technicans, and architects are increasingly using CAD to design and analysis. CAD systems are destined to become a major industrial tool. In education, CAD is used by the simulation and games. Simulation is a powerful technique that may be used to imitate or replicate some aspect of the world. Its purpose is to help students build a useful mental model of part of the world, and to provide an opportunity to test it safely and efficiently. Games are becoming more popular in the instructional setting because of their potential for motivating students to learn. In technical education, CAD will be practiced in mechanical, electrical, architectual, or structual drafting courses. Students should be taught and trained CAD skills and knowledge to be better prepared the desire of industry and business. So the Technology Education instructors be aware and competent in CAD to bridge from the current drafting technology to the future developments in industry.

Instructional materials must be prepared that will assist the secondary school Technology Education instructors to cope with the CAD trend. It was the purpose of this study to develop course materials which should be available to instuctors concerning the concepts, functions

and programming techniques of CAD. The content was grouped into the fifteen units. These units were arranged in sequential order essential for the delivering of an instructional program in Industrial Education. laboratory experiments were designed and developed for each of the units.

The experimental environment of the study was limited to CAD equipment available in the Industrial Technology Department at the University of North Dakota.

Conclusions

The following conclusions were based on the review of the literature and results of the actual performance testing of the experiments.

1. CAD is a faster method of creating drawings.
2. CAD systems give designers more time to experiment with new designs that might otherwise have gone untested.
3. CAD eliminates the drudgery of the drawing process.
4. CAD offers control and flexibility in drawing creation.
5. The memory capabilities of APPLE computer is not adequate to deal with complex drawings.
6. The high resolution graphics of the APPLE computer does not permit text to be displayed concurrently with graphics.
7. Requirements for program entry should include computer

language and technical mathmatics.

8. The activities in each experiment were flexible,modifications and changes may be needed for special purpose.
9. The CREATE CAD program can provide an effective and low cost instruction to the field of computer- aided drafting.

Recommendations

Based upon the results of the study, it was recommended that:

1. Further modifications and / or refinements to the laboratory experiments could be designed and tested.
2. More research be needed on the effects of CAD with students of special needs.
3. There is a tremendous need for in-service training on the uses and potential of the CAD. The development of simpler programming techniques will provide Technology Education instructors with greater control over the content of CAD materials.
4. Technology Education instructors be encouraged to share CAD experiences in their classes; this could be accomplished through the establishment of a net work.
5. Further investigation be done on the advancements which have been used or will be used in CAD programs and systems.

APPENDIX

APPLE IIe

COMPUTER - AIDED DRAFTING

CREATE PROGRAM

```
5  REM :MAIN MENU
10  TEXT : HOME
15  PRINT  TAB( 17);"MAIN MENU"
20  PRINT : PRINT
30  PRINT "1.DRAW THE PICTURE "
40  PRINT
50  PRINT "2.ADD TEXT"
60  PRINT
70  PRINT "3.ADD DIMENSIONS"
80  PRINT
90  PRINT "4.SAVE THE DRAWING"
100  PRINT
110  PRINT "5.PRINT OUT"
120  PRINT
130  PRINT "6.QUIT"
140  PRINT
150  PRINT
160  INPUT "SELECTING THE NUMBER YOU WANT TO DO. ==)";I
170  IF I = 1 THEN  PRINT  CHR$ (4);"RUN CREATE"
180  IF I = 2 THEN  PRINT  CHR$ (4);"RUN TEXTLN2"
190  IF I = 3 THEN  PRINT  CHR$ (4);"RUN DIMENSION"
200  IF I = 4 THEN 280
210  IF I = 5 THEN 400
220  IF I = 6 THEN 500
230  IF I = 0 OR I >  = 7 THEN 5
260  ONERR  GOTO 360: HOME : VTAB (22)
280  PRINT "INSERT THE WORK DISK"
290  PRINT : PRINT : INPUT "TYPE IN THE FILE NAME:";A$
300  HOME : VTAB (22): HTAB (10): PRINT "SAVING THE DRAWING"
310  PRINT  CHR$ (4);"BSAVE";A$;",A$2000,L$2000"
320  HOME : VTAB (22): INVERSE : FLASH : PRINT "INSERT THE MASTER DISK": NORMAL

330  PRINT "PRESS 'RETURN KEY' TO CONTINUE"
340  INPUT X$
350  GOTO 10
355  REM :ERROR ROUTINE
360 E =  PEEK (222)
370  IF E = 9 THEN  PRINT "DISK FULL": FOR A = 1 TO 1000: NEXT A: GOTO 5
380  IF E = 4 THEN  PRINT "WRITE PROTECT": FOR B = 1 TO 1000: NEXT B: GOTO
     5
390  POKE 216,0: REM  CLOSE ERROR ROUTINE
400  HOME
410  VTAB 5: HTAB 5: PRINT " 1. EPSON SCREEN DUMP "
420  VTAB 10: HTAB 5: PRINT " 2. PARAGRAPH SCREEN DUMP"
440  PRINT : INPUT "SELECT ONE ===)";P$
450  IF P$ = "1" THEN  PRINT  CHR$ (4);"RUN EPSON SCREEN DUMP"
460  IF P$ = "2" THEN  PRINT  CHR$ (4);" RUN PARAGRAPH SCREEN DUMP "
480  GOTO 10
500  HOME
510  PRINT  TAB( 20): INVERSE : FLASH "BE SURE THE DRAWING IS SAVED.IF NOT
      TYPE 'N' GO BACK TO MENU TO SAVE THE DRAWING.": NORMAL
520  VTAB (23): HTAB (10): INPUT "ARE YOU SURE (Y/N)?";J$
530  IF J$ = "Y" THEN 550
540  IF J$ = "N" THEN 10
550  PRINT : PRINT "END OF THE PROGRAM"
```

