MACINTOSH™

MIDNIGHT MADNESS

Utilities, Games &
Other Grand Diversions
in Microsoft® BASIC
for the Apple® Macintosh™

MICROSOFT® PRESS

THE WAITE GROUP: Mitchell Waite • Dan Putterman • Don Urquhart • Chuck Blanchard

MACINTOSH™
MIDNIGHT MADNESS

MICROSOFT PRESS

MACINTOSH MIDNIGHT MADNESS

Utilities, Games & Other Grand Diversions in Microsoft® BASIC for the Apple® Macintosh™

MICROSOFT PRESS

THE WAITE GROUP • Mitchell Waite • Dan Putterman • Don Urquhart • Chuck Blanchard

PUBLISHED BY
Microsoft Press
A Division of Microsoft Corporation
10700 Northup Way, Box 97200, Bellevue, Washington 98009

Copyright © 1985 by Mitchell Waite
All rights reserved. No part of the contents of this book may
be reproduced or transmitted in any form or by any means without
the written permission of the publisher.

Library of Congress Cataloging in Publication Data
Waite, Mitchell.
Macintosh midnight madness.
1. Macintosh (Computer)—Programming.
2. BASIC (Computer program language).
I. Waite, Mitchell. II. Waite Group.
QA76.8.M3M34 1985 005.265 85-21387
ISBN 0-914845-30-6

Printed and bound in the United States of America.

1 2 3 4 5 6 7 8 9 FGFG 8 9 0 9 8 7 6 5

Distributed to the book trade in the
United States by Harper and Row.

Distributed to the book trade in
Canada by General Publishing Company, Ltd.

Distributed to the book trade outside the
United States and Canada by Penguin Books Ltd.

Penguin Books Ltd., Harmondsworth, Middlesex, England
Penguin Books Australia Ltd., Ringwood, Victoria, Australia
Penguin Books N.Z. Ltd., 182-190 Wairau Road, Auckland 10, New Zealand

British Cataloging in Publication Data available

Apple® is a registered trademark, MacPaint™ and MacWrite™ are trademarks of, and Macintosh™ is a trademark licensed to Apple Computer, Incorporated.
IBM® is a registered trademark of International Business Machines Corporation.
Microsoft® is a registered trademark of Microsoft Corporation.

Contents

Acknowledgments ix
Introduction xi

I. UTILITIES

MacInterface 3
MacGrid 31
MacGraph 51
MacCursor 87
MacConvert 119
MacAnimate 149

II. GAMES

MacDart 191
MacBandit 209
MacMouse 233
MacBall 249
MacGurkha 273
MacSpace 297

III. DIVERSIONS

MacBuild 325
MacOrgan 345
MacCompose 359
MacFinance 381
MacMeasure 403

ACKNOWLEDGMENTS

When microcomputers first came on the scene, one of the first things that they were programmed to do was flash a patterned sequence of lights. Early demonstration programs, in fact, were games that were toggled into the machine through a series of switches. We owe our thanks to the early pioneers—to people like Bill Gates and Paul Allen who successfully got BASIC to run on an Altair, and the myriad nameless programmers, from electrical engineers to piano players—for the tradition that this book follows.

Creating games and utilities—sharing them, tearing them apart, and putting them back together—was how many of us first learned to program with BASIC. The development of this book followed that same spirit. Mitchell Waite, Chuck Blanchard, Harry Henderson, Dan Putterman, and Don Urquhart of The Waite Group development team, and Chris Matthews, Barry Preppernau, and David Laraway of Microsoft Press spent many hours devising, designing, refining, programming, testing, and describing the games, utilities, and other diversions you will find in this book.

We would like to acknowledge the help and encouragement that we received from so many people throughout this project. We would like to thank in particular Salley Oberlin of Microsoft Press for seeing this project through from the beginning; Lisa Yount, for her critique of the text through the rewrite phases; Mary Johnson of The Waite Group for coordinating the flow of materials among the participants; Bob Johnson for his cursor designs; and the unsung heroes and heroines in the realm of production—the people who turned the words, programs, and images into this book. Thank you all.

Introduction

With Midnight Madness *we invite you to participate in a programming* tour de force. *The Microsoft BASIC version 2 series for the Macintosh makes it easier than ever before to create powerful yet flexible programs that take full advantage of the Mac's unique user interface and graphics capabilities. Running and studying the 17 programs in this book will not only*

enhance your skills as a programmer, it will also give you hours of programming pleasure.

As the book's subtitle suggests, the programs in *Midnight Madness* are arranged in these three categories: utilities, games, and "other grand diversions."

Utilities are tools that help you do a job easier or faster. Some of our utilities provide resources for your programming; others help organize information. When you learn how a tool works, you can modify it to fit your needs or to add new capabilities.

Games are toys. They're fun to play with and great to share with friends of all ages. There's more to them than that, though: Programming tricks found in these games can be used for many other sorts of programs as well. You can also make the games harder or more sophisticated, and add strategic as well as arcade features.

Diversions combine the usefulness of utilities with the playful exploration of games. They are *"edutainment"*—a blend of education and entertainment—and represent the growing variety of creative and unique applications that Microsoft BASIC and the Macintosh make possible. We're betting you'll find many others!

Presenting the programs

Now it's time to introduce our all-star cast of programs. We'll briefly describe what each of the programs in the three categories does. The moons next to the program names indicate the general level of difficulty of the programming concepts involved:

is rather easy—the program code is short and straightforward, and the algorithms involved are not too complex;

is intermediate—you will find longer code and more involved structures, and the algorithms and techniques will help you learn some advanced concepts you will need in building programs of your own;

is somewhat difficult—but don't let this scare you—these programs will become the stars in your collection, and will teach you tricks and techniques you may have thought weren't possible before.

Utilities

MacInterface, the first program in the book, lets you move graphics back and forth between BASIC and applications like MacPaint via the Macintosh Clipboard. You can use the application of your choice to create the images, and then animate them with BASIC, or let BASIC create complex shapes to use with other applications. You can paste images to the Scrapbook and read them into other programs.

MacGrid makes it a snap to create any kind of graph paper you want, varying the line intervals, heavy lines, and the overall size of the page. Great for math and science projects!

MacGraph turns your data into bar, line, or pie charts, quickly and easily, with no complex formats or commands to learn. You will be able to plot business trends, or the results from your lab experiments, or your success with your diet.

MacCursor is a powerful utility that lets you create custom mouse pointers, complete with "mask" and "hot spot." Now your mouse can wield a pencil or control a starship!

MacConvert automates the conversion of programs from Microsoft Macintosh BASIC 1.0 to the new version 2. It also aids conversion from other dialects of Microsoft BASIC. You will be able to have your old favorite programs running on the Mac in no time.

MacAnimate explores the world of animation. It provides you with an editor for creating and modifying a series of images much like the frames of a strip of movie film, and also includes an animator that lets you control their motion. Now Mickey won't be the only mouse who can move across a screen.

Games

MacDart has a dart and target balloon that move at different speeds each time you throw. What's more, it even includes the effect of gravity on your throw! You will be able to tune up your hand-eye coordination, and you don't have to worry about hitting passing strangers. Timing is everything with this game.

MacBandit provides a Las Vegas-style "one-armed bandit." You drop your coins in the slot, the wheels spin, and with a bit of luck the Macintosh is stacking your winnings in neat little piles. This one is great for parties!

MacMouse features an animated mouse race complete with music. It's a good way to introduce young children to the Mac.

MacBall is a "break-out" game where placing a shot just right will reward you with a "chain reaction" of scoring. The algorithms show you how to re-create the rebound of the ball off the sides of the screen—a technique that will have you devising your own variations in no time at all.

MacGurkha is named for the intrepid paratroopers from Nepal. The challenge of this game is to guide your trooper past the barrage balloons into the jump zone. Not only will you learn techniques for moving objects, but you will also learn how to make animated objects interact with their environment.

MacSpace brings real arcade excitement to the Mac. This game integrates many of the features of the utility programs. It's all here: animation, a custom pointer, and complex graphics. Just about the only thing missing is that pointy-eared executive officer. Can you destroy the dreaded Klaxxon star cruisers before they get too close?

Diversions

MacBuild is a "drawing construction set." With it, you can assemble designs from our "prefab" shapes, and also design your own custom shapes. You will be able to design all sorts of interesting figures once you've entered this program. And if you don't like what you've built, you can always try building another.

MacOrgan explores the Mac's musical capabilities and turns your keyboard into an organ with two octaves and three chords. In no time at all, you will be entertaining your friends with tuneful little ditties that show off the voices of the mighty Macintosh.

MacCompose lets you express your musical ideas by placing notes on a staff and playing the resulting melody. While MacCompose is a more complex program than MacOrgan, it will give you hours of enjoyment as you explore the fundamentals of music composition.

Companion disk to *Macintosh Midnight Madness*

To save you hours of typing in the programs—and the additional hours of finding those inevitable typos—Microsoft Press has created a special program disk for *Macintosh Midnight Madness*. The disk contains all 17 projects included in the book, plus additional programs containing animation sequences and cursor patterns.

This disk is only available directly from Microsoft Press. To order, use the special bind-in card at the back of the book. If the card has already been used, send $19.95 (plus $1.00 per disk for domestic postage and handling charges, $2.00 for foreign orders) to: Microsoft Press, Box 97200, 10700 Northup Way, Bellevue, WA 98009. Payment must be in U.S. funds, California residents must add 6.5% sales tax, and Washington residents 8.1%. You may pay by check or money order (payable to Microsoft Press) or by American Express, VISA or MasterCard; please include both your credit card number and expiration date. Allow 4 weeks for delivery.

MacFinance answers "questions of interest" about your money—whether you're borrowing or investing it. It shows you some of the really practical things that you can do with the Macintosh. You might want to incorporate some of the algorithms that you learn here in other number-oriented programs.

MacMeasure answers a different kind of question: Is it a long way to Tipperary...or to Cleveland? After calibrating your mouse against a map's scale, you can then use the mouse to trace between any two points and learn the distance.

How to use this book

Each chapter in *Midnight Madness* starts with a description of how to use the program, including examples of actual screens. You can type in the program from the source code at the end of the chapter first and then learn how to use it from the description, or you can wait until you've worked through the chapter before entering and running the program—whichever you prefer.

Following the "how to use it" discussion is the "how the program works" section. Here's where the programming concepts and tricks are revealed in all their glory. This section starts with a brief overview of the program's operation and the concepts it features. While most programs embody several concepts, there is usually a major theme for a given chapter: MacAnimate focuses on moving objects on the screen, MacFinance features window-refreshing techniques, MacOrgan and MacCompose employ the Mac's sound and music features, and so on.

Next comes a complete *pseudocode* description of the program. What's pseudocode? It's like an outline you might make before doing a class paper. Pseudocode provides a high-level, English-like description of program operations in such a way that you can study the methods (algorithms) that are used by the program and see its structure, without getting bogged down in detail. For example, you might run into something like this:

```
WHILE there are images in the graphics file
   read an image into the graphics array
   add one to the image count
WEND
```

This tells you *what* the program is doing without your having to worry about the names of the variables used or the exact syntax of the statements that perform the operations.

Following the pseudocode outline is the in-depth, "blow-by-blow" description of how the program works. This description is keyed to the program-code listing at the end of the chapter, and uses the names of the subroutines plus some special colored labels we've added to the code for easy reference. These labels serve to break up long sections of code (such as the initialization part of the program) into logically related pieces that can be discussed one at a time. (Unlike the subroutine and other labels followed by colons, these special labels *aren't* part of the code and shouldn't be typed in with the program itself.)

In the discussion you will sometimes find references to other chapters in *Midnight Madness* where a given technique is discussed at greater length. You'll also sometimes find references to the companion book *Microsoft Macinations* (Microsoft Press, 1985). This book complements *Midnight Madness* by providing complete discussions and additional examples of most of the techniques used in our programs. In fact, if you are new to Microsoft BASIC for the Macintosh, or new to programming in general, we'd like to recommend that you read *Macinations* first or in conjunction with this book. Advanced programmers will also benefit from its comprehensive treatment of BASIC features for the Macintosh.

Finally, each chapter concludes with a discussion of possible modifications for the program and suggestions on how to go about implementing them. This is your chance to add fiendish features to the games, extend the functions of your favorite utility, or make a diversion a bit more diverting. In addition to extending the programs in this book, the tools and the concepts you'll learn will enable you to professionally polish your own programming projects. We think you'll end up agreeing with us that with Microsoft BASIC, the marvelous Mac, and this book, programming has never been so much fun!

