John Fowler

The IBM PC XT Graphics Book

A Spectrum Book

JOHN FOWLER

THE IBM PC/XT GRAPHICS BOOK

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John Fowler, Ph.D., is a computer scientist at Los Alamos National Laboratory in New Mexico. He has programmed machines from the Timex/Sinclair to the Cray 1 supercomputer.

Introduction

The aim of this book is to present graphics concepts and techniques by means of example programs. These programs were written to be understandable to the user, simple yet versatile, and adaptable. Only the reader can assess the success or failure of the first goal. To accomplish the second, many of the programs in the Advanced Graphics section were separated into preprocessor-processor form, rendering a long, complex program into two shorter and more versatile ones. A modular approach that allows programs to be assembled as blocks was adopted to satisfy the third goal. You should be able to assemble many of the various routines given here to suit your own needs. The detailed explanations that follow each program are intended to aid in understanding what the programs do and also to assist in modifying them if you desire.

We stand on the threshold of a new era. Computer graphics equipment available to the average user is growing rapidly in capability and refinement. In recognition of this, the programs in this volume were written to be easily adapted to improvements such as increases in resolution and color selection, which are sure to be available over the next few years.

The book is intended for use with the IBM PC using the advanced BASIC interpreter, BASICA, which comes with the disk operating systems (DOS). The considerable graphics enhancements available with DOS 2.00 are used, but alternate routines for many of these commands are also given in the Appendix. A color graphics board is required to run these programs on the PC, and a high-quality color monitor, though not required, will best display the results.

Three sections make up the book:

Getting Started. This section reviews graphics commands available on the PC and offers a glimpse into the hardware aspect of graphics. A chapter on graphs explains different types of coordinate systems. Finally, a valuable "electronic crayon" routine is described. This program can be used alone to draw pictures on the screen using the PC's function keys, or it can be readily combined with any of the other programs in the book to form a versatile and powerful image processor.

For Business and Pleasure contains routines to support business charts and graphs and several chapters which explain how to create myriads of interesting images. These include Lissajous and moire patterns, ladybugs and spirals, kaleidoscopes, and some amazing transformations of a checkerboard pattern.

Advanced Graphics Concepts introduces principles of scaling, rotation, translation, and perspective. These ideas are applied to the displaying of objects with hidden surface removal and to the drawing of wire-frame functions of two variables. The final chapter shows how to create true 3-D stereo images of three-dimensional figures on the PC.

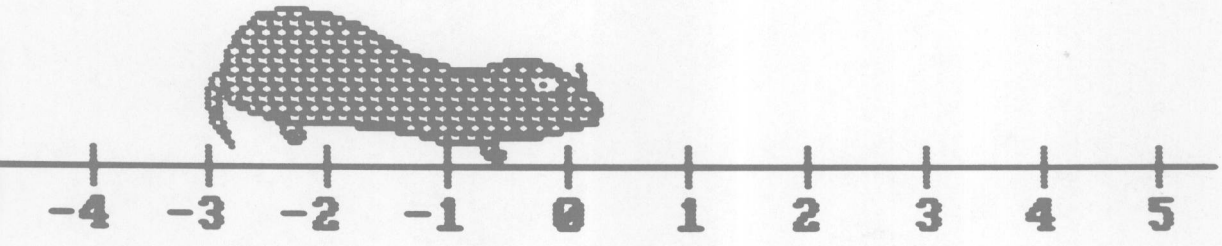
It is not necessary that you understand the theory behind these programs (or read the explanations) in order to use and enjoy them. Some of the chapters accentuate utilitarian programs, while other chapters were written simply for enjoyment. If you wish or need to modify any of the programs, sufficient description is included to allow you to understand line-by-line how they work. This should provide a sound starting point for adapting them to suit your own needs.

My wife Jo has been a great help in preparing some of the figures, proofreading, and offering general encouragement. My son John found and fixed many bugs and wrote The Rafting Game, which appears in Chapter 4. I also want to thank Jesse, James, and Shawna for keeping me on my toes.

Contents

1 GETTING STARTED

"Have a nice
day, dear."



Mole Leaving for the Office

GETTING
STARTED

1 Getting Started

Computer graphics covers a wide range of topics. With it you can create an eye-catching display for your business, arrange your data into instantly comprehensible form, or even amuse yourself with fast-moving games. You can use computer graphics to create your own Xanadu of things that never were—except in your mind's eye. It can be a tool to suit many purposes. This book will help you learn to use it better.

Our purpose in this chapter is to become acquainted with many of the graphics-related statements which are available in BASICA on the IBM PC.