Apple IIe Computer Create Program Continued

```
1  HGR : TEXT
2  PRINT  CHR$ (4);"BLOAD SHAPE ALPHABET,A$800"
3  POKE 232,0: POKE 233,8
5  REM :CREATE DRAFTING PROGRAM FOR APPLE COMPUTER
7  HOME : PRINT "          CREATE  PROGRAM          "
10  PRINT : PRINT : PRINT "SELECT THE APPROPRIATE NUMBER WHICH YOU LIKE TO
     DO."
20  PRINT : PRINT : PRINT "1.CREATE A NEW DRAWING  "
30  PRINT : PRINT : PRINT "2.MODIFY AN OLD DRAWING SAVED IN THE DISK "
40  PRINT : PRINT : PRINT "3.CONTINUE A DRAWING WHICH STILL SAVED IN THE M
    EMORY "
50  PRINT : PRINT : INPUT "WHICH ONE ====)";N
60  IF N = 1 THEN  GOSUB 5000
70  IF N = 2 THEN  GOSUB 5200
80  IF N = 3 THEN  GOSUB 5400
90  IF N )  = 4 OR N = 0 THEN 10
99  POKE  - 16301,0: HCOLOR= 3: SCALE= 1: ROT= 0
100  VTAB 22: HCOLOR= 3: PRINT "1.LINE 2.CIRC 3.ARC 4.RECT 5.ELLIPSE 6.DIM
     7.TEXT 8.PRINT 9.SAVE 10.MENU 11.EXIT "
110  INPUT "PRESS THE NUMBER=====)";A
120  IF A = 1 THEN 220
130  IF A = 2 THEN 1750
140  IF A = 3 THEN 2050
150  IF A = 4 THEN 2850
160  IF A = 5 THEN 3350
170  IF A = 6 THEN 3270
172  IF A = 7 THEN 3250
175  IF A = 8 THEN 3310
180  IF A = 9 THEN 3290
182  IF A = 10 THEN  TEXT : GOTO 7
185  IF A = 11 THEN 3330
190  INVERSE : FLASH : PRINT "UNRECOGNIZABLE ELEMENT TYPE.TRY AGAIN!": NORMAL

195  PRINT  CHR$ (7): FOR I = 0 TO 1000: NEXT I
200  GOTO 100
220  REM :DRAW A LINE
230  ONERR  GOTO 5500: REM  ERROR DETECTE
240  HOME : VTAB (22): PRINT "PRESS THE NUMBER 1.LINE 2.VER 3.HOR 4.PAL 5.
    L&A 6.POINT 7.QUIT "
250  INPUT A$
260  IF A$ = "1" THEN 397
270  IF A$ = "2" THEN 680
280  IF A$ = "3" THEN 910
290  IF A$ = "4" THEN 1040
300  IF A$ = "5" THEN 1350
310  IF A$ = "6" THEN 1550
320  IF A$ = "7" THEN 100
330  IF A$ = "0" OR A$ ) "7" THEN 220
350  REM :DRAW CONTINUOUS LINE
360  HOME : VTAB (21): PRINT "SELECT THE METHOD OF INPUT :"
370  PRINT "1.COORDINATE METHOD "
380  PRINT "2.CURSOR METHOD "
390  PRINT "3.EXIT"
395  INPUT "ENTER THE NUMBER ====)":A: RETURN
```