I. UTILITIES

- MacInterface
- MacGrid
- MacGraph
- MacCursor
- MacConvert
- MacAnimate

MacInterface

Integrated software combining two or more application programs is all the rage these days, and for good reason: In theory, integrated software is supposed to make it easy to move information from one application to another. For example, you might create a business graph with a statistical program and then insert the graph into a document that you're writing on your

word processor. Programs that claim such integration are widely available, but many of them have limitations. Some can't handle text and graphics together, while others can move information in one direction but not in another. If a particular function isn't available in a certain integrated software package, you may find it hard to set up communication between that program and another one that *can* do the job. In any case, you're limited to whatever integration the author of a particular software package chooses to provide.

The Macintosh, on the other hand, provides *system-level* integration. This means that the operating system is designed so that any application can easily access a standard set of tools such as the Clipboard and the desk accessories (Note Pad, Scrapbook, Calculator, and so on). Thus, instead of being "in" an application such as a word processor and having to use special commands to send information to another application, you're seated in front of a "desk" as you do your work. The desk contains a variety of applications that you use as needed, just as you might type a letter on a typewriter and then reach for a set of colored pencils to draw an illustration to go with the letter. The desk is always there to serve as your "home base" and to provide standard facilities as you move from one application to another.

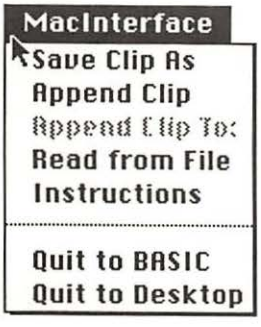
You have access to many of these handy Macintosh desk facilities when you're developing programs in Microsoft BASIC, but if you deal much with graphics, there's another capability that you probably wish you had. As you know if you've studied the code for our games, BASIC is great for animating pictures and manipulating them in other ways; a lot of nice things can be done with a few powerful commands. On the other hand, BASIC isn't very good for *creating* pictures. If you want to draw a realistic-looking spaceship, for example, you have to get some graph paper and try to draw the image as you want it to appear on the screen. Then you have to figure out what BASIC statements are needed to produce this image, and you probably have to go through several cycles of debugging before you get it to come out right.

Your Macintosh probably came with an excellent tool for creating pictures in a natural way, without a lick of programming: MacPaint. Of course, to animate pictures or make them interact with others, you do need to program, which is where BASIC comes in. Clearly it would be nice to use something like MacPaint to create pictures and a language like BASIC to manipulate them. Alas, this is easier said than done.

MacPaint lets you create a picture and put it on the Clipboard for temporary storage, and from there into the Scrapbook, if you wish to keep it as a more permanent file. Unfortunately, BASIC doesn't come with any built-in way of making a picture on the Clipboard accessible to your programs. Don't despair, though: MacInterface will come to your rescue! This utility lets you take pictures from the Clipboard that were created with MacPaint or some other application and save them in files that can be used by your BASIC programs. Many of the games in this book, as well as programs using similar code that you write yourself, can read files created with MacInterface and use the pictures they contain. Designing games and other programs that use graphics becomes much easier and more fun once you have this utility, since you can build up graphics library files and extract pictures from them later to use anywhere you wish. MacInterface provides a powerful new link between Microsoft BASIC and the rest of the Macintosh world.

How to use MacInterface

When you run MacInterface, a new menu appears to the right of the BASIC Windows menu:



If you choose Instructions from the menu, you'll be given the window shown in Figure 1 on the following page, which briefly summarizes MacInterface's features.

Let's step through an example to show a practical use of MacInterface. We'll create two new star-cruiser pictures with MacPaint and then use MacInterface to make them available for use in our MacSpace game. One is a new enemy ship, the Robiton, which represents a mechanical intelligence even more implacable than the vicious Klaxxons who terrorize

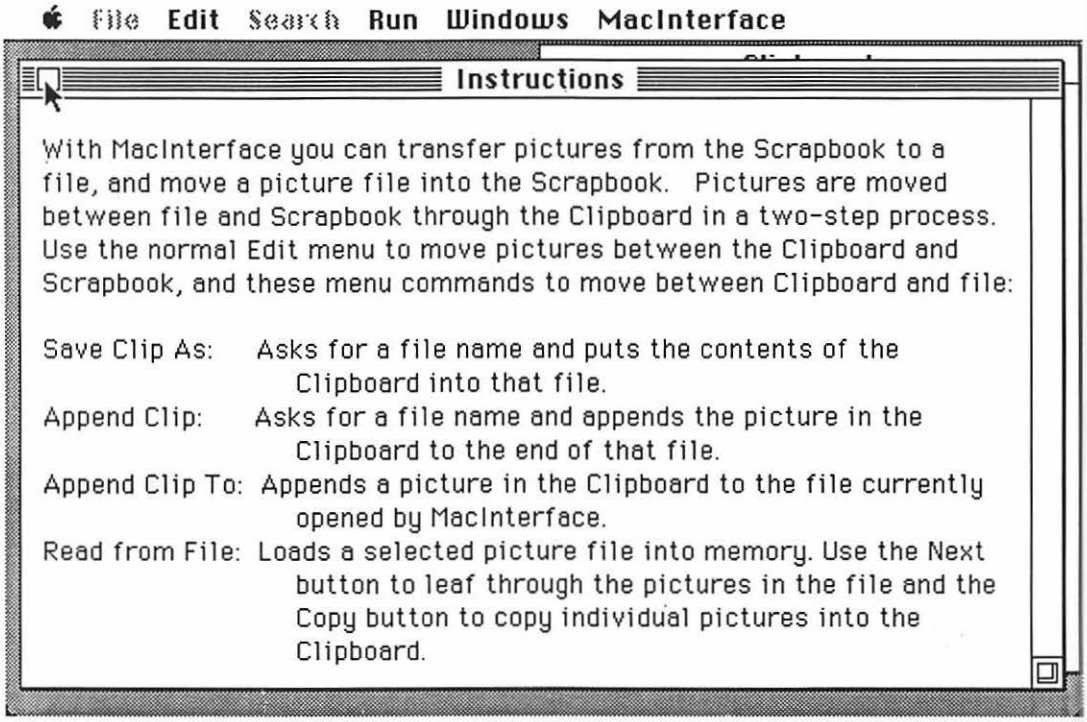


FIGURE 1. *The instruction window available from the MacInterface menu*

the galaxy in MacSpace. The other picture is a new player ship for the peace-loving defenders of truth and justice in that program. (If you haven't played MacSpace or looked over that chapter, you might want to do so now so you'll know how our pictures might be used.)

If you've studied the code for MacSpace or some of the other games, you'll remember that these programs are set up to read a graphics file if it is present on the disk. The name of the graphics file consists of the program's name followed by a period and the word *graphics,* so the graphics file we'll create for MacSpace will be called *MacSpace.graphics.*

Before we get started, there's one unfortunate problem with moving files between MacPaint, MacInterface, and BASIC programs that we'd better warn you about: There usually isn't room for everything on one disk, which means that you will have to do a fair amount of disk-swapping if you have only one drive. One Macintosh feature not advertised by Apple is that it's a great exercise machine for the arms; there always seems to be one more disk swap to make, right down to the Mac's demand that you reinsert the disk with the smear of peanut butter on it that you haven't seen since last Tuesday. This is a cross that those of us with single-drive systems simply have to bear.

This problem can be eased somewhat by copying MacPaint, Microsoft BASIC, MacInterface, and a couple of the games or other programs you're going to be experimenting with to one disk. Since copying the System files to this same disk to make it a startup disk wouldn't leave much space, however, you probably will have to start up with another disk and then switch to your MacInterface "working disk." That will still leave more disk-swapping than you'd like, but it should be fairly tolerable. If you're lucky enough to have two disk drives, life is much easier. Or, you could use the Font/DA Mover, which comes with the Finder 4.1 system disk, to reduce the size of the system file by removing fonts and desk accessories.

In the unlikely event that you haven't yet used MacPaint, we recommend that you take some time to play with it and familiarize yourself with its capabilities now. Since games usually require small but detailed pictures, you should probably use MacPaint's FatBits option (chosen from the Goodies menu) when creating these pictures. We used FatBits to create the star cruisers shown in Figures 2 and 3.

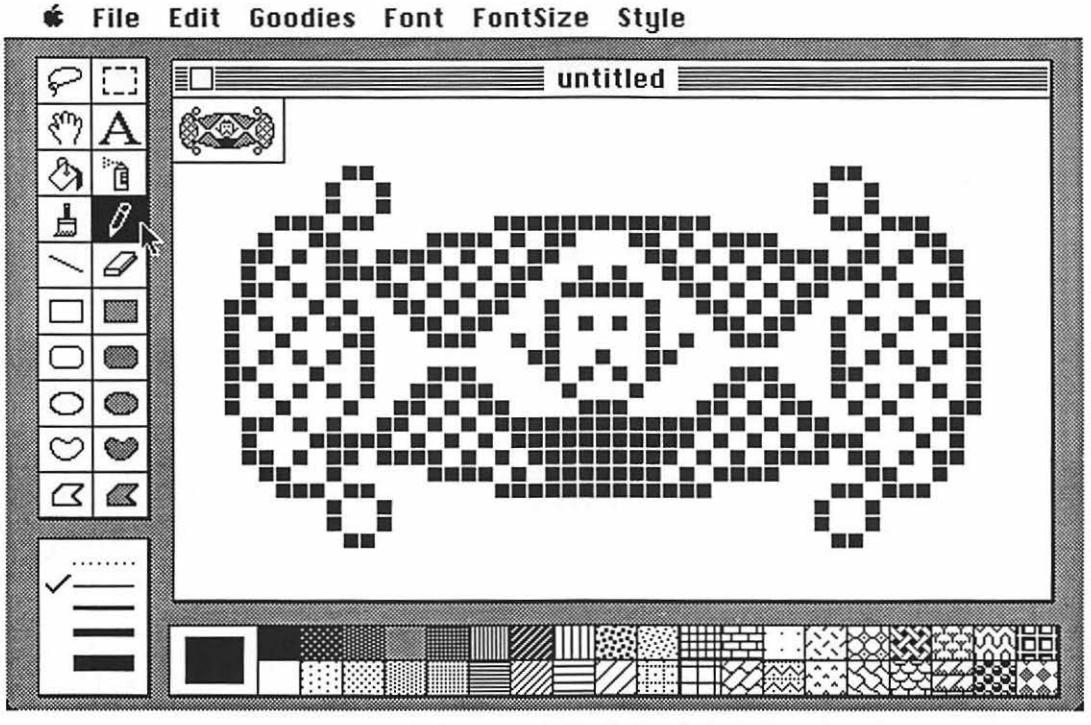


FIGURE 2. *A FatBits view in MacPaint of the Robiton Star Cruiser to be used in MacSpace*

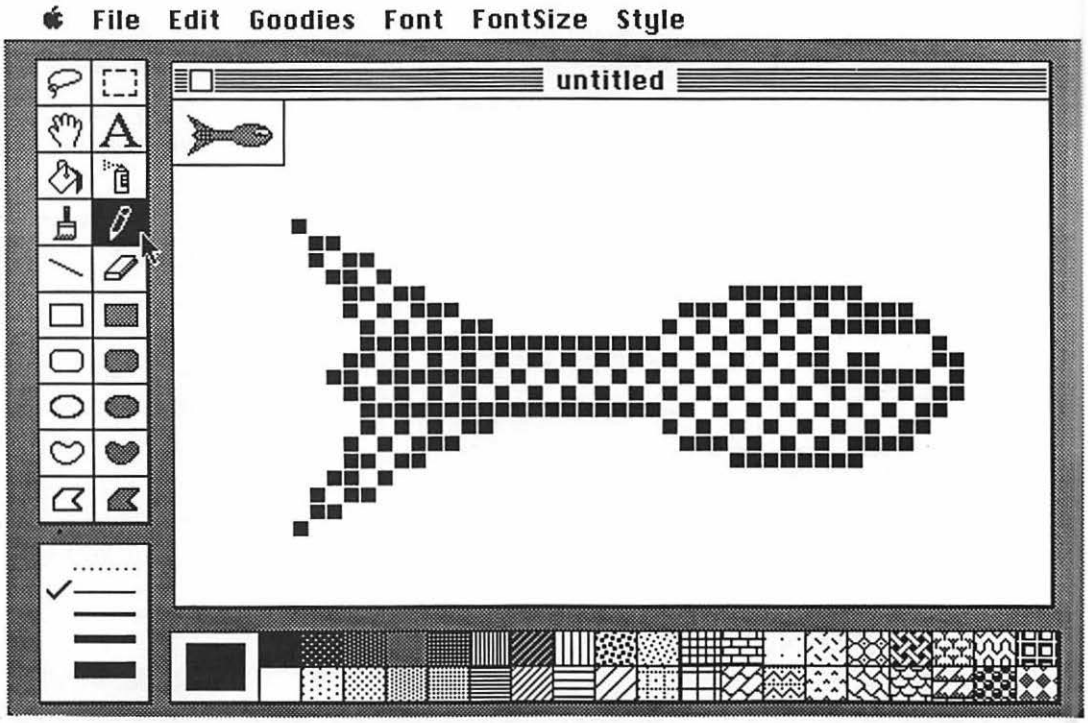


FIGURE 3. *A FatBits view of the player's starship to be used in MacSpace*

We created the Robiton star cruiser first because MacSpace loads the "enemy" cruiser picture before it loads the picture of the player's starship. After creating the Robiton picture, we then copied it to the Clipboard. This is done by selecting the picture with the Marquee or Lasso and then choosing Copy from the MacPaint Edit menu.

