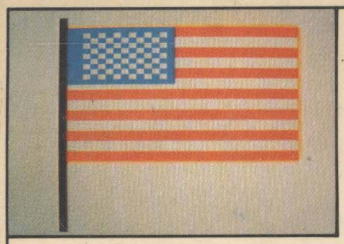

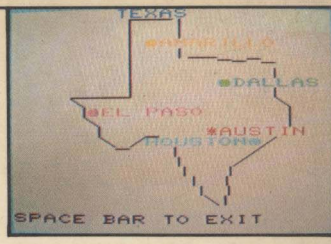

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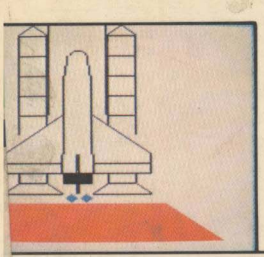

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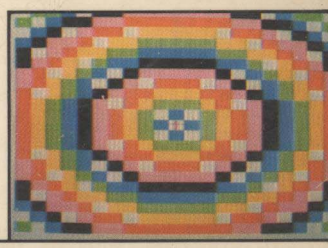

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FOREWORD

Where do you find the crowds at the computer shows? Usually around the booths that feature graphics and its applications in flight simulators, computer-aided design and engineering, drawing of human portraits, video games, and the creation of animated figures. Even people with no interest in (and perhaps even a little fear of) computers cannot resist an opportunity to use one to draw lines, rectangles, circles, game pieces, cartoon characters, and other pictures. Schnapp and Stafford show the beginner how to do all these things through a series of simple programs.

The key features of this book are the following:

- All the examples are interesting ones that you can RUN and see unfold on the screen. You get the chance to draw a heart, a flag, an elephant, maps, a calendar, a Christmas tree with flashing lights, lines, rectangles, circles, a tic-tac-toe board, a hand of cards, a pair of dice, a maze, a Martian lander, and a spaceship launch.
- Complete explanations and suggested modifications let you readily build on the initial programs.
- Full, documented listings written in BASIC give you examples you can study and use for reference.
- Two picture editors provide surprisingly advanced tools for drawing, saving, and changing pictures. These also demonstrate the principles of advanced graphics systems.
- An extensive turtle graphics program explains the ideas behind LOGO and provides an excellent demonstration program for novices and children.
- Complete maze, tic-tac-toe, and spaceship lander programs illustrate the principles of game design, including drawing of game pieces, animation, interaction with the players, keyboard control, scoring, and timing.

This book lets the beginner explore computer graphics easily and inexpensively. I think you'll find the subject really is just as fascinating as it looks.

LANCE A. LEVENTHAL, Series Editor

PREFACE

Graphics, the drawing of figures and pictures, is surely among the most intriguing and exciting uses of personal computers. Computer drawings of spaceships, cartoon characters, vehicles, forms, landscapes, mechanisms, and human figures attract large audiences at computer shows and demonstrations. In video arcades, games with smooth animation, attractive colors, familiar or amusing characters, and exciting visual and sound effects always draw the players.

The purpose of this book is to show someone who is familiar with BASIC how to create simple drawings on an inexpensive home computer, the Commodore VIC 20.

Rather than merely telling you how to do it, we present a series of programs. These range from a simple one that creates a color test pattern to more complex ones that shuffle and deal playing cards, draw rectangles and circles, and simulate a spacecraft landing. We have written all programs in BASIC, the most popular language for home computers, and have explained each step in detail. We have also described modifications that readers may make on their own. The best way to learn graphics is by doing it yourself, so you should try the modifications and experiment with the programs.

We have assumed no special background in either computers or mathematics. You should have read the VIC 20 user's guide, titled *Personal Computing on the VIC 20,* and have some familiarity with BASIC before starting this book. We have used a little mathematics (particularly geometry) on occasion, but we have always explained the reasons for this and what the mathematics actually means in practice.

To use this book, you will need a standard Commodore VIC 20 computer. Our programs do not require extra memory, although it is always nice to have. You will also need a television set. A cassette recorder or floppy disk drive will be very helpful. The recorder must be Commodore's C2N cassette unit (Datassette) or the equivalent. The floppy disk drive can be either the Commodore VIC-1540 or VIC-1541. You can use almost any black-and-white or color television, but we recommend a 13-inch color model. Several programs optionally allow you to use a joystick to play games or draw figures. Both Commodore and other manufacturers supply this item. All the programs are available on cassette or disk from the publisher. Ordering information is elsewhere in the book.

This book begins with a description of the program format. **Chapter 1** then explains the program notation, provides a brief overview of the VIC 20, discusses the use of the cassette recorder and disk, and introduces the computer's graphics capabilities. The first program, "COLORBARS", not only illustrates the notation but also produces a test pattern you can use to adjust your color television set.

Chapter 2 contains programs that draw pictures using both characters and graphics symbols. The pictures include a heart, cartoon figures, two maps, a flag, and a Christmas tree. The final program demonstrates the production of standard forms by generating a calendar for any month of any year.