Apple IIe Computer Create Program Continued

```
397  GOSUB 360
400  IF A = 1 THEN 460
410  IF A = 2 THEN 670
420  IF A = 3 THEN 220
430  INPUT "INPUT THE FIRST POINT (X1,Y1)= ";X1,Y1
440  INPUT "INPUT THE SECOND POINT (X2,Y2)= ";X2,Y2
450  GOSUB 520
455  RETURN
460  GOSUB 430
465  HPLOT X1,Y1 TO X2,Y2
470  INPUT "1.OK 2.ERASE  SELECT ONE ==)";N
480  IF N = 1 THEN 500
490  IF N = 2 THEN  HCOLOR= 0: GOTO 465
500  HCOLOR= 3: GOTO 397
520  IF X1 < 0 THEN X1 = 0
530  IF X1 > 279 THEN X1 = 279
540  IF Y1 < 0 THEN Y1 = 0
550  IF Y1 > 159 THEN Y1 = 159
560  IF X2 < 0 THEN X2 = 0
570  IF X2 > 279 THEN X2 = 279
580  IF Y2 < 0 THEN Y2 = 0
590  IF Y2 > 159 THEN Y2 = 159
600  RETURN
610  HOME : VTAB 21: PRINT "INPUT THE FIRST POINT (X1,Y1)": FOR A = 1 TO 1
     000: NEXT A
620  GOSUB 6000
630 X1 = VT:Y1 = HT
640  VTAB 21: PRINT "INPUT THE SECOND POINT (X2,Y2) ": FOR B = 1 TO 1000: NEXT
     B
650  GOSUB 6000
660 X2 = VT:Y2 = HT
665  RETURN
670  GOSUB 610
675  GOSUB 450
676  HCOLOR= 3: HPLOT X1,Y1 TO X2,Y2: GOTO 470
680  REM :DRAW VER LINE
690  GOSUB 360
740  IF A = 1 THEN 770
750  IF A = 2 THEN 840
760  IF A = 3 THEN 220
770  GOSUB 430
800  HPLOT X1,Y1 TO X1,Y2
810  INPUT "1.OK 2.ERASE  SELECT ONE ==)";N
820  IF N = 1 THEN  HCOLOR= 3: GOTO 690
830  IF N = 2 THEN  HCOLOR= 0: GOTO 800
840  GOSUB 610
850  GOSUB 450
860  GOTO 800
910  REM :DRAW HOR LINE
920  GOSUB 360
930  IF A = 1 THEN 960
940  IF A = 2 THEN 1010
950  IF A = 3 THEN 220
960  GOSUB 430
970  HPLOT X1,Y1 TO X2,Y1
980  INPUT "1.OK 2.ERASE  SELECT ONE==)";N
```

Apple IIe Computer Create Program Continued:

```
990  IF N = 1 THEN  HCOLOR= 3: GOTO 920
1000  IF N = 2 THEN  HCOLOR= 0: GOTO 970
1010  GOSUB 610
1020  GOSUB 450
1030  GOTO 970
1040  REM :DRAW PAL LINE
1050  GOSUB 360
1060  IF A = 1 THEN 1090
1070  IF A = 2 THEN 1305
1080  IF A = 3 THEN 220
1090  GOSUB 430
1100  HPLOT X1,Y1 TO X2,Y2
1110  INPUT "INPUT THE DISTANCE FROM THE ORIGINAL LINE (+/- D)==> ";D
1130  IF Y1 = Y2 THEN P = Y1 + D:Q = Y2 + D: GOTO 1230
1140 M = X1 + D:N = X2 + D
1150  IF M < 0 THEN 1210
1160  IF M > 279 THEN 1210
1170  IF N < 0 THEN 1210
1180  IF N > 279 THEN 1210
1190  HPLOT M,Y1 TO N,Y2
1192  INPUT "1.OK 2.ERASE   SELECT ONE ==> ";N
1195  IF N = 1 THEN  HCOLOR= 3: GOTO 1050
1200  IF N = 2 THEN  HCOLOR= 0: GOTO 1140
1210  PRINT "X IS OUT OF SCREEN,TRY AGAIN"
1220  GOTO 1110
1230  IF P < 0 THEN 1290
1240  IF P > 159 THEN 1290
1250  IF Q < 0 THEN 1290
1260  IF Q > 159 THEN 1290
1270  HPLOT X1,P TO X2,Q
1275  INPUT "1.OK 2.ERASE  SELECT ONE ==>";N
1280  IF N = 1 THEN  HCOLOR= 3: GOTO 1050
1285  IF N = 2 THEN  HCOLOR= 0: GOTO 1130
1290  PRINT "Y IS OUT OF SCREEN,TRY AGAIN"
1300  GOTO 1110
1305  GOSUB 610
1320  GOSUB 450
1330  GOTO 1100
1350  REM :DRAW LINE WITH L&A
1360  GOSUB 360
1370  IF A = 1 THEN 1400
1380  IF A = 2 THEN 1510
1390  IF A = 3 THEN 220
1400  INPUT "INPUT THE FIRST POINT OF THE LINE (X,Y)= ";X,Y
1410  INPUT "INPUT THE LENGTH OF THE LINE  L= ";L
1420  IF L = 0 THEN 1400
1430  INPUT "INPUT ANGLE  A= ";A
1440 I =  - A / 360 * 6.2832
1450 X1 = X + L *  COS (I):Y1 = Y + L *  SIN (I)
1460  GOSUB 520
1470  HPLOT X,Y TO X1,Y1
1480  INPUT "1.OK  2.ERASE   SELECT ONE==> ";N
1490  IF N = 1 THEN  HCOLOR= 3:X = X1:Y = Y1: GOTO 1360
1500  IF N = 2 THEN  HCOLOR= 0: GOTO 1470
1510  HOME : VTAB 22: PRINT "INPUT THE FIRST POINT (X,Y)"
```