Figure 4 shows how our Macintosh desktop looked after we copied the Robiton picture to the Clipboard and quit from MacPaint. We obtained the display of the Clipboard by choosing Show Clipboard from the Macintosh Edit menu—a useful way to check the contents of the Clipboard. If you're working with several pictures, you can save them in the Scrapbook and copy them to and from the Clipboard using the Edit menu's Copy and Paste functions.

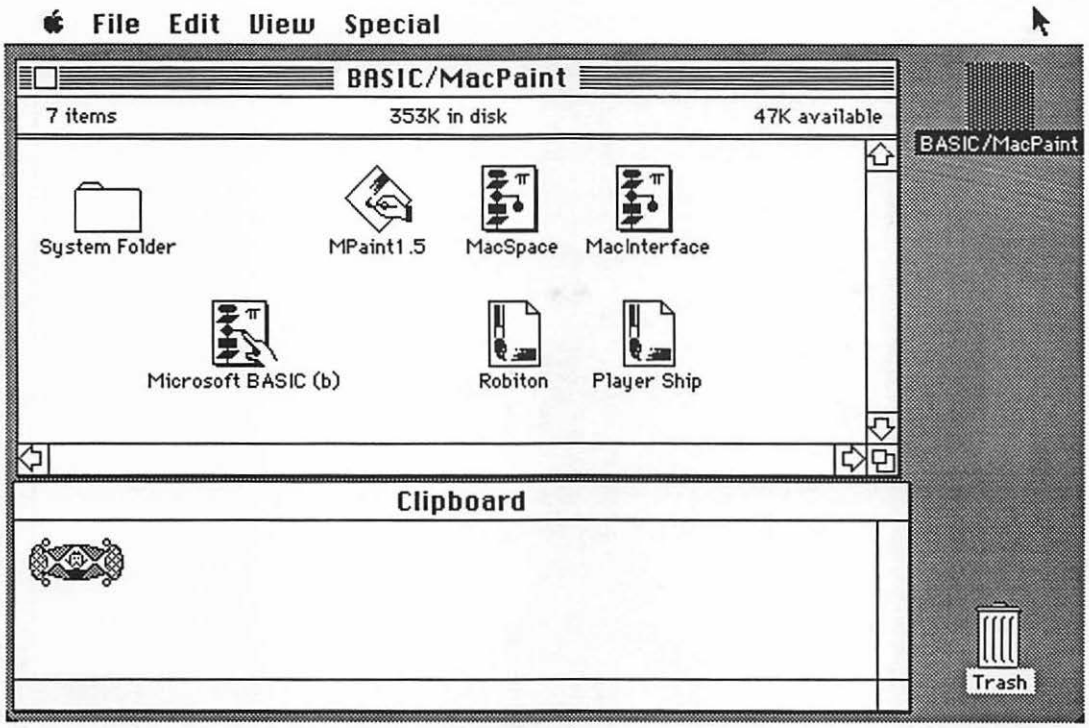
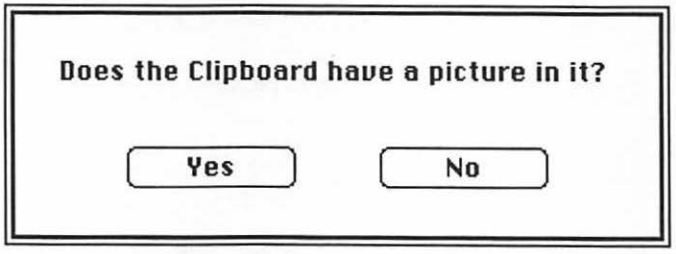


FIGURE 4. *The Macintosh desktop after creating the pictures in MacPaint that will be used in the MacSpace game*

Next, we ran MacInterface, which presented us with this dialog box:



We clicked the Yes button, which opened the window shown in Figure 5 on the next page displaying our Robiton picture. Then we pulled down the MacInterface menu, and chose the Save Clip As option. We called the file *MacSpace.graphics,* and the picture was saved in it.

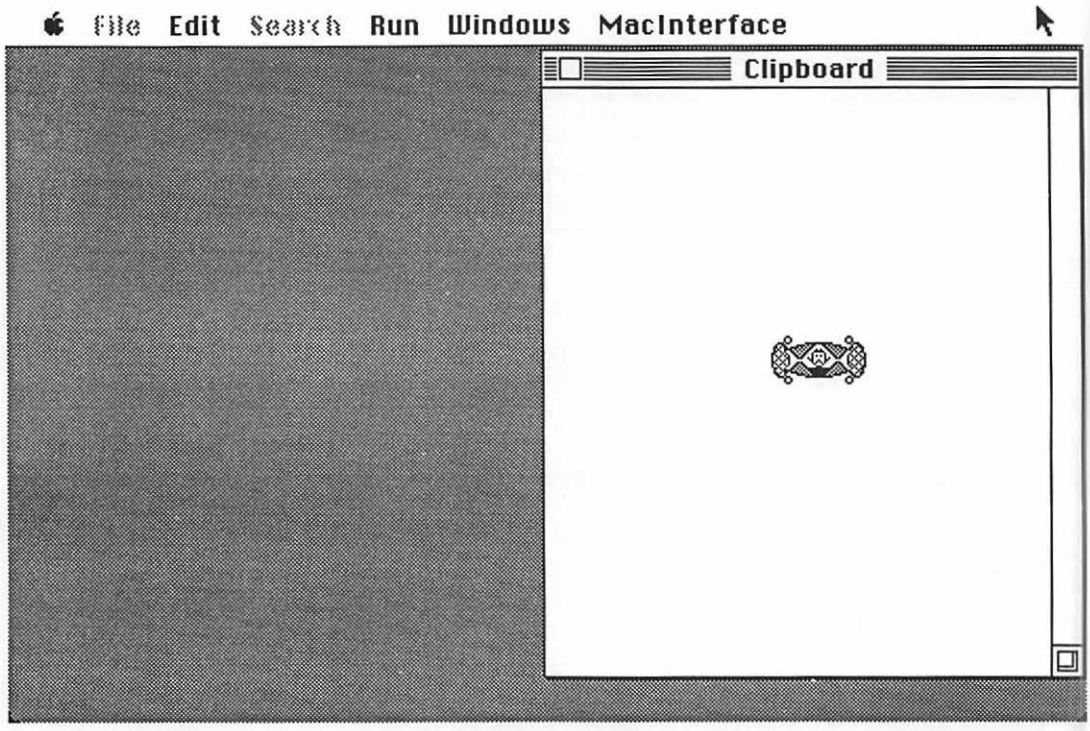


FIGURE 5. *The MacInterface Clipboard window*

We followed the same steps with the picture of the player ship, except that, after we clicked the Yes button in the dialog box, we *appended* it to the already-created *MacSpace.graphics* file by choosing the Append Clip option from the MacInterface menu.

After both pictures were placed in *MacSpace.graphics,* we verified that everything had taken place as expected by choosing Read from File from the MacInterface menu, which resulted in the screen display shown in Figure 6. First, the Robiton picture was displayed, then we clicked the Next button to see the picture of the player's starship.

The final test is running MacSpace with the new pictures. Assuming that the *MacSpace* and *MacSpace.graphics* files are on the same disk (MacSpace won't ask for another disk if it doesn't find the graphics file), the new pictures should appear on the title screen as shown in Figure 7. If you remove the *MacSpace.graphics* file from the disk containing *MacSpace,* the game will run with its own built-in pictures.

We recommend that you practice using MacPaint and MacInterface together by creating two ship pictures of your own for MacSpace. Then try it with another game. Any program that has code that reads a file with the extension *.graphics* will read a file created by MacInterface. Make

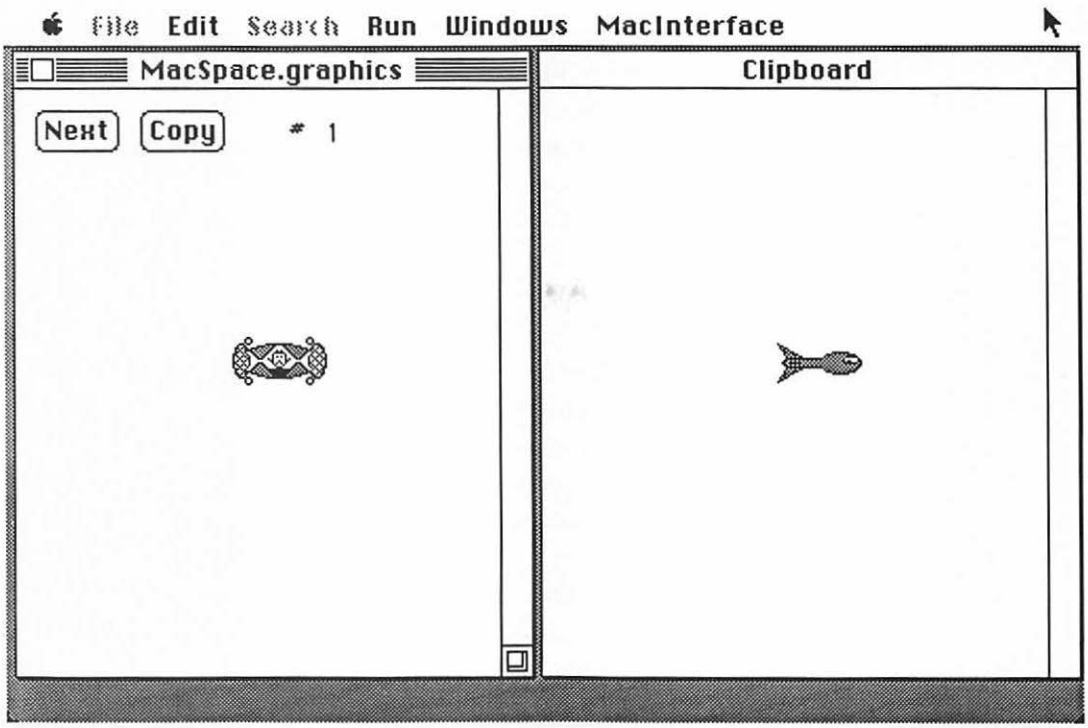


FIGURE 6. *The two MacInterface windows*

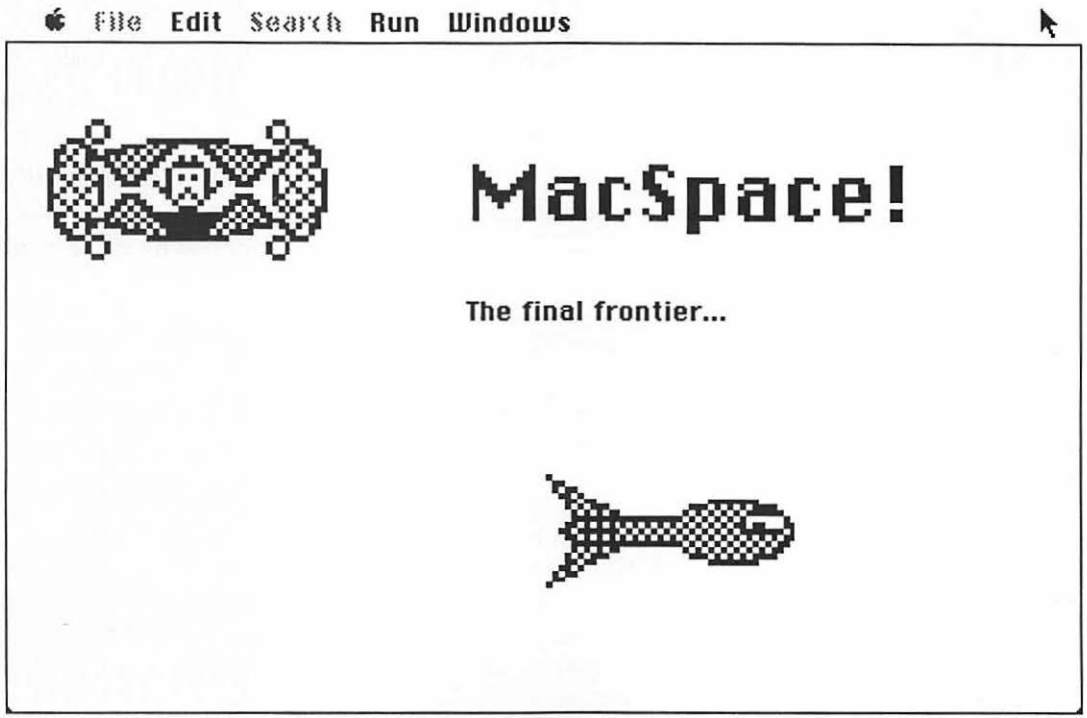


FIGURE 7. *MacSpace title screen displaying pictures saved in a MacInterface file.*

sure the file you create has the exact name specified in the code and that it's on the same disk as the program that will use it.

