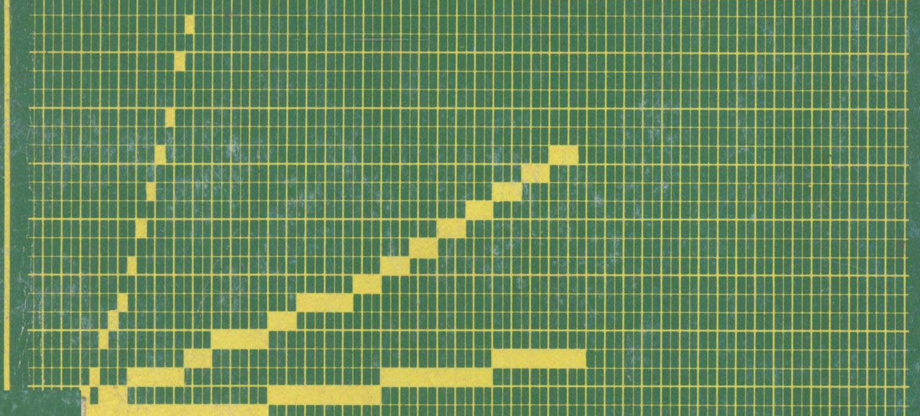
Introduction to TRS-80 Graphics

Don Inman



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TRS-80 GRAPHICS

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dilithium Press
Portland, Oregon

10 9 8 7 6 5 4 3 2

ISBN: 0-918398-18-5
Library of Congress catalog card number: 78-24835

Printed in the United States of America.

dilithium Press
P.O. Box 92
Forest Grove, Oregon 97116

PREFACE

The video display is one of the most significant characteristics of the inexpensive personal computer such as the Radio Shack TRS-80. The ability of the user to create images and alter them as he wishes provides an astounding number and variety of uses which were unheard of in the past. In order to make full use of the advantages of the video display over printed copy, you must investigate the manner in which data may be manipulated to create ever-changing pictures on the screen.

The purpose of this book is to introduce you to the capabilities of TRS-80 graphics and to stimulate you to make further investigations yourself. It is intended for fun and entertainment, but it also has educational values. It is *not* intended as a complete course in BASIC language programming.

Although Level I BASIC (an ideal vehicle for beginners) was used in writing this book originally, an appendix has been added to provide Level II BASIC compatibility. Level I BASIC has all the necessary statements and commands for learning the fundamentals of programming, but some modifications are necessary to run some of the programs in Level II. These modifications with comments are shown in the appendix.

Explanations are provided throughout the book for statements and commands used to create the graphics displays. It is assumed that you have a TRS-80 Reference Manual and will use it when necessary.

INTRODUCTION

The material presented is designed to be used for self-instruction. You should enter and run each program on your own computer. Exercises and answers are provided to apply what you learn. Try them! Suggestions for extensions of key ideas are given at the end of most chapters. Experiment with the extensions.

The programs are written in a straightforward style with logically connected portions separated from other portions. Abbreviations and multiple-line statements are avoided (except for a few examples) so that each program line will stand by itself. This makes the programs easy to read and understand. The programs are not perfect in style or content, but are meant as a basis for you to learn to write your own programs.

CONTENTS

1

WHERE ARE WE GOING?

Our goal is to provide some informal assistance in understanding the graphics capabilities of the TRS-80 computer using Level I BASIC. Numerous examples are given to illustrate the techniques discussed. Exercises are provided for you to work out, and numerous additional suggestions for practice are given at the end of each chapter.

No attempt is made to teach programming in BASIC. There are many, many books on the market about programming — some are good and others are not. We will assume you have some programming experience and have read the TRS-80 Level I User's Manual. We will demonstrate the TRS-80 graphics through statements and commands explained in the user's manual.

Chapter two begins with the statements: SET(X,Y), RESET(X,Y), and PRINT AT to show how individual points may be turned on and off and how characters may be printed at any location on the video display. You then progress to a more detailed explanation of manipulating plotted points to draw rectangles. This technique is used to demonstrate games and pictures that will stir your imagination. The use of line drawings to form graphs and charts is explored. We then move from vertical and horizontal lines to the formation of lines at oblique angles, triangles, and finally, curved lines.

By this time, you will be able to display complex figures, and possible applications will burst forth from you imagination with no limitation.

Programs begin with a few simple statements of a few lines, but you will quickly build up the capability of combining short program segments into more complex programs.

Let's begin with a peek at computer graphics in general and then examine the specifics of the TRS-80 system.