Chapter 3 describes the drawing of geometrical shapes such as lines, rectangles, and circles. It also contains a program that demonstrates the popular "turtle graphics."

Chapter 4 covers games and animation. It includes programs that throw dice, shuffle and deal playing cards, and simulate a bouncing ball, a spaceship landing, and a rocket launch.

Chapter 5 contains two artist's assistant programs that will help you create pictures. These programs let you place sequences of characters anywhere on the screen, transfer pictures to or from tape or disk, change parts of pictures, and insert text and geometrical shapes. All commands are either single keystrokes or simple movements of a joystick.

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Thanks are due to the following people who helped the authors with this book:

Our spouses, Brigid Hom-Schnapp and Rosemary Stafford, for putting up with us (again!) during this book's gestation process.

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Commodore Electronics Limited for their permission to reproduce certain figures and tables from the manual, *Personal Computing on the VIC 20.*

Certain members of the publisher's staff, namely, Jim Fegen of Acquisitions and Lynn Frankel of Production, for their competence and serenity (not respectively, but respectfully).

Our photographer, Carter Stafford.

RUSSELL L. SCHNAPP
IRVIN G. STAFFORD

PROGRAM FORMAT

All programs in this book appear in the following format:

PROGRAM NAME: Name used to load or save the program on tape or disk. This always starts and ends with a quotation mark.

PURPOSE: What the program does.

TECHNIQUES DEMONSTRATED: Programming techniques that are being introduced or that you may want to use in other programs.

PROCEDURE: How to use the program.

VARIABLES: A list of all the variables and their meanings, in alphabetic order.

SPECIAL CASES: Exceptions, limitations, and other considerations.

BRIEF DESCRIPTION: Concise description of the program, by line number.

LISTING: Complete, commented program listing. When entering a program from this listing, you may simply omit the REM statements. This will not affect program execution.

MODIFICATIONS: How to change the program to illustrate its limitations, expand its capabilities, or demonstrate alternative methods.

NOTES: Additional information.

REFERENCES: Additional reading on the subject.

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1

INTRODUCTION TO GRAPHICS

INTRODUCTION

In this chapter, we begin with a brief overview of the Commodore VIC 20's major features. We emphasize the special keys—what they do, how you use them, and how we refer to them. COLORBARS, which produces a color test pattern, serves as a typical example program. We then describe how to use the cassette recorder and disk drive. Finally, we introduce a standard numbering system for describing positions on the screen.

OVERVIEW OF THE VIC 20

The inexpensive Commodore VIC 20 is a complete home computer. Together with a television set and a cassette recorder or disk drive, it is capable of playing games, giving lessons, keeping accounts and files, performing business and engineering calculations, preparing letters and reports, creating charts and pictures, recording grades and attendance, and even controlling your lights, furnace, or appliances. It is truly the equal of many large computers of the 1960s and 1970s that cost hundreds of thousands of dollars and occupied entire rooms.

By itself, the VIC is about the size of a portable typewriter. In fact, when you first see it, it looks much like a typewriter keyboard that someone detached from its printing mechanism. A complete VIC system consists of the following:

1. *A "brain" or controller, called a* ***central processing unit*** *in computer jargon.* This unit, located inside the keyboard, does the computer's calculating.
2. ***Memory,*** *also located inside the keyboard.* This is like a person's memory except that the computer forgets everything when its power is turned off. We measure computer memory in units of *bytes* (note the odd spelling). A byte can hold a single typed *character* (i.e., a letter, digit, punctuation mark, or other symbol, such as $ or + or space). Thus, if you have a standard VIC that starts with the message 3583 BYTES FREE, your computer has room in its memory for 3583 typed characters, or about two double-spaced typed pages.
3. *Television set or, in computer terminology,* ***video display.*** This is where you see your entries and the computer's prompts, responses, and results. The VIC can put 23 lines on the display at a time, and each of them can be up to 22 characters long. While the lines are quite short, the characters are large and easy to read.
4. ***Cassette recorder*** *or* ***disk drive.*** These are used to "play" tapes or disks into the computer and to record them from it. A disk drive acts much like a record player, except that it plays thin, flexible pieces of plastic called *floppy disks.* As with musical tapes, you can buy prerecorded disks or tapes for use with your VIC, or you can record your own. When buying disks or tapes, however, be careful to buy only ones intended for a VIC 20 (ask for "5-¼ inch, single-sided, single-density, soft-sector" variety). Trying to use tapes or disks intended for other computers would be like trying to play the wrong size of record on a phonograph.
5. ***Keyboard.*** This is the main part of the VIC 20 and looks much like a typewriter keyboard. There is no printing mechanism, since what you type appears on the screen instead of on paper.