Of course, you can do much more with MacInterface than create new pictures for your games. Your own BASIC programs can also read and use picture files created with MacPaint and MacInterface. And you aren't limited to MacPaint as a source of pictures: The output of any application that can place something on the Clipboard can be used by MacInterface. For example, you can take pictures from any of the commercially available libraries of pictures for the Mac. Just select a picture from the library and put a copy on the Clipboard, then use MacInterface to file the picture for use with your BASIC programs.

You can also send information in the other direction—from BASIC to MacPaint, for example. You could write a BASIC program to generate a pie chart and place the chart on the Clipboard. You could then run MacPaint and paste the picture from the Clipboard into a MacPaint document so you could use those neat little brushes and pens to embellish the graph. Finally, you could copy the enhanced graph back to the Clipboard and then use MacWrite to copy it into a document.

Using the Scrapbook with MacInterface

It's probably occurred to you that we had to go back and forth between MacPaint and BASIC twice in order to get both of our spaceships into MacInterface. We did this so the necessary steps could be clearly explained. However, when you want to bring two or more images from MacPaint or another application into MacInterface, you can bypass several steps by saving them in the Scrapbook as you create them *if both the application and BASIC are on the same disk.* For example, here's what you would do with the two spaceships in MacPaint if both MacPaint and BASIC were on the same disk:

1. Select the Robiton ship with the Marquee or Lasso.
2. Choose Copy from the Edit menu.
3. Choose Scrapbook from the Apple menu.
4. Choose Paste from the Edit menu.
5. Close the Scrapbook.
6. Select the player's ship with the Marquee or Lasso.
7. Choose Copy from the Edit menu, open the Scrapbook, and choose Paste from the Edit menu.

At this point both of the ships would be stored in the Scrapbook, and you would quit MacPaint and start up MacInterface. To get the ships into a

MacInterface file, you would:

1. Open the Scrapbook and scroll to the Robiton image.
2. Choose Copy from the BASIC Edit menu.
3. Close the Scrapbook.
4. Choose Save Clip As from the MacInterface menu and enter a file name in the dialog box.
5. Open the Scrapbook and scroll to the player's ship.
6. Choose Copy from the BASIC Edit menu.
7. Close the Scrapbook.
8. Choose Append Clip from the MacInterface file menu.

By using the Scrapbook like this you would achieve the same results, but by staying in one application at a time you would spend much less time looking at the little wristwatch while the Macintosh quit one application and loaded the other. Figure 8 summarizes the interaction of MacInterface, MacPaint, the Scrapbook and Clipboard, and BASIC programs.

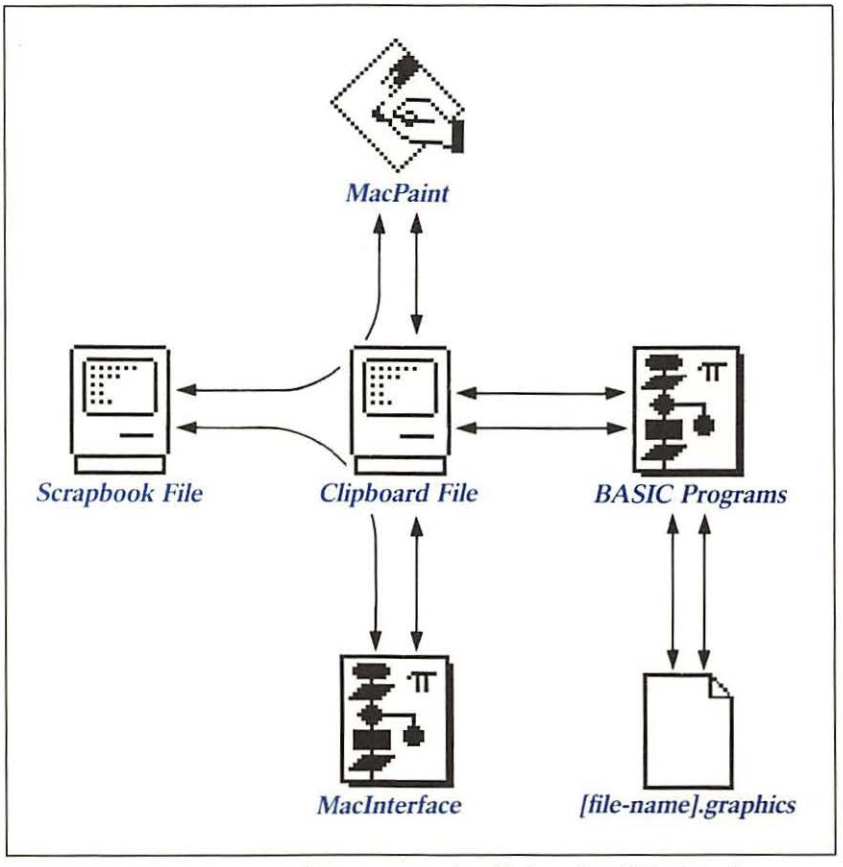


FIGURE 8. *The movement of images using the Clipboard and MacInterface*

How MacInterface works

How can BASIC programs use the Clipboard? The brief answer is that the Macintosh treats the Clipboard just about like any other file, so the BASIC statements used for creating or reading disk files will also work with the Clipboard. You'll learn a more detailed answer as we study the MacInterface program outline shown in Figure 9.

Initialization	
initialize variables and arrays	**Init 1**
define functions for picture-string and file-name handling	**Init 2**
install MacInterface menu and menu event-trapping	**Init 3**
ask if a picture is in the Clipboard (**ClipHere**)	SR 1
enable dialog event-trapping and create Output window	**Init 4**
Main Program	
establish endless loop:	**Main**
interrupted by menu and dialog events,	DE 0, ME 0
and ended by clicking in close box of Clipboard (**CloseBox**)	DE 3
Dialog Events	
DialogEvent: find number of event, item affected, and branch to appropriate subroutine:	**DE 0**
BtnClick: a button was clicked	**DE 1**
get number of button and pertinent window	
if picture file window:	
either display next image in file, (**DisplayNext**)	SR 7
or copy image to Clipboard (**CopyToClip**)	SR 6
ActiveWindow: button was clicked in inactive window	**DE 2**
make window active	
CloseBox: close box clicked in active window	**DE 3**
if Clipboard window, end program	
if other, enable menu items	
RegenWindow: window needs refreshing	**DE 4**
depending on window, regenerate contents of:	
Clipboard (**ShowClip**)	SR 3
image file "pseudo-scrapbook" (**RefreshRead**)	SR 8
instruction window (**PrintInst**)	SR 9
Menu Events	
MenuEvent: disable menu, branch to subroutine:	**ME 0**
SaveClip: save clipboard to a new file	**ME 1**
if clipboard empty, display message (**ClipEmpty**)	SR 5
get filename and save clipboard to file (**ClipToFile**)	SR 4

(continued)

FIGURE 9. *Program outline*

```
   AppClip: append Clipboard to existing file                    ME 2
     if clipboard empty, display message (ClipEmpty)             SR 5
     get filename and append clipboard to file (AppToFile)       ME 3

   AppToFile: append Clipboard to file currently opened          ME 3
     save Clipboard contents to file (ClipToFile)                SR 4

   ReadPics: read images from file                               ME 4
     get filename of graphics file
     if no filename entered, exit
     open file
     WHILE there are more images
       read each image into picture array
     WEND
     create window for "pseudo-scrapbook"
     create buttons in window
       for advancing to next picture
       for copying picture to Clipboard

   Inst: show instructions                                       ME 5
     create Output window for instructions; opening window
       generates refresh dialog event (RegenWindow)            DE 4

   BasQuit: quit to BASIC                                        ME 6
     reset menu, close all windows (CleanUp)                     SR 2

   DeskQuit: quit to Mac Desktop                                 ME 7
     reset menu, close all windows (CleanUp)                     SR 2

Subroutines
   ClipHere:                                                     SR 1
     open window
     ask user if Clipboard has picture
       if no, clear Clipboard for use
     close window

   CleanUp: reset menu, close all windows                        SR 2

   ShowClip:                                                     SR 3
     open Clipboard; if empty, return
     read image and store in picture string
     display in Clip window (DisplayPict)                        SP 1

   ClipToFile:                                                   SR 4
     open Clipboard; if empty, show message (ClipEmpty)          SR 5
     read image into picture string
     send string to opened file
     close files and update menu with filename

   ClipEmpty: show "empty Clipboard" message                     SR 5
```

(continued)

Figure 9. Program outline (continued)

```
CopyToClip:                                                    SR 6
   disable buttons in "pseudo-scrapbook" while copying
   open Clipboard for output and store current image
   switch to Clip window and display image (ShowClip)          SR 3

DisplayNext:                                                   SR 7
   increment current picture counter
   display image (RefreshRead)                                 SR 8

RefreshRead:                                                   SR 8
   display image (DisplayPict)                                 SP 1
   update image number in window

PrintInst: print instructions                                  SR 9

Subprograms

DisplayPict:                                                   SP 1
   get current window dimensions
   calculate current picture dimensions
   display image in center of window if possible, else just top left corner
```

Figure 9. Program outline (continued)

Constants and initialization

The constants defined in [Init 1] simply define the Output window. We'll discuss the function defined in [Init 2] later, when it's used. The GOSUB CleanUp [SR 2] statement gets rid of any Output windows that might be left over from a previously run program and frees up the memory that had been used to maintain them. This is an example of what could be called "defensive programming." We would like to assume that all programs have the courtesy to leave the Macintosh environment the way they found it, but it's safer not to make that assumption. Since memory is tight on a 128K Mac, it's a good idea to have a program reclaim memory that may be tied up in windows or other facilities left over from previous programs.

The MacInterface menu is created in [Init 3]. Since the program is menu-driven, the seven main functions are accessed via a pull-down menu. (The program produces dialog boxes with buttons when it needs more information to carry out a particular function.) You'll note that the program line for the sixth menu item has "-" for a title; this causes a line to be drawn, dividing the menu selections into two parts. The first five items call subroutines that actually do the main work, while the last two contain the quit functions. Breaking a menu into groups of related functions like

this gives the user a little more help in seeing how things are organized, and it looks nicer, too.

Next, the ON MENU GOSUB statement enables menu event-handling. When a menu event occurs, MenuEvent [ME 0] gets the number of the item selected from the MENU(1) function and dims the MacInterface menu with *MENU 6,0,0.* This shows the user that a function is in progress and that further menu selections can't be made until the currently selected function is completed. The *ON item GOSUB* statement sends control to the subroutine in charge of the function selected. (Note the extra comma after *Inst* in the *ON item GOSUB* statement; it's needed for the sixth menu event, the "dummy" event that was used to print the line across the menu. If someone tries selecting this event, no branching takes place, since that menu item was never enabled.

In [Init 4], the GOSUB statement that calls ClipHere [SR 1] first creates a window, then sets up two buttons, Yes and No, for answering the question "Does the Clipboard have a picture in it?" If the answer is no, we will not be using the Clipboard for input, so the subroutine then opens the Clipboard for output.

Next, dialog events are enabled with the ON DIALOG GOSUB statement. Following this statement, the window to display the Clipboard is set up and displayed.

When the window is opened, a dialog event 5 is generated. Since all dialog events are handled in DialogEvent [DE 0], control temporarily goes to RegenWindow [DE 4], where ShowClip [SR 3] is encountered. ShowClip opens the Clipboard, reads its contents, and uses the subprogram DisplayPict [SP 1] to put the image on the Clipboard, if there is one in Window 1. The main program [Main] is an endless loop that is interrupted when a menu or dialog event occurs and resumes when processing is completed. The program is exited not by the loop terminating, but by a particular menu event: a Quit selection, which exits via the BasQuit [ME 6] or DeskQuit [ME 7] subroutines. Both of these subroutines call the CleanUp subroutine [SR 2]. The loop and therefore the program also ends if the close box of the Clipboard window is clicked.

When a dialog event occurs, DialogEvent [DE 0] gets the number of the item selected from the DIALOG(0) function and sets the variable *dilog* equal to it. The subroutine then makes choices based on the value of *dilog.* If *dilog* is not equal to zero, then the variable *dInfo* is set equal to *DIALOG(dilog).* On the next line, control is branched to a subroutine based on the number of the dialog event that happened—1, 3, or 4 (this program doesn't use edit fields, so a dialog event 2 can't be generated).