GRAPHICS

A graphic video display allows you to draw pictures in addition to printing the usual typewriter characters. In general, black and white picture capability is less expensive than color pictures. Somewhere in between (in cost) is the capability to display one or more shades of grey along with black and white.

You will find a wide range in price for graphics capability in various computers or in various display devices which may be added to a computer. The price range for the displays range from under one hundred dollars to several thousands of dollars. Why such a wide range in price? It is largely a function of the method used and the resolution provided. Careful thought must be given to how "good" a picture you need and how much you are willing to pay for picture quality.

Without going into a technical description, let's take a look at two common methods used to draw pictures on the display. Both methods make use of straight lines to achieve their objective.

Method I

The video screen is divided into a grid of columns and rows as shown in Figure 1.

The finer the division of the screen (into more rows and more columns), the better the *resolution* of the picture will be.

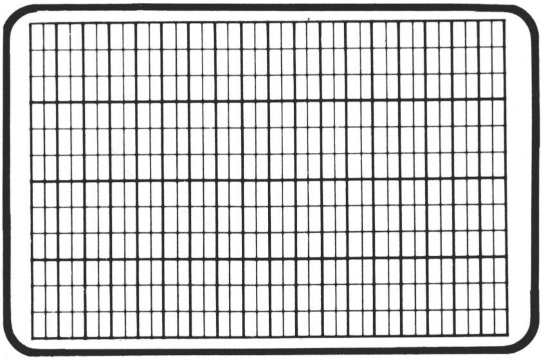


Figure 1

Displays of this kind are able to "light up" (or turn on) any given rectangle (or square) on the screen. They can also "turn off" any given rectangle on the screen.

A display which is divided into 256 columns and 256 rows (256 x 256) is capable of "better" pictures than one which is divided into 128 columns and 128 rows (128 x 128).

For example: a circle attempted in 3 columns and 3 rows compared to a circle attempted in 6 columns and 6 rows.

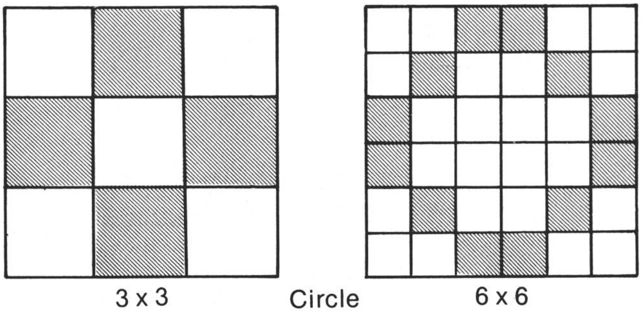


Figure 2

The 6 x 6 (even though far from perfect) more closely resembles a circle than the 3 x 3 display.

Another example: a triangle, on a 4 x 4 grid compared to a triangle on an 8 x 8 grid.

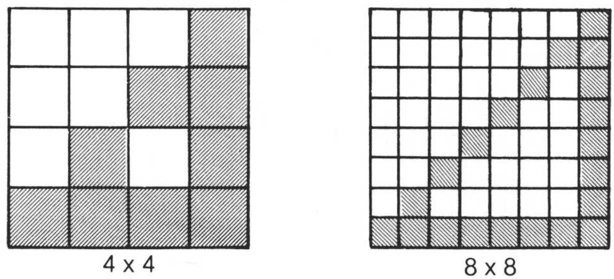


Figure 3

Some imagination must be used in the 4 x 4 display in order to recognize the triangle. The 8 x 8 display is more reasonable.

Figure 3 also shows that the result of drawing a diagonal line leaves something to be desired. This method, however, is easily adapted to today's TV sets and inexpensive monitors.

It stands to reason that, given the same size display, the price will rise as some function of the number of columns and rows which a display is capable of producing.

Method II

The video screen is divided into a grid of points for this method. It is similar to the grid of the first method, but you should now consider only the centers of the rectangles.

Now instead of lighting up individual rectangles, we can select any two points and draw a line between them. This would be called drawing a *vector.*

Once again, the more points provided in the grid, the better the picture will be. But here too, the better picture costs more to produce.

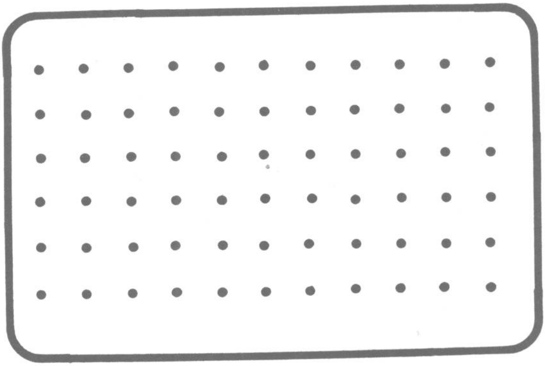


Figure 4

Let's display the same example as in Figure 2, a circle.