Apple IIe Computer Create Program continued:

```
 1520  GOSUB 6000
 1530 X = VT:Y = HT
 1540  GOTO 1410
 1550  REM :DRAW POINT
 1560  GOSUB 360
 1570  IF A = 1 THEN 1600
 1580  IF A = 2 THEN 1710
 1590  IF A = 3 THEN 220
 1600  INPUT "INPUT POINT (X,Y)= ";X,Y
 1610 A = X - 1:B = X + 1:C = Y - 1:D = Y + 1
 1620  IF A < 0 THEN A = 0
 1630  IF B > 279 THEN B = 279
 1640  IF C < 0 THEN C = 0
 1650  IF D > 159 THEN D = 159
 1660  HPLOT A,Y TO B,Y
 1670  HPLOT X,D TO X,C
 1680  INPUT "1.OK 2.ERASE  SELECT ONE==> ";N
 1690  IF N = 1 THEN 1560
 1700  IF N = 2 THEN  HCOLOR= 0: GOTO 1660
 1710  HOME : VTAB 22: PRINT "INPUT THE POINT (X,Y) "
 1720  GOSUB 6000
 1730 X = VT:Y = HT
 1740  GOTO 1610
 1750  REM :DRAW A CIRCLE
 1760  ONERR  GOTO 5500: REM  ERROR DETECT
 1770  GOSUB 360
 1780  IF A = 1 THEN 1810
 1790  IF A = 2 THEN 1990
 1800  IF A = 3 THEN 100
 1810  INPUT "INPUT THE CENTER POINT (X1,Y1)= ";X1,Y1
 1820  INPUT "INPUT THE RADIUS  R= ";R
 1830 PI = 3.1416
 1840 A1 = 0:A2 = 2 * PI
 1850 N = 100
 1860 INC = (A2 - A1) / N
 1870  FOR I = A1 TO A2 STEP INC
 1880 X = R *  SIN (I) * 1.2:Y = R *  COS (I)
 1890 M = X1 + X:N = Y1 + Y
 1900  IF M < 0 THEN M = 0
 1910  IF M > 279 THEN M = 279
 1920  IF N < 0 THEN N = 0
 1930  IF N > 159 THEN N = 159
 1940  HPLOT M,N
 1950  NEXT I
 1960  INPUT "1.OK  2.ERASE   SELECT ONE ==> ";N
 1970  IF N = 1 THEN  HCOLOR= 3: GOTO 1770
 1980  IF N = 2 THEN  HCOLOR= 0: GOTO 1830
 1990  HOME : VTAB 22: PRINT "INPUT THE CENTER POINT (X1,Y1) "
 2000  GOSUB 6000
 2010 X1 = VT:Y1 = HT
 2020  GOTO 1820
 2050  REM :DRAW A ARC
 2060  PRINT "ARC METHOD PLOTTING"
 2070  INPUT "(1). 3 POINTS  (2).C.B.E.R (3). EXIT  CHOOSE ONE  ";T$
```

Apple IIe Computer Create Program Continued:

```
2080  IF T$ = "1" THEN 2100
2090  IF T$ = "2" THEN 2580
2095  IF T$ = "3" THEN 100
2100  IF T$ ) "3" THEN 2050
2105  ONERR  GOTO 5500: REM  ERROR DETECT
2110  GOSUB 360
2120  IF A = 1 THEN 2150
2130  IF A = 2 THEN 2470
2140  IF A = 3 THEN 2050
2150  INPUT "INPUT THE CIRCLE CENTER POINT (XC,YC)= ";XC,YC
2160  INPUT "INPUT THE BEGINNING POINT (XB,YB)= ";XB,YB
2170  INPUT "INPUT THE END POINT (XE,YE)= ";XE,YE
2180  INPUT "INPUT ANGLE INCREMENT (DEGREE) ";DPHI
2190 DPHI = DPHI * 3.1416 / 180
2200 A = XB - XC:B = YB - YC
2210 RB =  SQR (A * A + B * B)
2220 UX = A / RB:UY = B / RB
2230 A = XE - XC:B = YE - YC
2240 RE =  SQR (A * A + B * B)
2250 VX = A / RE:VY = B / RE
2260 A = UX * VY - UY * VX
2270  IF A = 0 THEN WZ = 1: GOTO 2290
2280 WZ = (UX * VY - UY * VX) /  SQR ((UX * VY - UY * VX) ^ 2)
2290 NX =  - WZ * UY
2300 NY = WZ * UX
2310  DEF  FN AC(A) =  - ANT(A /  SQR ( - A * A + 1)) + 1.5708
2320 A = UX * VX + UY * VY
2330 PT =  FN AC(A)
2340 R = (RB + RE) / 2
2350 PT = PT * 1.01
2360  HPLOT XB,YB
2370  FOR PHI = 0 TO PT STEP DPHI
2380 AA = R *  COS (PHI)
2390 BB = R *  SIN (PHI)
2400 X = XC + AA * UX + BB * NX
2410 Y = YC + AA * UY + BB * NY
2420  HPLOT  TO X,Y
2430  NEXT PHI
2440  INPUT "1.OK 2.ERASE   SELECT ONE==)";N
2450  IF N = 1 THEN  HCOLOR= 3: GOTO 2110
2460  IF N = 2 THEN  HCOLOR= 0: GOTO 2190
2470  HOME : VTAB 22: PRINT "INPUT THE CENTER POINT (XC,YC) "
2480  GOSUB 6000
2490 XC = VT:YC = HT
2500  VTAB 23: PRINT "INPUT THE BEGINNING POINT (XB,YB) "
2510  GOSUB 6000
2520 XB = VT:YB = HT
2530  VTAB 24: PRINT "INPUT THE END POINT (XE,YE)"
2540  GOSUB 6000
2550 XE = VT:YE = HT
2560  GOTO 2180
2580  REM :C.B.E.R
2590  ONERR  GOTO 5500
2600  GOSUB 360
2610  IF A = 1 THEN 2640
```