If a button was clicked, *dilog* is equal to 1, and control transfers to BtnClick [DE 1]. Here, some checks are made to make sure the buttons clicked were in Window 2, where images from our graphics file are displayed. Depending on the button clicked, we either want to see the next image (DisplayNext [SR 7]) or copy the current image to the Clipboard (CopyToClip [SR 6]).

A dialog event 3 occurs when the mouse button is clicked with the pointer in an inactive window, so ActiveWindow [DE 2] changes the current window to the desired one. If *dilog* equals 4, then the close box of the active window was clicked. If the close box is that of the Clipboard window (2), then *finished* is set to *true* and the main loop terminates, ending the program. Otherwise, the user clicked on the other window and the two pertinent menu items are enabled.

Finally, if a window is resized, *dilog* equals 5 and RegenWindow [DE 4] is called, which recreates the contents of the window specified by *dInfo,* using ShowClip [SR 3], RefreshRead [SR 8], or PrintInst [SR 9].

As we look at each of the functions that MacInterface performs, we will show you how this whole dialog event area works.

The Clipboard item functions

While there are seven main functions in MacInterface, they can be considered in groups. There are those functions that relate to saving Clipboard items either to new files or appending them to existing files, a function which allows you to "leaf" through a file image by image, a function which lets you read the instructions, and then the standard exit functions to BASIC or to the Macintosh desktop. Let's take a closer look at the Clipboard functions now.

The first three menu selections basically show you the current contents of the Clipboard and ask if they are to be saved as a new file or appended to an existing one.

Save Clip As

The first Clipboard menu function, SaveClip [ME 1] saves the contents of the Clipboard to a new file. It does this by first opening the file "CLIP:PICTURE" for input. The Clipboard, or "CLIP:", is a "predefined" device, analogous to a disk file. The "PICTURE" tells BASIC that the information on the Clipboard is encoded graphics information rather than text.

Of course, there may be nothing on the Clipboard to read. Therefore, the length of the Clipboard file is checked with the LOF function: If the length of the file is zero bytes, there's nothing on the Clipboard. In that case, control passes to ClipEmpty [SR 5], where DIALOG is set to OFF and the message "Sorry, the Clipboard is empty" is displayed. An OK button is drawn, and the program sits in a WHILE...WEND loop waiting for the user to press the button. There isn't really too much you can do with an empty Clipboard.

If the Clipboard isn't empty, LOF is greater than zero and the program requests a name for the file that will save the Clipboard image. The FILES$ function is used to display a standard file-selection dialog box, and the parameter 0 indicates that this is to be a new file and that a file name needs to be obtained. The prompt "Save as" is displayed, an insertion point and the usual editing facilities are provided, and an option to eject the disk and insert another is also automatically provided by FILES$. You can see that this dialog box saves the programmer a lot of work and gives the user something familiar from many other Macintosh applications.

After a name is entered via the dialog box, the name is saved in the variable *appFile$*. This variable is the name of the file to be used in the append subroutines. After the file in *appFile$* is opened for output, control passes to ClipToFile [SR 4]. This subroutine first opens "CLIP:PICTURE" for input, then checks to see if there is anything on the Clipboard. If there isn't, the control jumps down to the label EmptyClip, which then closes the "files," and goes to ClipEmpty [SR 5], which we described earlier. If there is something on the Clipboard, the Clipboard contents are read. The actual data is read in by the INPUT$ function using the length of the file returned by LOF and assigned to the string *clip$*. For reading a chunk of data that doesn't need to be divided into fields, the combination of the LOF and INPUT$ functions gives Microsoft BASIC a real advantage over BASICs that lack these functions and have to use a loop to read the data.

Once the Clipboard picture has been read and stored in *clip$*, control jumps to the section labeled AClipEnd and gives the third item in the MacInterface menu the name of the file stored in the variable *appFile$* for later use. Control then returns first to SaveClip [ME 1], and then back to the endless loop in the main program [Main].

Append Clip

The next menu choice is Append Clip; its purpose is to append the contents of the Clipboard to an existing file. This is handled in AppClip [ME 2]. In it, "CLIP:PICTURE" is opened, and like SaveClip [ME 1], the Clipboard is checked to see if it contains something. If it doesn't, control passes to ClipEmpty [SR 5], which we described earlier.

In AppClip, the FILES$ function has the parameter 1, meaning that an existing file will be used. The parameter TEXT specifies that we will be concerned only with text-type files. Although our files contain encoded pictures, remember that these are *strings* and thus text as far as the operating system is concerned. The FILES$ statement creates a dialog box similar to that produced in SaveClip, except that an inner window with the names of the text files on the current disk is created. (Using the TEXT parameter prevents the names of non-picture files from being displayed.) The user then double-clicks on the name of the file to which the picture is to be appended. Everything else works the same way as in SaveClip except, of course, that the file is opened for APPEND rather than for OUTPUT.

If the Clipboard does contain something, *appFile$* is set equal to the name selected in the dialog box. If a name is not entered, the Cancel button must be pressed and the third item in the menu is reset to show no active file name. If a name is entered, control passes to AppToFile [ME 3]. This subroutine opens the file named in *appFile$* for appending the picture and transfers control to ClipToFile [SR 4] which was described above.

Append Clip To

The third menu option is Append Clip To. The corresponding subroutine AppToFile [ME 3], appends the Clipboard's contents to an already opened file. The name of the file is the last file used in the Append Clip option described above and is stored in *appFile$*. Control then passes to ClipToFile [SR 4] before returning to the main program.

Reading picture files

Now let's look at MacInterface's other principal activity: reading files of pictures and saving selected pictures to the Clipboard. ReadPics [ME 4] manages this function. First, it uses FILES$ to obtain the name of the file to be read, just as was done in AppClip. But if no file name is obtained,

ReadPics returns to MenuEvent without doing anything. Otherwise, the selected file is opened and a WHILE...WEND loop reads the pictures into the string-array *pict$*. This code is similar to that used in many of the games for reading images; the only puzzler might be the statement starting with *dummyByte$*. This is needed to read past the line-feed character that the PRINT statement tacked onto each picture string as it was appended to the file.

Next, a window is set up via the next few lines of code. The chosen file name is used as its title. The buttons give the choices of Next (display the next picture in the file), or Copy (copy the picture to the Clipboard). The fact that Window 2 is opened generates a dialog event 5. Since we are trapping dialog events, program control takes a quick sidestep to RegenWindow [DE 4]. The current window is number 2, so RefreshRead [SR 8] is called, which in turn calls the DisplayPict subprogram [SP 1] to display the current picture. Defining this routine as a subprogram rather than a subroutine allows it to handle any picture string; the STATIC qualifier guarantees that the contents of all the internal variables will not be disturbed between calls. The constants for window width and window height are accessed (using the WINDOW function) so that the subprogram will "know" where the Output window is located regardless of whether it was resized or not.

Remember the function definition IntVal in [Init 2] that we passed over when discussing the constants at the beginning of the program? Let's take a look at this function now, because it's used in DisplayPict. The function simply converts two characters, starting at a specified position, into an integer. The ASC function gets the integer ASCII value of the characters. Since integer values have two bytes, with the high-valued byte coming second, the second byte's value is multiplied by 256 and added to the first to get the full integer represented by the two characters.

We have to take the long way around here because the picture string contains characters in a specific format that encodes the information and graphics instructions necessary for creating the picture. These must be converted to integer values before they can be used for displaying the picture. In particular, the height of the picture must be obtained by finding and subtracting the values of the y coordinates of the top (bytes 7 and 8 in the picture string) and bottom (bytes 3 and 4). The picture's width is similarly obtained from its right and left x coordinates: bytes 9 and 10, and bytes 5 and 6, respectively.

The two IF statements that follow the code using IntVal take care of positioning the picture within the Output window. If the picture fits in

the window, it is centered; otherwise the x and/or y coordinates are changed to 10 to display as much of the picture as will fit, starting at the upper left. Finally, the PICTURE statement displays the picture.

After the current picture is displayed, control returns to ReadPics, where two buttons are created, one to advance from the currently displayed image to the next one in the file, and the other to copy the current image to the Clipboard. After this is done, ReadPic returns through MenuEvent to the main idle loop.

If the first button is clicked, the user wants to see the next picture. When the first button is clicked, a dialog event 1 occurs and the program flows through a DialogEvent [DE 0] and BtnClick [DE 1] to DisplayNext [SR 7]. DisplayNext increments *current,* wrapping back to image 1 if we are already at the last image in the file, and calls RefreshRead [SR 8]. RefreshRead displays the current image and prints its number in the window.

If the second button is clicked, the user wants to copy the currently displayed picture to the Clipboard, so CopyToClip [SR 6] is called. This deactivates the buttons, opens the "CLIP:PICTURE" file, and saves the current picture string from the array (*pict$(current)*) to the Clipboard. After the file is closed, the buttons are reactivated for the next selection. The window is closed, and program control then ends up back in the main program loop.

Auxiliary functions

We have now covered all but the Instruction and Quit choices from MacInterface's pull-down menu. The Quit menu options [ME 6] and [ME 7] are just our old standbys. In this case they both call CleanUp [SR 2], which resets the menu and closes the windows before exiting. If the Instructions menu item is selected, MenuEvent calls Inst [ME 5]. This opens a window entitled Instructions, with no buttons, and returns to the main program. The opening of the window generates a dialog event 5 which is trapped by RegenWindow [DE 4] in DialogEvents. Here, *dInfo* is set so that PrintInst [SR 9] is called. After the instructions are printed, the main loop waits until another menu or dialog event occurs.

The main thing to note here is that the instructions are available *whenever* a menu selection can be made—not just at the beginning of the program. This means that the user can review the instructions without restarting the program any time he or she needs help. Since the help is provided as a menu event, it's not necessary to anticipate all the places where

the user might get confused so that the program can test repeatedly for the entry of a help command. This may not be too important in a program like MacInterface that has only a few options, but help (perhaps even several levels of help) provided in this way can become invaluable in more complicated programs.

Suggestions for MacInterface

Rather than suggesting modifications for MacInterface, we recommend that you adapt some of its subroutines to your own programs. The most generally useful ones are those that read from and copy to the Clipboard, those that create or append to files of pictures, and the method presented here for maintaining two levels of event-trapping simultaneously. If you write a program that produces output you might want to use with MacPaint, MacWrite, or other applications, giving your program the option of sending output to the Clipboard would be very useful—and very easy to do, once you understand how MacInterface works. Long after you've gotten tired of a favorite game, a reliable utility or general-purpose subroutine or subprogram will continue to pay dividends in your work.