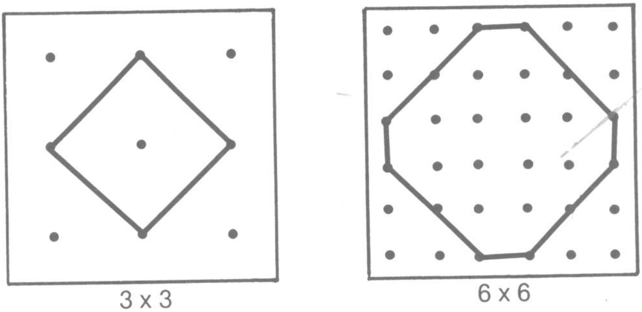


Figure 5

Once again, the 6 x 6 grid produces a more realistic circle than the 3 x 3 grid.

Now for the triangles similar to those of Figure 3.

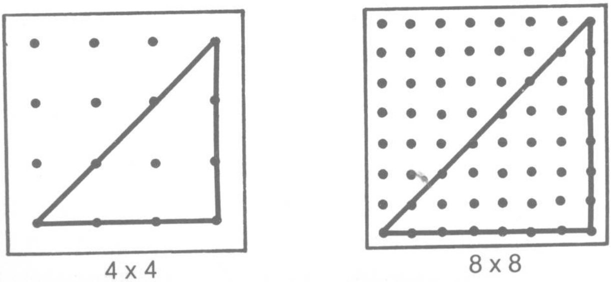


Figure 6

The 4 x 4 and 8 x 8 grids produce equally recognizable triangles. The improvement over Method I is obvious.

The vector plotting method (II) is clearly better than the block plotting (I) method. However, it is more expensive. Some "purists" will not admit that Method I produces valid graphics. But it all lies in the definition of the term.

A manufacturer is faced with two choices; either (a) keep the graphics capability to a reasonable minimum with a price that everybody can afford; or (b) increase the graphics capability and price the product at a higher level (thus eliminating some buyers).

In the TRS-80, Radio Shack has chosen the former alternative, and that will result in increased sales as more people are able to afford the product. Thus, we have a consumer product which is comparable in price to other household appliances. It will appear in homes and schools much faster than expected, and the demand for usable programs and self-teaching materials will be tremendous. We hope this book will be an aid, in a small way, in satisfying that demand.

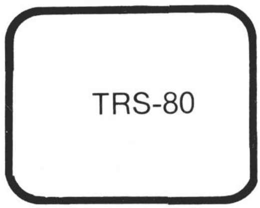
TRS-80 graphics are accomplished using a grid of rectangles arranged in 128 columns and 48 rows as shown on the Video Display Worksheet (page 133). Each individual rectangle may be turned on or off under the programmer's control. Chapter two explains the procedure.

Numeric and alphabetic characters may also be printed at specified locations on the screen. The print positions, numbered 0 through 1023, are also described in Chapter two. They are also shown on the Video Display Worksheet.

With the conclusion of this brief introduction, let's move right into the video display features.

2

THE VIDEO DISPLAY



One of the first desires of all first-time computer users is to make something happen on the video screen. The goal of the rest of this book will be to make that desire reality.

Many experienced programmers and computer scientists (especially those who have million dollar systems!) will call these graphics crude, awkward, and elementary, but many of us are so "computer starved" that any graphics are better than none. Also, one of the challenges to any programmer is to write usable programs within the constraints of his system. The TRS-80 graphics are great as a learning device *because* of their elementary and straightforward nature.

Many may also complain of the slowness of the plotting technique, but this too is an educational advantage. You can actually see the pictures being "painted" on the screen just as you instructed the computer to do it.

There are two methods to light up the screen, and each uses a similar, yet unique, numbering scheme. I will call one the PLOT method and the other the PRINT method.

THE PLOT METHOD

This technique makes use of a numbered grid of 6144 "points" arranged in 48 rows of 128 columns. The grid is numbered from the upper left corner of the screen. Each point is designated by both Column and Row similar to the (X,Y) Cartesian Coordinates used in beginning algebra courses. The order is important: (column, row). The "points" are not really points. They are tiny rectangles (taller than they are wide). See Figure 7 for the arrangement of the points. The plot position (127,47) is shaded in the figure.