Apple IIe Computer Create Program Continued:

```
2620  IF A = 2 THEN 2800
2630  IF A = 3 THEN 2050
2640  INPUT "INPUT THE CIRCLE CENTER (XC,YC)= ";XC,YC
2650  INPUT "RADIUS= ";RAD
2660  INPUT "INPUT THE BEGINNING ANGLE (DEGREE) ";P1
2670  INPUT "INPUT THE END ANGLE (DEGREE) ";P2
2680  INPUT "INPUT ANGLE INCREMENT (DEGREE) ";DPHI
2690 DPHI = DPHI * 3.1416 / 180
2700 P1 = P1 * 3.1416 / 180:P2 = P2 * 3.1416 / 180
2710 R = RAD
2720  FOR PHI = P1 TO P2 STEP DPHI
2730 X = R *  COS ( - PHI) * 1.2:Y = R *  SIN ( - PHI)
2740 X = XC + X:Y = YC + Y
2750  HPLOT X,Y
2760  NEXT PHI
2770  INPUT "1.OK 2.ERASE  SELECT ONE ==)  ";N
2780  IF N = 1 THEN  HCOLOR= 3: GOTO 2600
2790  IF N = 2 THEN  HCOLOR= 0: GOTO 2720
2800  HOME : VTAB 22: PRINT "INPUT THE CIRCLE CENTER (XC,YC)"
2810  GOSUB 6000
2820 XC = VT:YC = HT
2830  GOTO 2650
2850  REM :DRAW A RECTANGLE
2870  INPUT "1.RECTANGLE 2.BORDER 3.EXIT  CHOOSE ONE ===)";A$
2880  IF A$ = "1" THEN 2920
2890  IF A$ = "2" THEN 3140
2900  IF A$ = "3" THEN 100
2910  IF A$ ) "3" THEN 2850
2920  ONERR  GOTO 5500
2930  GOSUB 360
2940  IF A = 1 THEN 2970
2950  IF A = 2 THEN 3070
2960  IF A = 3 THEN 2870
2970  INPUT "INPUT THE ORIGINAL POINT (X1,Y1)= ";A1,B1
2980  INPUT "INPUT THE OPPOSITE POINT (X2,Y2)= ";A2,B2
2990  IF A1 = A2 THEN 3050
3000  IF B1 = B2 THEN 3050
3010  HPLOT A1,B1 TO A1,B2 TO A2,B2 TO A2,B1 TO A1,B1
3020  INPUT "1.OK 2.ERASE  SELECT ONE ==) ";N
3030  IF N = 1 THEN  HCOLOR= 3: GOTO 2930
3040  IF N = 2 THEN  HCOLOR= 0: GOTO 3010
3050  PRINT "THE TWO POINTS ARE IN THE SAME LINE ,TRY AGAIN."
3060  GOTO 2930
3070  HOME : VTAB 22: PRINT "INPUT THE ORIGINAL POINT (X1.Y1)"
3080  GOSUB 6000
3090 A1 = VT:B1 = HT
3100  VTAB 22: PRINT "INPUT THE OPPOSITE POINT  (X2,Y2) "
3110  GOSUB 6000
3120 A2 = VT:B2 = HT
3130  GOTO 2990
3140  REM :BORDER
3150  HCOLOR= 3
3160  HPLOT 0,0 TO 270,0 TO 270,159 TO 0,159 TO 0,0
3170  HPLOT 180,130 TO 270,130
3180  HPLOT 180,140 TO 270,140
```