MacInterface program listing

```
'*****************************************************************
'                          MacInterface
'              Interface between files and the Clipboard
'*****************************************************************

'*********************************************************** INITIALIZE
INIT 1
DEFINT A-Z
DIM pict$(20)

false = 0 : true = NOT false
wTop = 40 : wLeft = 5 : wBot = 320 : wRight = 250          'output window size,
wWidth = wRight - wLeft                                      'width and height
wHeight = wBot - wTop
appFile$ = ""

INIT 2
                              'IntVal extracts a two byte integer value from s$ at position n
DEF FN IntVal(s$,n) = ASC(MID$(s$, n, 1)) * 256 + ASC(MID$(s$, n + 1, 1))

                          'FileName$ returns just the filename from a 'Volume:Filename' string
DEF FN FileName$(f$) = RIGHT$(f$, LEN(f$) - INSTR(f$, ":"))

INIT 3
GOSUB Cleanup                                              'reset any open windows
MENU 6, 0, 1, "MacInterface"                               'install MacInterface menu
MENU 6, 1, 1, "Save Clip As"
MENU 6, 2, 1, "Append Clip"
MENU 6, 3, 0, "Append Clip To:"
MENU 6, 4, 1, "Read from File"
MENU 6, 5, 1, "Instructions"
MENU 6, 6, 0, "-"
MENU 6, 7, 1, "Quit to BASIC
MENU 6, 8, 1, "Quit to Desktop"
ON MENU GOSUB MenuEvent : MENU ON

INIT 4
GOSUB ClipHere
ON DIALOG GOSUB DialogEvent : DIALOG ON
WINDOW 1, "Clipboard", (wRight + 5, wTop) - (510,wBot), 1

'*********************************************************** MAIN PROGRAM
MAIN
finished = false                                 'loop interrupted by menu or dialog events
WHILE NOT finished : WEND                        'loop ended by click in Close Box of Clip wind.
GOSUB Cleanup
END

'*********************************************************** DIALOG EVENTS
DE 0
DialogEvent:
  dilog = DIALOG(0)                                                    'get event type
  IF dilog <> 0 THEN dInfo = DIALOG(dilog)                  'get event number within type
  ON dilog GOSUB BtnClick, , ActiveWindow, CloseBox, RegenWindow
  RETURN
```

```
BtnClick:                    '_____ if 'Next' or 'Copy' buttons clicked
   buttn = dInfo : wind = WINDOW(0)
   IF wind = 2 THEN ON buttn GOSUB DisplayNext, CopyToClip
   RETURN

ActiveWindow:                '_____ make inactive window active
   WINDOW dInfo
   RETURN

CloseBox:                    '_____ respond to click in Close Box
   IF dInfo = 1 THEN finished = true          'if closing 'Clip' window, end Main loop
   IF dInfo >= 2 THEN MENU 6, 2 + dInfo, 1    'if other, enable menu items
   RETURN

RegenWindow:                 '_____ if window needs refreshing, regenerate contents
   currWind = WINDOW(1)                       'save current window number
   WINDOW OUTPUT dInfo                        'change to window that needs refresh
   ON dInfo GOSUB ShowClip, RefreshRead, PrintInst   'refresh needed window
   WINDOW OUTPUT currWind                     'change back to first window
   RETURN

'********************************************** MENU EVENTS
MenuEvent:
   item = MENU(1)
   MENU 6,0,0
   ON item GOSUB SaveClip, AppClip, AppToFile, ReadPics, Inst, , BasQuit, DeskQuit
   MENU 6,0,1
   RETURN

SaveClip:                    '_____ save Clipboard to a new file
   OPEN "CLIP:PICTURE" FOR INPUT AS #2
   length = LOF(2) : CLOSE #2
   IF length = 0 THEN GOSUB ClipEmpty : RETURN
   file$ = FILES$(0, "Save as?")
   IF file$ = "" THEN  SNoFile
   appFile$ = file$
   OPEN appFile$ FOR OUTPUT AS #1
   GOSUB ClipToFile
SNoFile:
   RETURN

AppClip:                     '_____ append Clipboard to an existing file
   OPEN "CLIP:PICTURE" FOR INPUT AS #2
   length = LOF(2) : CLOSE#2
   IF length = 0 THEN GOSUB ClipEmpty: RETURN
   appFile$ = FILES$(1, "TEXT")
   IF appFile$ = "" THEN MENU 6,3,0,"Append Clip to:"
   IF appFile$ <> "" THEN  GOSUB AppToFile
   RETURN
```

DE 1

DE 2

DE 3

DE 4

ME 0

ME 1

ME 2

ME 3
```
AppToFile:          '_____ append Clipboard to appFile$
  OPEN appFile$ FOR APPEND AS #1
  GOSUB ClipToFile
  RETURN
```

ME 4
```
ReadPics:           '_____ read pictures from file
  file$ = FILES$(1, "TEXT")                    'read from what file?
  IF file$ = "" THEN RNoAction                 'user hit cancel, do nothing
  MENU 6,4,0
  OPEN file$ FOR INPUT AS #1                   'read all pictures in file
  pictures = 0 : current = 0
  WHILE NOT EOF(1)                             'loop for each picture
    INPUT #1, bytes
    pictures = pictures + 1                    'pictures = number of pictures in file
    pict$(pictures) = INPUT$(bytes,1)
    dummyByte$ = INPUT$(1,1)
  WEND
  CLOSE #1
  current = 1
  title$ = FN FileName$(file$)
  WINDOW 2, title$, (wLeft,wTop) - (wRight,wBot), 1
  BUTTON 1, 1, "Next", (10,10) - (50,30)
  BUTTON 2, 1, "Copy", (60,10) - (100,30)
RNoAction:
  RETURN
```

ME 5
```
Inst:               '_____ display instructions
  WINDOW 3, "Instructions", (8,47) - (502,328), 1
  RETURN
```

ME 6
```
BasQuit:            '_____ quit to BASIC
  GOSUB Cleanup
  END
```

ME 7
```
DeskQuit:           '_____ quit to Mac Desktop
  GOSUB Cleanup
  SYSTEM
```

```
'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
```

SR 1
```
ClipHere:           '_____ ask user if Clipboard has a picture
  WINDOW 3, "", (100,100) - (400,200), -2
  TEXTFONT(0) : LOCATE 2,3
  PRINT "Does the Clipboard have a picture in it?";
  BUTTON 1, 1, "Yes", (50,60) - (130,80)
  BUTTON 2, 1, "No", (170,60) - (250,80)
  WHILE DIALOG(0) <> 1 : WEND
  IF DIALOG(1) = 1 THEN HasPict
  OPEN "CLIP:PICTURE" FOR OUTPUT AS #1
  CLOSE #1
HasPict:
  WINDOW CLOSE 3
  RETURN
```

SR 2

```
Cleanup:                '_____ clean up desktop to quit program
   MENU RESET
   FOR n = 1 TO 3 : WINDOW CLOSE n : NEXT
   RETURN
```

SR 3

```
ShowClip:               '_____ show contents of Clipboard
   CLS
   OPEN "CLIP:PICTURE" FOR INPUT AS #10
   IF LOF(10) = 0 THEN NoShowClip
   sBytes = LOF(10)                          'get contents of Clipboard
   sClip$ = INPUT$(sBytes,10)
   CALL DisplayPict(sClip$)                  'show contents of Clipboard
NoShowClip:
   CLOSE #10                                 'close Clipboard file
   RETURN
```

SR 4

```
ClipToFile:             '_____ write Clipboard to file #1 (already open)
   FOR t = 1 TO 1000 : NEXT                  'give DialogEvent time to refresh Clipboard
   OPEN "CLIP:PICTURE" FOR INPUT AS #2
   bytes = LOF(2)                            'get length of Clipboard in bytes
   IF bytes = 0 THEN EmptyClip

   clip$ = INPUT$(bytes,2)
   PRINT #1, bytes : PRINT #1, clip$         'append to disk file
   CLOSE #1 : CLOSE#2
   GOTO AClipEnd
EmptyClip:
   CLOSE #1: CLOSE #2
   GOSUB ClipEmpty
AClipEnd:
   MENU 6, 3, 1, "Append Clip to: " + FN FileName$(appFile$)
   RETURN
```

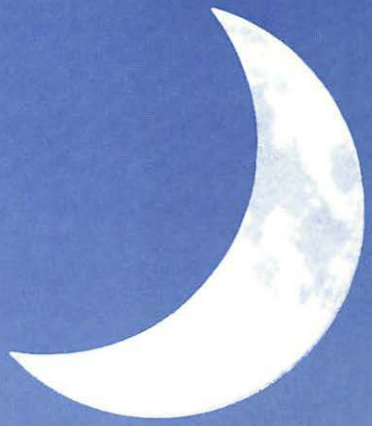
SR 5

```
ClipEmpty:              '_____ tell user Clipboard is empty
   DIALOG OFF
   WINDOW 4, "", (100,100) - (400,200), -2
   TEXTFONT(0) : LOCATE 2,5
   PRINT "Sorry, the Clipboard is empty.";
   BUTTON 1, 1, "OK", (230,60) - (280,80)
   WHILE DIALOG(0) <> 1 : WEND
   DIALOG ON
   WINDOW CLOSE 4
   RETURN
```

SR 6

```
CopyToClip:             '_____ copy current picture in file to Clipboard
   BUTTON 1,0 : BUTTON 2,0
   OPEN "CLIP:PICTURE" FOR OUTPUT AS #2
   PRINT #2, pict$(current)
   CLOSE #2
   currWind = WINDOW(1) : WINDOW OUTPUT 1
```

```
    GOSUB ShowClip
    WINDOW OUTPUT currWind
    BUTTON 1,1 : BUTTON 2,1
    RETURN

SR 7
DisplayNext:                    '_____ display next picture in pict$
    current = (current MOD pictures) + 1        'increment, reset to 1 if last image
    GOSUB RefreshRead
    RETURN

SR 8
RefreshRead:                    '_____ refresh 'Read from file' window
    CALL DisplayPict(pict$(current))
    CALL MOVETO(130,25) : PRINT "#"; current;
    RETURN

SR 9
PrintInst:                      '_____ print instructions
    CLS
    PRINT
    PRINT "  With MacInterface you can transfer pictures from the Scrapbook to a"
    PRINT "  file, and move a picture file into the Scrapbook.  Pictures are moved"
    PRINT "  between file and Scrapbook through the Clipboard in a two-step process."
    PRINT "  Use the normal Edit menu to move pictures between the Clipboard and"
    PRINT "  Scrapbook, and these menu commands to move between Clipboard and file:"
    PRINT
    PRINT "  Save Clip As:    Asks for a file name and puts the contents of the"
    PRINT "                     Clipboard into that file."
    PRINT "  Append Clip:     Asks for a file name and appends the picture in the"
    PRINT "                     Clipboard to the end of that file."
    PRINT "  Append Clip To:  Appends a picture in the Clipboard to the file currently"
    PRINT "                     opened by MacInterface."
    PRINT "  Read from File:  Loads a selected picture file into memory. Use the Next"
    PRINT "                     button to leaf through the pictures in the file and the"
    PRINT "                     Copy button to copy individual pictures into the"
    PRINT "                     Clipboard. ";
    RETURN

SP 1
SUB DisplayPict(p$) STATIC      '_____ display picture in p$
    winW = WINDOW(2) : winH = WINDOW(3)        'get window height and width
    IF LEN(p$) < 10 THEN BadPic
    picLen = FN IntVal(p$,7) - FN IntVal(p$,3)          'find picture height
    picHi = FN IntVal(p$,9) - FN IntVal(p$,5)          'and width.  (bytes 3-10)

                                'if picture bigger than window, just display top left part
    IF picLen > winW THEN x = 10 ELSE x = INT((winW - picLen) / 2)
    IF picHi > winH THEN y = 10 ELSE y = INT((winH - picHi) / 2)
    CLS : PICTURE(x,y), p$                      'clear screen and display picture
BadPic:
    END SUB
```



MacGrid

For many people, gridlocks have become a part of everyday life. The flight to the suburbs means that millions of us now spend sizable chunks of our lives locked in one traffic jam or another. We can't promise you hassle-free commutes, but there is *a kind of gridlock our MacGrid utility can banish forever. We're talking about graph paper, the prosaic but useful tool*

that makes it possible to plot the results of school lab experiments, lay out maps and plans, design computer screen displays, and accomplish many other applications where scale or relationship between objects must be shown precisely.

The "gridlock" comes from the fact that only a few sizes of commercially produced graph paper are readily available. If the size of the squares is too small, it's hard to plot the data and show the reference points. If the squares are too big, the plot is too coarse or can't fit all the data. Until now, you've had to compromise.

MacGrid allows you to create and print customized graph paper by specifying the margins, total height and width, vertical and horizontal spacing, and intervals for heavy reference lines. If you need just a few sheets, you can print them on your printer, or print just one and use it as a master for photocopying. Once you've seen how fast and easy it is to create customized graph paper, you may even discover some new uses for it.

Before we begin our discussion of the program, we should first mention that this program is set up to work with the ImageWriter, since most of you have this printer.

How to use MacGrid

When the program starts running, you first see the title screen shown in Figure 1. A sample grid is shown in the bottom half of the screen, and you are informed that the MacGrid menu is now active. This menu has two main options: Grid Setup and Print.

To specify the characteristics of a grid, choose Grid Setup from the menu. You then see a screen like that in Figure 2, with edit-field boxes for entering the numbers needed. A default value is given for each characteristic, and the first field is inverted, indicating that the insertion point is there. You can edit these values using the standard Macintosh editing functions, including Cut, Paste, and Copy. You can move from field to field using the Tab or Return keys, or you can click the mouse in a field to move the insertion point there. When you're satisfied with the values, click the OK button in the lower right corner of the screen. If you decide you don't want to change the specifications, click the Cancel button instead.

Grid specifications

The program instructions, obtainable by choosing Instructions from the MacGrid menu, briefly summarize the dimensions and other specifications used to create a grid. We will elaborate on them a bit here.