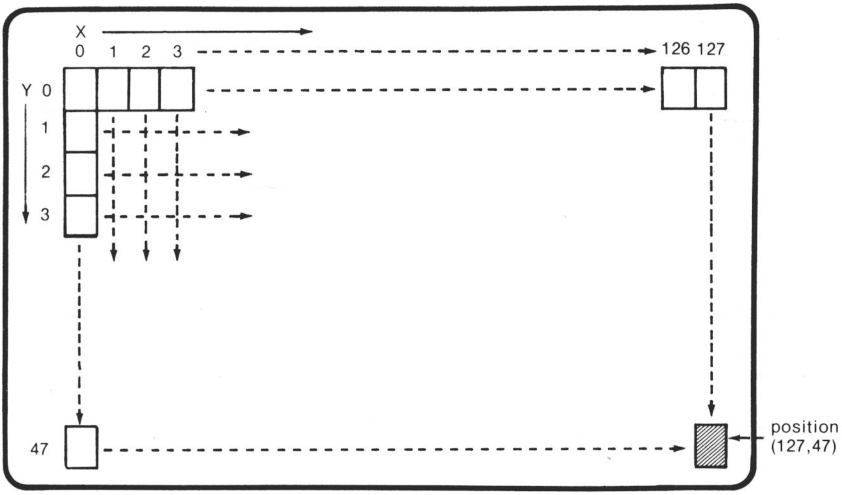


Figure 7
Plot Positions On The Video Screen

The TRS-80 BASIC statement to plot a point is:

```
SET (X,Y)
```

As used in a typical program:

```
10 X = 60          Column
20 Y = 30          Row
30 SET (X,Y)       "Turns on" point (60,30)
```

The statement SET(X,Y) would turn on the rectangle indicated in Figure 8.

There is also an instruction to "erase" a point on the screen. It is:

```
RESET (X,Y)
```

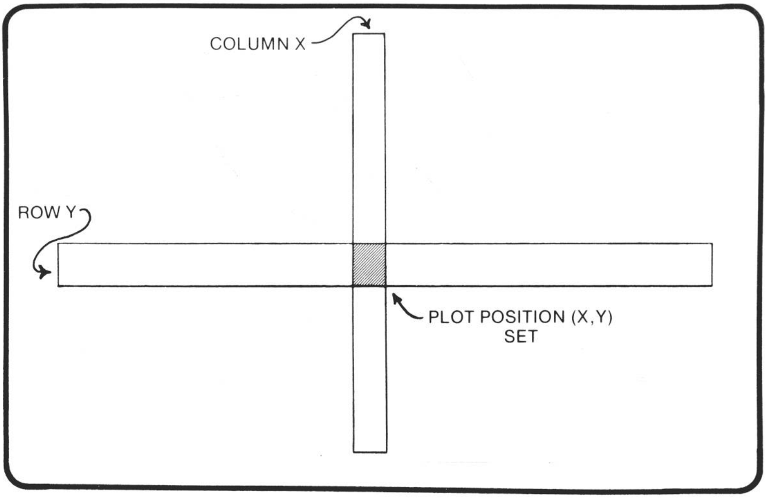


Figure 8

As an example: If we add a new line to the above program segment, we can turn off the point (60,30) by the statement:

```
40 RESET (X,Y)
```

The statement RESET (X,Y) would turn off the rectangle indicted by Figure 9.

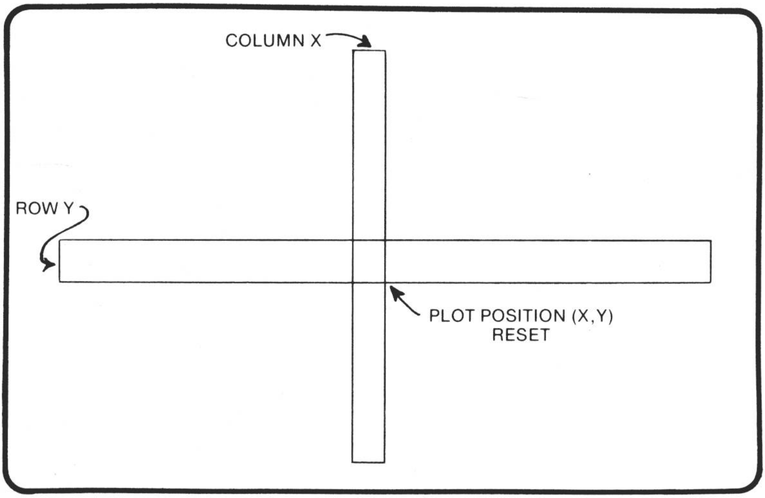


Figure 9