Apple IIe Computer Create Program Continued:

```
3190  HPLOT 180,150 TO 270,150
3200  HPLOT 180,130 TO 180,159
3220  INPUT "1.OK 2.ERASE  SELECT ONE ==)";N
3230  IF N = 1 THEN  HCOLOR= 3: GOTO 2870
3240  IF N = 2 THEN  HCOLOR= 0: GOTO 3160
3250  REM :TEXT
3260  PRINT  CHR$ (4);"RUN TEXTLN2"
3270  REM :DIM
3280  PRINT  CHR$ (4);"RUN DIMENSION"
3290  REM :SAVE
3300  PRINT  CHR$ (4);"RUN MAIN MENU"
3310  REM :PRINT
3320  PRINT  CHR$ (4);"RUN MAIN MENU"
3330  REM :EXIT
3340  PRINT  CHR$ (4);"RUN MAIN MENU"
3350  REM :DRAW AN ELLIPSE.
3360  GOSUB 360
3370  IF A = 1 THEN 3400
3380  IF A = 2 THEN 3540
3390  IF A = 3 THEN 100
3400  INPUT "INPUT THE CENTER POINT (X1,Y1)";CX,CY
3410  INPUT "INPUT THE SEMIMAJOR  A= ";A
3420  INPUT "INPUT THE SEMIMINOR  B= ";B
3425  HCOLOR= 3
3430 SC = 1.16
3440  FOR TH = 0 TO 6.4 STEP 0.1
3450 X = A *  COS (TH):Y = B *  SIN (TH)
3460 SX = SC * X + CX:SY = CY - Y
3470  IF SX < 0 OR SX > 279 OR SY < 0 OR SY > 159 THEN FL = 0: GOTO 3510
3490  HPLOT SX,SY
3510  NEXT TH
3520  INPUT "1.OK 2 ERASE  SELECT ONE ==)";N
3530  IF N = 1 THEN  HCOLOR= 3: GOTO 3350
3535  IF N = 2 THEN  HCOLOR= 0: GOTO 3430
3540  HOME : VTAB 22: PRINT "INPUT THE CENTER POINT (X1,Y1)"
3545  GOSUB 6000
3550 CX = VT:CY = HT
3560  GOTO 3410
5000  REM :CREATE A NEW DRAWING
5010  HGR : HCOLOR= 3: RETURN
5200  REM :MODIFY AN OLD DRAWING SAVED IN THE DISK
5210  HOME : VTAB 12: PRINT "INSERT YOUR DRAWING WORK DISK"
5220  INPUT "PRESS 'RETURN' TO CONTINUE";A$
5230  PRINT  CHR$ (4);"CATALOG"
5240  PRINT : PRINT "WHAT IS THE FILENAME OF THE DRAWING?": INPUT A$
5250  HGR : VTAB 23: HOME : VTAB 22: PRINT "LOAD DRAWING"
5260  PRINT  CHR$ (4);"BLOAD";A$;",A$2000"
5270  POKE  - 16300,0: POKE  - 16301,0: POKE  - 16297,0: POKE  - 16304,0
5280  RETURN
5400  POKE  - 16300,0: POKE  - 16301,0: POKE  - 16297,0: POKE  - 16304,0
5410  RETURN
5500 E =  PEEK (222): REM  ERROR ROUTINE
5510  IF E = 53 OR E = 254 OR E = 255 THEN 180
5520  POKE 216,0: REM :CLOSE ERROR ROUTINE
5530  RESUME
```

Apple IIe Computer Create Program Continued:

```
6000  PRINT "MOVE THE CURSOR"
6010  PRINT "USING I,J,K,M. PRESS Z TO SET THE POINT (X,Y) ==)";
6020  HCOLOR= 3:P = 3:Q = 3
6030  GET A$:P1 = P:Q1 = Q
6040  XDRAW 11 AT P1,Q1: HCOLOR= 3
6050  IF A$ = "I" THEN Q = Q - 3: GOTO 6100
6060  IF A$ = "M" THEN Q = Q + 3: GOTO 6100
6070  IF A$ = "J" THEN P = P - 3: GOTO 6100
6080  IF A$ = "K" THEN P = P + 3: GOTO 6100
6090  IF A$ = "Z" THEN  GOTO 6170
6100  IF P (  = 3 THEN P = 3
6110  IF Q (  = 3 THEN Q = 3
6120  IF P )  = 276 THEN P = 276
6130  IF Q )  = 156 THEN Q = 156
6140  XDRAW 11 AT P,Q: HOME
6150  VTAB 21: HTAB 27: PRINT "X= ";P;"  ";"Y= ";Q;"  "
6160  GOTO 6030
6170 P = P + 3:Q = Q - 3
6180 VT = P:HT = Q: HPLOT P,Q: RETURN
```

Apple IIe Computer Create Program Continued:

```
5  REM : TEXT PROGRAM
10  POKE  - 16300,0: POKE  - 16301,0: POKE  - 16297,0: POKE  - 16304,0
20  REM :TEXT LN2
30  PRINT  CHR$ (4);"BLOAD SHAPE ALPHABET,A$800"
40  POKE 232, PEEK (43634): POKE 233, PEEK (43635)
50  HOME : HCOLOR= 3
60  HOME : VTAB 21: PRINT "SELECT THE METHOD :": FOR A = 1 TO 1000: NEXT A

70  VTAB 22: PRINT "1.COORDINATE METHOD:
80  PRINT "2.CURSOR METHOD "
90  PRINT "3.EXIT"
100  INPUT "ENTER THE NUMBER ====)";A
110  IF A = 1 THEN 180
120  IF A = 2 THEN 340
130  IF A = 3 THEN  PRINT  CHR$ (4);"RUN MAIN MENU"
140  IF A = 0 OR A ) 4 THEN 60
150  INVERSE : FLASH : PRINT "UNRECOGNIZABLE ELEMENT TYPE.TRY AGAIN.": NORMAL

160  PRINT  CHR$ (7): FOR I = 0 TO 1000: NEXT I
170  GOTO 60
180  REM  :COORDINATE METHOD
190  HOME : VTAB 21: INPUT "ENTER LABELS====)";ST$
200  INPUT "INPUT SCALE (1)= ";S
210  INPUT "INPUT ROT (0)= ";D
220  INPUT "INPUT LABEL POSITION (X,Y)= ";HT,VT
230  IF HT (  = 7 THEN 320.
240  IF VT (  = 7 THEN 320
250  IF HT )  = 262 THEN 320
260  IF VT )  = 158 THEN 320
270  GOSUB 600
280  INPUT "1.OK 2.ERASE   SELECT ONE ===)  ";N
290  IF N = 1 THEN 60
300  IF N = 2 THEN  GOTO 220
320  HOME : VTAB 21: PRINT "COORDINATE ISN'T APPROPRIATE ,TRY AGAIN.": FOR
     I = 1 TO 1000 STEP 0.5: NEXT I: GOTO 190
340  REM :CURSOR METHOD
345  HOME : VTAB 21: INPUT "ENTER LABELS ===) ";ST$
350  INPUT "INPUT SCALE (1)=  ";S
360  INPUT "INPUT ROT (0)=  ";D
370  HOME : VTAB 21: PRINT "INPUT LABEL POSITION (X,Y)= "
380  PRINT "MOVE THE CURSOR "
390  PRINT "USING I,J,K,M.PRESS Z TO SET THE POSITION (X,Y) ==)";
400  HCOLOR= 3:P = 5:Q = 5
410  GET A$:P1 = P:Q1 = Q
420  XDRAW 11 AT P1,Q1: HCOLOR= 3
430  IF A$ = "I" THEN Q = Q - 5: GOTO 480
440  IF A$ = "M" THEN Q = Q + 5: GOTO 480
450  IF A$ = "J" THEN P = P - 5: GOTO 480
460  IF A$ = "K" THEN P = P + 5: GOTO 480
470  IF A$ = "Z" THEN  GOTO 550
480  IF P (  = 5 THEN P = 5
490  IF Q (  = 5 THEN Q = 5
500  IF P )  = 274 THEN P = 274
510  IF Q )  = 154 THEN Q = 154
520  XDRAW 11 AT P,Q: HOME
```