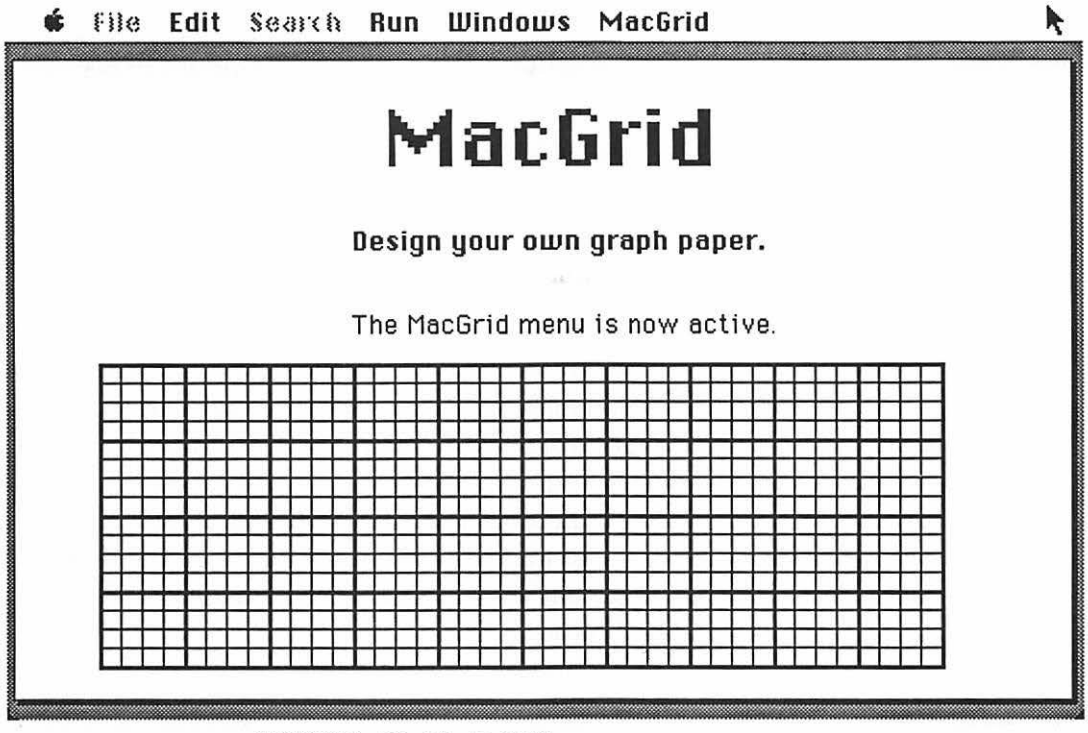


FIGURE 1. *The MacGrid title screen*

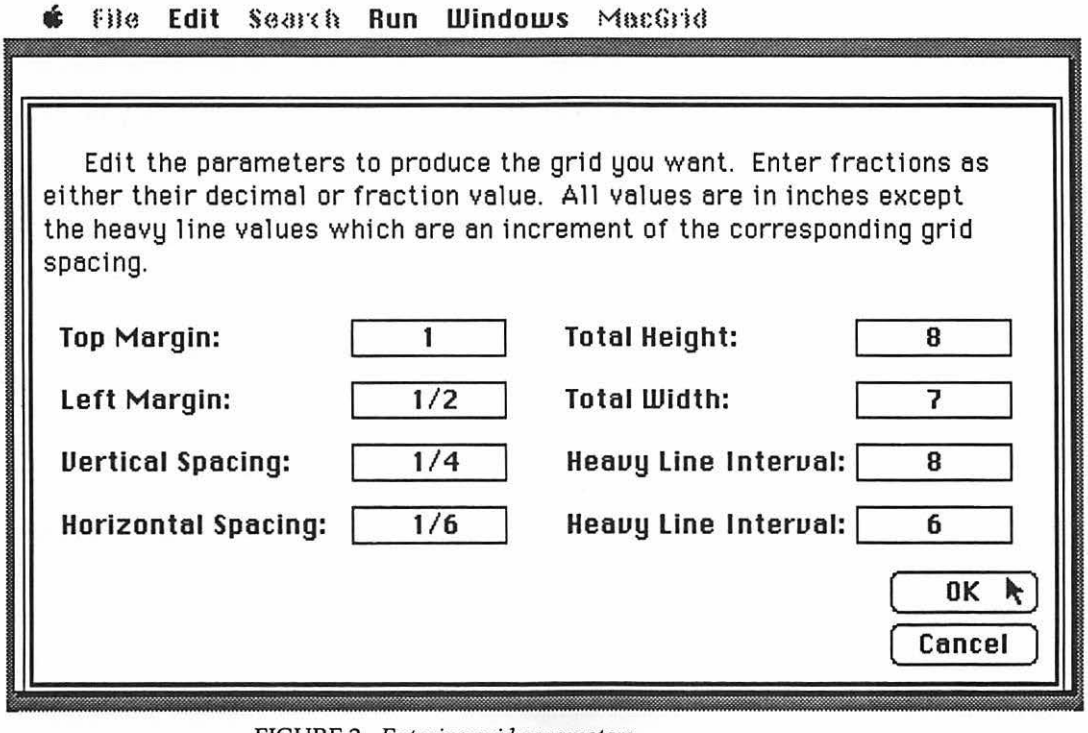


FIGURE 2. *Entering grid parameters*

Top Margin is the distance in inches from the top of the print head down to the line at which printing of the grid will begin. Because the reference point used is the print head (from its starting position on the left side of the printer), make sure you have it aligned with the top perforation of the paper before printing a piece of graph paper. Our example grid has a top margin of 1 inch.

Left Margin sets the distance in inches from the left edge of the print head (in its starting position) to the first vertical line of the grid. Our sample grid has a left margin of ½ inch.

Vertical Spacing is the spacing between horizontal lines as you move vertically down the grid. Since the inch is the basic unit of measurement used, vertical spacing is expressed in inches and fractions of an inch. It would usually be small fractions of an inch, unless you want a grid with very wide spaces. You can express these and other values as either decimal numbers or fractions. We find that using fractions actually makes it clearer: For example, our specification in Figure 2 of a vertical spacing of ¼ inch also translates to "four horizontal lines per inch," with the denominator of the fraction being equal to the number of lines per inch. You could say "0.25," but then you would have to divide it into 1.00 to get the number of lines per inch.

Horizontal Spacing establishes the spacing between vertical lines as you move across the grid (that is, horizontally). As a fraction, the denominator expresses the number of vertical lines per inch. (Our example grid has a horizontal spacing of ⅙ inch, or six vertical lines per inch.) It follows that if you want the grid to consist of little *squares*, you should specify equal horizontal and vertical spacing. You would usually want equal vertical and horizontal spacing to plot equations, for example. For other uses where you have a much finer scale in one direction than in the other, you might want unequal spacing, as we have shown in Figure 2. For example, if you wanted to plot the hourly temperature as measured by a weather station, you might want the grid to have only 24 vertical lines across, with a horizontal spacing of ¼ inch (four vertical lines per inch) for a total page width of 6 inches. You might want a vertical spacing of 1/10 inch (10 horizontal lines per inch) for a total page height of ten inches, allowing you to plot a range of up to 100 degrees.

Total Height is the total height of the *grid*, not of the sheet of paper. The printer will move to the top of the next sheet automatically after the

grid has been printed (assuming that you have normal 8½- by 11-inch paper and the normal top-of-form setting). In our example in Figure 3, on the next page, the grid height is 8 inches.

Total Width again refers to the *grid,* not the sheet of paper as a whole. In our example, Total Width is set to 7 inches.

Heavy Line Interval is simply the interval at which a heavy, or emphasized, line will be printed. You can see in Figure 2 that there are two specifications for heavy lines, one vertical and one horizontal. We have a heavy line every eighth line vertically (that is, every eighth horizontal line is heavy), and a heavy line every sixth line horizontally (every sixth vertical line is heavy). If you look at the line spacing and corresponding heavy line specifications in Figure 2, then look at our example printout in Figure 3 on the next page, you'll see the grid is in effect subdivided by the heavy lines into sectors 1 inch across by 2 inches down.

You will want to choose the heavy line intervals according to meaningful divisions of the units your grid will represent. For measuring temperature, for example, you might want a heavy line every tenth line vertically to indicate a division of 10 degrees. In general, you might find it useful to sketch what the grid is intended to represent or plot to help you determine the specifications needed. If you don't want any heavy lines in a particular direction, simply enter 0 in the appropriate field.

Once you've entered the specifications and clicked the OK button, you'll return to a screen displaying the menu bar and the upper left corner of the grid you've just specified. Although you won't be able to tell how all your margins will look, you can use this display to check your line spacing and heavy line intervals before printing.

Printing the grid

To print the grid you've specified, pull down the MacGrid menu and choose Print. (Make sure that your paper is lined up properly and that the printer is on and has the "select" indicator lit.) Printing will take a while, so this might be a good time to get up and stretch a bit.

That's all there is to using MacGrid to create customized graph paper. We'll suggest some additional features you might want to add to the program after we've discussed its operation.

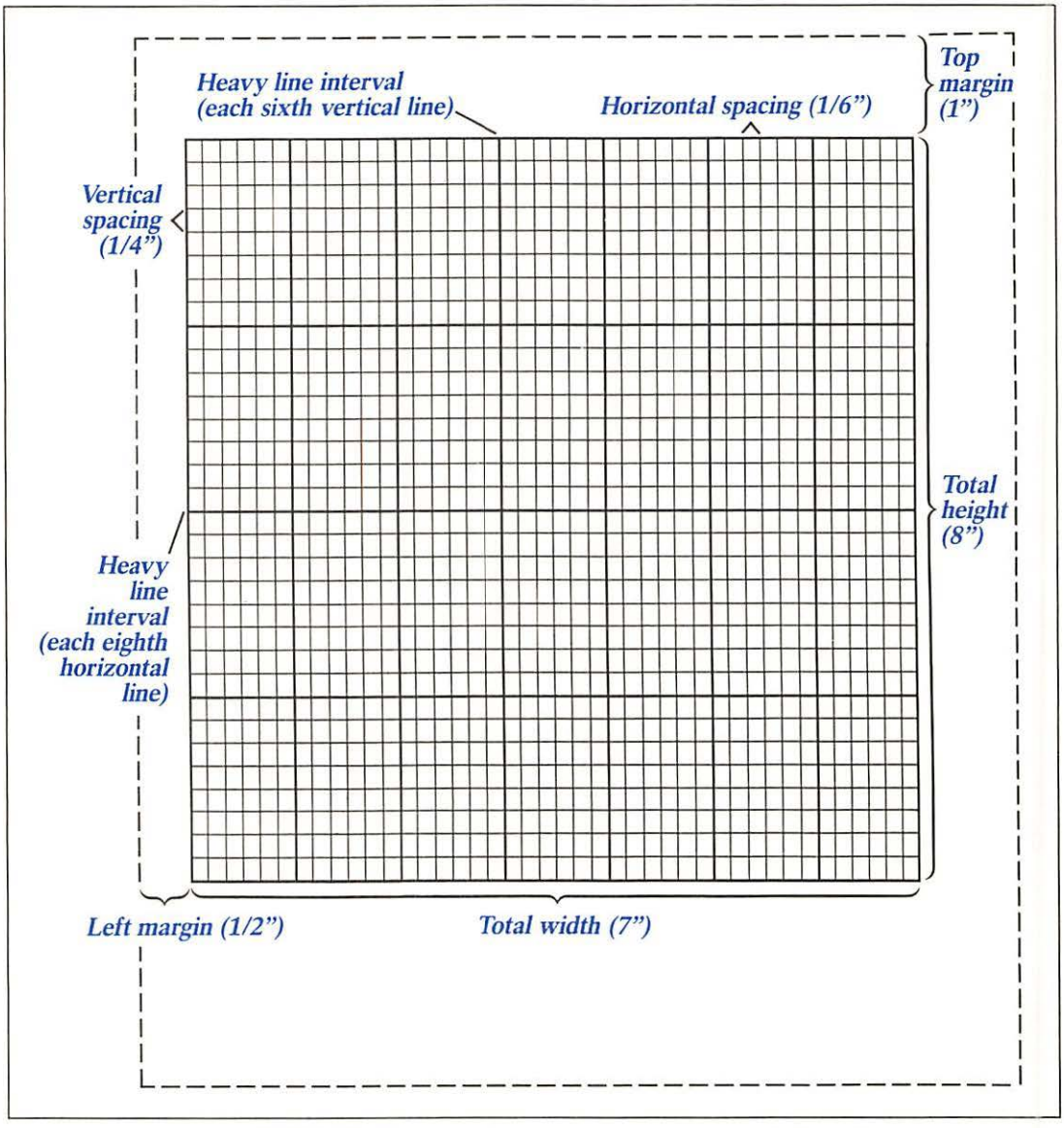


FIGURE 3. *Grid printed using example parameters in Figure 2*

How MacGrid works

MacGrid has our standard menu event-driven structure with an endless WHILE...WEND loop waiting for events. The main interest in the program is not in its flow of control, but instead in the way the grid lines are laid out using the specifications given. A program outline for MacGrid is shown in Figure 4.

```
Initialization
  initialize array references, window dimensions, other constants      Init 1
  open Output window                                                   Init 2
  display title screen
  install MacGrid menu

Main Program
  endless loop interrupted by menu events                              Main

Menu Events
  MenuEvent: branch to appropriate subroutine                          ME 0
    after routine, draw graph (DrawGraph)                              SR 5

  GridSetup: set up grid parameters                                    ME 1
    open secondary window (OpenWindow)                                 SR 7
    print instruction text
    set up edit fields (SetEdit)                                       SR 1
    set up OK and Cancel buttons
    WHILE not quitting
      if dialog event is a button, check if OK or Cancel (XitBtn)      SR 2
      if event is clicking in new edit field, change to that field
      if event is Tab or Return key, change to next field
    WEND
    close secondary window

  PrintIt: print grid                                                  ME 2
    save ID number of current window
    send window output to printer
    draw grid (DrawGraph)                                              SR 5
    close output
    restore output to saved window ID

  BasQuit: quit to BASIC                                               ME 4

  DeskQuit: quit to Mac Desktop                                        ME 5

Subroutines
  SetEdit:                                                             SR 1
    read edit-field labels from DATA statements                        Dat 1
    calculate edit-field label coordinates and print label
    convert edit-field parameters into string-fraction form (Numberize) SR 4
    display fields

  XitBtn:                                                              SR 2
    if OK button, read edit fields (ReadEdit)                          SR 3

  ReadEdit:                                                            SR 3
    for each field, read constants of field
    convert into numerator and denominator form
    calculate numeric parameter
```