BASICA is the advanced version of the BASIC language interpreter, which comes with the Disk Operating System (DOS). Although other versions of BASIC are available, BASICA contains the most extensive set of commands useful for graphics. These versions of BASIC were written by Microsoft, a company which has supplied BASIC interpreters for other computer manufacturers also. Most BASICA statements are similar, if not identical, to those in other Microsoft BASICs; however, some are unique to the PC. As an aid in translating programs from one BASIC to another, we have included in the Appendix a routine which you can substitute for the important VIEW and WINDOW statements which most BASICs lack.

The programs listed in this book were written for use with the BASICA interpreter which comes with DOS 2.0. Earlier versions of BASICA lack some of the statements needed to run some of these programs. The Appendix contains line-by-line alterations for those programs that must be changed to run with the earlier BASICAs.

Listings of the programs contain numerous remark (REM) statements to aid in understanding how the programs work. These statements are not required in order to make the programs run properly and may be omitted when you enter the programs into your computer. Some versions of this book come with a disk containing the major programs; the remarks are omitted from the disk listings.

Also, to aid in your understanding of program flow, the listings contain indentations inside FOR–NEXT loops. Statements separated by colons are

listed on separate lines to make them easier to read. As you type them, you should place all statements belonging to a given line number on the same line. You may omit the extra spaces between line numbers and statements when they occur.

VARIABLE NAMES AND TYPES

Let's establish a few ground rules for naming variables. If you've used other BASICs you probably have been content to use one- or two-letter variable names. Most BASICs won't recognize more than the first two characters anyway. So the variables COST and CORNER would be indistinguishable. The IBM BASICs recognize unique variable names up to 40 characters long. Most of the variables in this book will have descriptive names. For a variable which contains the background color of the graphics screen, we might find BC not descriptive enough. THISVARIABLEHOLDSTHEBACKGROUND-COLOR, on the other hand, is unnecessarily long. We might settle on IBKG-COLR, which at least gives you a chance of recognizing right away the variable's purpose.

There are sound reasons for using variables no longer than necessary in an interpreted language such as BASICA. Longer variables take up valuable memory space, and program execution is slowed since the interpreter has to check the full variable name each time it's encountered. These must be balanced against the reasons for using long names: descriptive purpose and a decrease in the likelihood of using the same variable name inadvertently to perform two different functions.

BASICA also allows the user to declare variable types explicitly with a DEFtype statement. As a rule, we will begin variables which are, or could be, integers with one of the letters I through O. That's the reason for beginning the background color variable, above, with "I." Often we will use a DEFINT I-O statement near the beginning of the program. Using integer variables when possible saves memory and also increases the program's execution speed.

All other numeric variables will be single-precision real number (variables are created this way by default), unless explicitly defined in a DEFDBL statement. Any variable ending with a dollar sign will be a string variable.

ABOUT DISPLAYS

You can use three types of color display with your PC.

With the addition of an RF adapter, you can use a regular color television set. The RF adapter converts the standard video signal available on the

color board into a regular television channel signal. Because of the inherent limitations of the standard video signal and the additional losses in the process of converting it to a television frequency and then un-converting it again in the television set, this method offers the lowest picture quality.

One step up the quality ladder are the composite color monitors which use the standard video signal directly. This signal is known as NTSC video, which stands for National Television Standards Committee. In the 1950s, when color TV was born, there were several alternative proposals as to how the signal should be constituted. The NTSC signal was adopted. The color information in the NTSC signal is modulated onto a subcarrier, which must also fit into the limited bandwidth available. This means that the color resolution, the resolvability of adjacent dots on the screen, is severely limited. Usually this isn't apparent on your home TV because the colors rarely change rapidly from point to point. Because of the way the color information is contained in the signal, color fidelity sometimes suffers also, prompting the suggestion that NTSC really stands for Never Twice the Same Color.

The best results are obtained with direct drive or RGB monitors, so-called because the signal for each of the three video colors (red, green, and blue) goes independently from the color graphics card to the monitor. The resolution is limited only by the quality of the monitor. RGB monitors are expensive but offer the best picture quality. The photographs in this book were taken from an RGB monitor.

We'll get more involved with the relationship between the computer and the display device in Chapter 2.

SCREEN MODES

There are two ways of putting data on the screen: text and graphics. With the PC, these modes are not mutually exclusive. You can make pictures using characters (text), and you can also mix text with graphics. Many of the BASIC statements, however, have different meanings, depending on which mode you're using. For that reason we'll begin by considering them independently.

TEXT MODE

In text mode the display area consists of 25 lines of either 40 or 80 characters. The number of characters per line is determined by the statement

```
WIDTH N
```

where N is either 40 or 80. You need a high-quality display in order to use the larger number. The number of characters per line with which the PC "wakes