Apple IIe Computer Create Program Continued:

```
530  VTAB 21: HTAB 27: PRINT "X= ";P;"  ";"Y= ";Q;"  "
540  GOTO 410
550 HT = P:VT = Q: HPLOT P,Q
560  GOSUB 600
570  INPUT "1.OK 2.ERASE   SELECT ONE ===> ";N
580  IF N = 1 THEN 60
590  IF N = 2 THEN  GOTO 220
600  REM :TEXT
605  HCOLOR= 3: SCALE= S: ROT= D
610  FOR I = 1 TO  LEN (ST$)
620 CH =  ASC ( MID$ (ST$,I,1)) - 32
630  IF CH = 0 THEN 650
640  XDRAW CH AT HT,VT
650 HT = HT + 7
660  NEXT I
665  SCALE= 1: ROT= 0
670  RETURN
```

Apple IIe Computer Create Program Continued:

```
5  REM : DIMENSION PROGRAM
10  POKE  - 16300,0: POKE  - 16301,0: POKE  - 16297,0: POKE  - 16304,0
30  PRINT  CHR$ (4);"BLOAD SHAPE ALPHABET,A$800"
40  POKE 232, PEEK (43634): POKE 233, PEEK (43635)
50  HOME : HCOLOR= 3: SCALE= 1: ROT= 0
60  HOME : VTAB 21: PRINT "SELECT THE METHOD :": FOR A = 1 TO 1000: NEXT A

70  PRINT "1.LINEAR DIMENSION"
80  PRINT "2.RADIAL DIMENSION"
90  PRINT "3.EXIT"
100  INPUT "ENTER THE NUMBER====)";A
110  IF A = 1 THEN 150
120  IF A = 2 THEN 580
130  IF A = 3 THEN  PRINT  CHR$ (4);"RUN MAIN MENU"
140  IF A = 0 OR A ) 4 THEN 60
150  HOME : VTAB 21: PRINT "1.HORIZONTAL DIMENSION"
160  PRINT "2.VERTICAL DIMENSION"
165  PRINT "3.EXIT"
170  INPUT "WHICH ONE ?  ====)";N
180  IF N = 1 THEN 220
190  IF N = 2 THEN 400
200  IF N = 3 THEN 60
210  IF N = 0 OR N ) 3 THEN 150
220  REM :HOR DIM
225  FLASH : PRINT "FROm LEFT TO RIGHT SIDE.FROM UPPER TO BOTTOM ": FOR A =
     1 TO 1000 STEP 0.5: NEXT A: NORMAL
230  PRINT "INPUT THE LEFT ENTITY LOCATION  D1": FOR B = 1 TO 1000 STEP 0.
     5: NEXT B
240  GOSUB 720
250 M = P:N = Q
260  PRINT "INPUT THE RIGHT ENTITY LOCATION  D2 ": FOR B = 1 TO 1000 STEP
     0.5: NEXT B
270  GOSUB 720
280 A = P:B = Q
290  PRINT "INPUT THE LOCATION OF THE DIMENSION "
300  GOSUB 720
310 X = P:Y = Q:HT = X:VT = Y
320 I = A - M:T =  ABS (I) * 0.027:F =  INT (T * 100 + 0.5) / 100
340  HPLOT M,Y - 5 TO M,Y + 7: HPLOT A,Y - 5 TO A,Y + 7: HPLOT X - 5,Y TO
     M,Y: HPLOT X + 26,Y TO A,Y: HPLOT M,Y TO M + 3,Y - 3: HPLOT A - 3,Y -
     3 TO A,Y
345  VTAB 22: PRINT "DIM(";F;")";"=": INPUT ST$
350  GOSUB 920
360  VTAB 23: INPUT "1.OK 2.ERASE  SELECT ONE ===)";N
370  IF N = 1 THEN  HCOLOR= 3: GOTO 60
380  IF N = 2 THEN  HCOLOR= 0: PRINT "INPUT THE POSITION OF THE DIMENSION
     (";X;",";Y;")": INPUT X,Y: HOME : GOTO 310
400  REM :VER DIM
405  FLASH : PRINT "FROM LEFT TO RIGHT SIDE.FROM UPPER TO BOTTOM": FOR A =
     1 TO 1000 STEP 0.5: NEXT A: NORMAL
410  HOME : VTAB 22: PRINT "INPUT THE UPPER ENTITY LOCATION  D1": FOR A =
     1 TO 1000 STEP 0.5: NEXT A
420  GOSUB 720
430 M = P:N = Q
440  PRINT "INPUT THE BOTTOM ENTITY LOCATION  D2 ": FOR A = 1 TO 1000 STEP
     0.5: NEXT A
450  GOSUB 720
460 A = P:B = Q
```