KEYBOARD

Now that we have briefly described all the VIC 20's components, let us concentrate on the keyboard. If you just look at the tops of the keys, only the ones along the edges are unfamiliar. Most of the inside keys are like those on a typewriter. You will, however, notice a few extra symbol keys. The colon and semicolon are on separate keys, and +, −, @, *, and = each has its own key. There are also arrow keys, a separate key for the British pound symbol (after all, there'll always be an England), and some extra brackets.

Some outside keys are also the same as on a typewriter. The SHIFT keys (one on each side) have two uses: (1) In the normal (graphics) mode,

they let you type special graphics characters (we will talk more about these later). (2) In the other (text) mode, the SHIFT keys let you type capital letters. In either mode, SHIFT lets you type uppercase symbols such as $, ", and ?. The SHIFT LOCK key (just above the left-hand SHIFT key) lets you lock SHIFT in, so you don't have to press it each time when entering several consecutive shifted characters. RETURN (the large key to the right of =) acts like the carriage return on a typewriter; you use it to conclude a line and go on to the next one.

How about the other keys around the edges of the keyboard? We may describe them generally as falling into three categories: program control, screen functions and editing, and color control.

Of these, the easiest to describe are the program control keys. The RUN/STOP key (just left of SHIFT LOCK) is used mainly (as you might guess) to stop a program. If the computer continues to make noises at you, or has a strange screen color, you should also press the RESTORE key (just above RETURN). The only thing to watch here is not to press RESTORE instead of RETURN; these keys are easy to confuse, since they are close together and have similar names.

Screen Functions and Editing

The screen control and editing keys are necessary because working on a screen differs from working on paper. Unlike a typewriter, the computer has no typing element or carriage to indicate the typing position. Thus the computer itself must provide a moving indicator, which we call the *cursor.* The VIC's cursor is a flashing square that is always just ahead of where you are typing.

We can move the cursor with the two CRSR keys located in the lower right-hand corner. The one on the left (marked with arrows pointing up and down) moves the cursor up or down a line (up if you press SHIFT at the same time or have SHIFT LOCK down). The one on the right (marked with arrows pointing right and left) moves the cursor right or left a column (left if you press SHIFT at the same time or have SHIFT LOCK down). Thus these two keys (together with SHIFT) let you move the cursor anywhere on the screen. Since the CRSR keys repeat if you hold them down, you can move the cursor a long way quickly.

Once you have the cursor where you want it, entering things is simple. To enter something new, you just type it. To change what is already there, you type over the old characters. The new characters replace the old ones automatically; you do not have to erase the old ones first, as you do on a correcting typewriter.

Watch one subtle difference between the VIC and the typewriter. Pressing the space bar on a VIC actually puts something on the screen (that is, it puts a space character in the current character position, replacing

whatever was there before). This is unlike a typewriter, where pressing the space bar just moves the carriage or typing element to the right. To produce that effect on the VIC, you must press the CRSR key with right and left arrows.

Although pressing the space bar erases a character, it still leaves a space behind. To remove a character completely (say, you typed PRIUNT instead of PRINT), move the cursor just right of it with the arrowed CRSR keys (e.g., on top of the N that follows the U in PRIUNT) and press INST/DEL (the key in the top right-hand corner). This erases the character left of the cursor (e.g., the U) and moves the cursor and the characters [to its right (e.g., NT) to the left automatically] to fill the gap. Try it. The doing and seeing are much easier than is the explanation. The DEL erases the character to the left of the cursor, not the one underneath it. Note the difference between DELeting a character and erasing it (that is, printing a space over it).

To insert a character (say, you typed PRNT instead of PRINT), move the cursor to where you want the addition to appear (e.g., to the N in PRNT) and press SHIFT and INST/DEL simultaneously. A space opens up under the cursor. You can then enter the I into it. To insert a space, be sure to press the space bar; the space that appears on the screen is only for display purposes. The character that was under the cursor (and the part of the line to the right of it) move to the right to make room for the addition.

Using the VIC's delete and insert features (particularly the delete) becomes more natural with practice. Note that you can delete several characters (always to the left of the cursor) by pressing INST/DEL repeatedly. In fact, you can just hold INST/DEL down, since it repeats (rather quickly, we should warn you). The cursor moves left as the characters disappear. Similarly, you can make room for several extra characters (always to the right of the cursor) by pressing SHIFT and INST/DEL together repeatedly. When you do this, the cursor does not move. Instead, spaces appear to the right of it as the rest of the line moves right.

The last cursor or screen control key we will discuss is CLR/HOME, which is just left of INST/DEL. CLR (uppercase) clears the screen and moves the cursor to the top left-hand corner; HOME (lowercase) moves the cursor to the same place, but does not affect the screen. This key thus provides a quick way in which to remove unwanted material from the screen or return the cursor to its normal starting point.

Color

The VIC also provides keys for changing the printing color. These are the number keys 1 through 8; note that each has a three-letter color designation on the front. The only one that isn't obvious is CYN, which stands for cyan (greenish-blue), the VIC's normal border color. To change the printing color,

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