Apple IIe Computer Create Program Continued:

```
470  PRINT "INPUT THE LOCATION OF THE DIMENSION D2": FOR A = 1 TO 1000 STEP
     0.5: NEXT A
480  GOSUB 720
490 X = P:Y = Q:HT = X - 5:VT = Y
500 I = B - N:T =  ABS (I) * 0.04
510 R =  INT (T * 100 + 0.5) / 100
515  HPLOT X,Y - 10 TO X,N: HPLOT X + 3,N + 3 TO X,N: HPLOT X - 5,N TO X +
     5,N
520  HPLOT X + 3,B - 3 TO X,B: HPLOT X - 5,B TO X + 5,B: HPLOT X,Y + 8 TO
     X,B
525  VTAB 22: PRINT "DIM(";R;")";"=": INPUT ST$
530  GOSUB 920
540  VTAB 23: INPUT "1.OK 2.ERASE   SELECT ONE ===)";N
550  IF N = 1 THEN  HCOLOR= 3: GOTO 60
560  IF N = 2 THEN  HCOLOR= 0: PRINT "INPUT THE POSITION OF THE DIMENSION
     (";X;",";Y;")": INPUT X,Y: HOME : GOTO 490
580  REM :RADIAL DIM
590  HOME : VTAB 21: PRINT "INPUT THE CENTER POINT OF THE CIRCLE C1": FOR
     A = 1 TO 1000 STEP 0.5: NEXT A
600  GOSUB 720
610 X = P:Y = Q
620  PRINT "MOVING K KEY TO THE ENTITY LOCATION,PRESS Z KEY TO SET THE POS
     ITION": FOR A = 1 TO 1000 STEP 0.5: NEXT A
630  GOSUB 750
640 C = P:D = Q
650 I = C - X:T =  ABS (I) * 0.027:F =  INT (T * 100 + 0.5) / 100
665 HT = C + 10:VT = D - 10
670  HPLOT C + 8,D - 8 TO C,D: HPLOT C + 2,D - 7 TO C,D
675  VTAB 22: PRINT "DIM (R";F;")";"=": INPUT ST$
680  GOSUB 920
690  VTAB 23: INPUT "1.OK 2.ERASE   SELECT ONE  ===)";N
700  IF N = 1 THEN  HCOLOR= 3: GOTO 60
710  IF N = 2 THEN  HCOLOR= 0: PRINT "INPUT THE ENTITY LOCATION (";C;",";D
     ;")": INPUT C,D: HOME : GOTO 640
720  REM : MOVE THE CURSOR
730  PRINT "MOVE THE CURSOR"
740  PRINT "USING I,J,K,M. PRESS Z TO SET THE POSITION (X,Y) ==)"
750  HCOLOR= 3:P = 3:Q = 3
760  GET A$:P1 = P:Q1 = Q
770  XDRAW 11 AT P1,Q1: HCOLOR= 3
780  IF A$ = "I" THEN Q = Q - 3: GOTO 830
790  IF A$ = "M" THEN Q = Q + 3: GOTO 830
800  IF A$ = "J" THEN P = P - 3: GOTO 830
810  IF A$ = "K" THEN P = P + 3: GOTO 830
820  IF A$ = "Z" THEN  GOTO 910
830  IF P (  = 3 THEN P = 3
840  IF Q (  = 3 THEN Q = 3
850  IF P )  = 276 THEN P = 276
860  IF Q )  = 156 THEN Q = 156
870  XDRAW 11 AT P,Q: HOME
880  VTAB 21: HTAB 27: PRINT "X= ";P;"  ";"Y= ";Q;"  "
900  GOTO 760
```

Apple IIe Computer Create Program Continued:

```
910 P = P + 3:Q = Q - 3
915  HPLOT P,Q: RETURN
920  REM :TEXT
925  GOSUB 1010
930  HCOLOR= 3: SCALE= 1: ROT= 0
940  FOR I = 1 TO  LEN (ST$)
950 CH =  ASC ( MID$ (ST$,I,1)) - 32
960  IF CH = 0 THEN 980
970  XDRAW CH AT HT,VT
980 HT = HT + 7
990  NEXT I
1000  RETURN
1010  IF HT <  = 7 THEN HT = 7
1020  IF HT >  = 262 THEN HT = 262
1030  IF VT <  = 7 THEN VT = 7
1040  IF VT >  = 158 THEN VT = 158
1050  RETURN
```

End of Program

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