(continued)

FIGURE 4. *Program outline*

Numberize: **SR 4**
turn parameter into numerator/denominator string form

DrawGraph: **SR 5**
get horizontal and vertical spacing of grid lines; heavy line intervals
get values for margins
calculate total lines across and down
draw vertical lines at specified spacing
if a line should be heavy, use larger pen width
draw horizontal lines at specified spacing
if a line should be heavy, use larger pen width

TitleScreen: **SR 6**
display opening title
draw sample grid

OpenWindow: open secondary window **SR 7**

Figure 4. Program outline (continued)

Initialization

The constants *top, height, left,* and *wide* are set to the values 0 through 3, respectively. These will be used to refer to the first four elements of the *params* array, which will contain the grid dimensions. Using names to refer to the array elements is a useful technique because it means that as we write code, we can use the name rather than having to look up the number; that is, when we want the left margin we can refer to *params(left)*, rather than having to go back and look up the number for that array element. (Pascal programmers will recognize this technique as being similar to the use of enumerated types.)

The other constants initialized in this segment are the boundaries for the secondary window (to be used for dialog boxes), and the number of pixels-per-inch horizontally and vertically. The latter two numbers are used in converting grid specifications in inches to the actual number of pixels (and thus the screen coordinates) needed to enable the ImageWriter to print the grid.

In [Init 2], the title screen is drawn by calling TitleScreen [SR 6]. This subroutine starts by reading the parameters for the default grid from the data statements following the label TitleParams [Dat 1]. (If most of your grids are going to have the same margins, you can of course substitute your own values and save time on data entry.) The title text is displayed, and five sample grids are drawn in successively finer gradations by a FOR...NEXT loop. Each grid is superimposed on the preceding one.

We will discuss how a grid is drawn later, after we've looked at how the specifications are obtained. For now, note that the top margin is 2 inches, enough to avoid overprinting the title text. As each of the superimposed grids is drawn, a FOR...NEXT delay loop nested within the main loop slows things down enough so that you can see each grid laid on top of the preceding one. Note how the values for vertical and horizontal spacing in the *params* array are successively divided by 2 to make each graph twice as "dense" as the preceding one. Finally, the user is reminded that the MacGrid menu is available for selection.

After the program returns from drawing the title screen, the MacGrid menu is created and installed. Menu event-trapping is enabled: Menu events will be handled by MenuEvent [ME 0]. Note that after a menu choice is processed, MenuEvent calls DrawGraph to draw whatever grid is currently specified. This is handy because it means that the user, after entering new grid specifications, can see what the new grid will look like. The Instructions, Quit to BASIC, and Quit to Desktop options are standard for our programs.

The program now enters the usual endless loop [Main] to wait for menu events. There are two subroutines that do the real work of the program: GridSetup, where the user's specifications for a grid are obtained, and Print, where the grid is drawn in the Output window and is then sent to the printer.

Grid setup

GridSetup [ME 1] handles the Grid Setup choice from the MacGrid menu. First, OpenWindow [SR 7] is called to open the secondary window. Note that the window type is 2, which is a bordered dialog box that can't be moved or resized. After returning from OpenWindow, some instructions are displayed.

Next, SetEdit [SR 1] is used to set up the edit fields, where the user enters the specifications. The constants *meX* and *meY* mark the (x,y) coordinates for the start of the edit field area. A FOR...NEXT loop is used to display and activate each of the eight fields.

Each field on the screen is preceded by a label describing the specification. These labels are read into the string *m$* from EdData [Dat 2]. Next, the position for displaying the string is calculated. Note how the x coordinate will alternate between just *meX=10* and *meX+240,* or *250.* This is because of the expression (*n MOD 2*), which will be 0 when the loop index *n* is 0, 1 when it is 1, 0 again when it is 2, and so on. Since we want the

y coordinate to stay the same for each horizontal pair of fields, then increase for the next pair, and so on, the expression *INT(n / 2)* is used. Since *INT(n / 2)* equals 0 for both $n = 0$ and $n = 1$, the y coordinate for the first pair of fields will be just *meY*. For both $n = 2$ and $n = 3$, the expression will equal 1, so the y coordinate will increase by 30, putting these fields 30 pixels farther down the screen. For the next pair, the expression will equal 2 and thus add another multiple of 30, and so on. You might make a note of this use of MOD and INT expressions, because it's a handy way to format any tabular arrangement of strings or other items.

After the label string for a field has been displayed, the default value for the field, which is the corresponding element from the *params* array, is assigned to the variable *num*. Numberize [SR 4] has the job of converting a number *num* to a string containing the number with the appropriate fraction in numerator/denominator form. First, the easy part: The variable *n1* is set to *INT(num)*, which takes care of the whole-number part of *num*. The fractional part is *num* − *n1*, which is assigned to *n2*. The string *n$*, which will contain the string form of the complete number, is initialized as empty, or null ("").

The next step is to convert the whole-number part to a string. If $n1 <> 0$, there is a whole-number part, since *n1* was obtained as the INT part of *num*. If $num = 0$, we consider the 0 to be the whole-number part. The BASIC functions RIGHT$, LEN, and STR$ can then be used to obtain the string. The RIGHT$ of 1 character less than the length of *STR$(n1)* is taken so that the leading blank that STR$ automatically supplies can be stripped off. At this point, if $n2 = 0$, the user entered *only* a whole number, and the subroutine returns.

If a fraction remains, we will try to convert it from a decimal fraction to a numerator/denominator-type fraction. A FOR...NEXT loop is used to test possible fractions to see if they equal the decimal value *n2*. The denominator (*n4*) is increased by 1 each time through the loop, starting at 2. The first statement in the body of the loop divides 1 by the current denominator and then divides the result into the decimal fraction we're trying to match (*n2*). The next statement tests to see if the result of this operation is a whole number; that is, if $n3 = INT(n3)$. If it is a whole number, the denominator divided evenly without any remainder, which means that we have found the right denominator. In this case control goes to the label Fraction. The numerator of our fraction is the number of times the fraction *1 / n4* goes into *n2*, which is assigned to *n3*. The denominator is the value *n4* had when we left the loop. The string functions are then used to format *n3 / n4* as a string.

If we go through all the values of *n4* and exit the loop without finding the correct denominator, it means either that the decimal fraction is too small for our possible denominators, or that it is one of those decimals that can't be converted to a fraction with a denominator under 16; for example, 0.33. Numbers like these work perfectly well for producing the grid; they just can't be converted to simple fractions. None of our default values causes this problem, but the user might enter such a value. In the case of such "intractable" fractions, we give up, convert the number *num* to a string without converting it to an ordinary fraction, and return.

After the "numberization" of the default specification, the EDIT FIELD statement in SetEdit [SR 1] is used to set up the edit field, complete with the default value in *n$* returned by Numberize [SR 4] and the rectangle in which data will be entered. We cover the meaning of the various parameters used in edit fields, and the use of the EDIT$ function (which appears later in this program), in the chapter on MacGraph, so we will refer you to that chapter for details. When the FOR...NEXT loop is finished, SetEdit returns to GridSetup [ME 1].

The first edit field is then made the current one, and another EDIT FIELD statement places the insertion point there and inverts the field so the user knows where to enter data. Next, the OK and Cancel buttons are created, and the *xit* (exit) flag, which will indicate the user has clicked one of the buttons, is set to *false*.

A WHILE...WEND loop then takes care of responding to the user's activity. There are basically two things the user may be doing: moving between edit fields, or clicking buttons. The DIALOG(0) function provides information on which of these activities is being performed, and the code it returns is assigned to the variable *diag*.

If *diag* is 1, a button was clicked. The ID of the button clicked is returned by DIALOG(1). XitBtn ("exit button") [SR 2] is called. The first thing it does is set *xit* to *true*. If the button clicked was number 2 (Cancel), we don't need to do anything else: When the subroutine returns, the WHILE...WEND will be exited because *xit* is true, and GridSetup will return without changing any parameters, since the user wanted to cancel the operation. If the button was number 1 (OK), the user has finished entering values and we need to update the *params* array with these values. ReadEdit [SR 3] is called for this purpose.

A FOR...NEXT loop in this subroutine is used to obtain the values for each of the eight edit fields. First, the string in the edit field is

obtained using BASIC's EDIT$ function. Since edit field identifiers start with 1, and while the elements of *params* start with 0, 1 is added to the loop index *n* to get the edit field corresponding to the array element.

The two WHILE...WEND loops that follow are used to strip off any leading and trailing blanks from the string. BASIC's VAL function is then used to get the first part of the value of the string and assign it to the variable *m*. The string may be an integer plus fraction (for example, 4½), or it may not have an integer part. The VAL function stops converting when it runs into a slash (/). Thus if the string has only an integer, the integer will be found and converted. If it has only a fraction, the numerator of the fraction will be obtained. If it has both an integer and a fraction, the integer plus the numerator of the fraction will be obtained.

The INSTR function is used to check for an internal space in the string, which would indicate that there is both an integer and a fraction, since the space would separate them. If the space is found, the portion of the string up to the space is given to VAL and its value is assigned to *m1*. The remaining part of the string is assigned to *m$*, and its value is put into *m*. If this turns out to be a fraction, VAL will convert only up to the slash dividing the numerator and denominator, and the numerator of the fraction will have been converted to *m*.

If the space isn't found, we have only a fraction, so control goes to the label NoInt, and the location of the slash dividing the numerator and denominator is searched for. If it is found, we know that *m* has the numerator, obtained in the original conversion following the WHILE...WEND loops, and we use RIGHT$ to extract the portion of the string to the right of the slash; that is, the denominator. We then simply divide the denominator into the numerator to get the decimal value of the fraction. This is then added to *m1* (the integer value, if any) to get the total value of the string, which is assigned to the appropriate element of *params*.

If the slash isn't found there's no fraction, so *m* remains at its original value (the integer part), and is put into the array element. When the main loop (FOR...NEXT) is done, ReadEdit has converted all the parameters in the edit fields to their proper numeric values and stored them in the *params* array. Control then returns to XitBtn, and since *xit* was set to *true*, the program returns to GridSetup and finishes processing it.

If the user hasn't clicked either button, we check next for a value of *diag* = 2. This means the user has clicked on a new edit field. In this case, the current edit field is set to the new field. If *diag* = 5, the Return or Tab keys were used to move the insertion point to the next edit field. The MOD expression is used to wrap around to the first edit field if necessary.

Assuming the user has entered data and finally clicked the OK button, the program is now ready to draw and print the grid when the Print option on the MacGrid menu is chosen.

Drawing and printing the grid

PrintIt [ME 2] handles the Print option. It first saves the identifier of the current Output window (returned by the WINDOW(0) function) in the variable *crntWindow,* so it can be restored later. The printer file *Lpt1:* is opened for output.

DrawGraph [SR 5] is then called, and starts by getting the values it needs from the *params* array. The values *vSpacing, vHeavy* (spacing and interval for emphasized vertical lines) and the corresponding horizontal values (*hSpacing, hHeavy*) are simply obtained from the corresponding elements of the *params* array. The values that have to be converted to screen coordinates (that is, number of pixels) are the top and left margins and the width and height of the grid. In each case the value is obtained from the corresponding array element and multiplied by the number of pixels-per-inch in the appropriate direction (*inchVert* or *inchHorz*).

As you might expect, FOR...NEXT loops are used to draw the vertical and horizontal lines. The general procedure is to use the STEP clause to give the proper spacing and step through the index values to place and draw the lines. We also have to check if a line should be heavy. We will use the counter-variable *heavy* for this purpose; it is initialized to 0. The space between the vertical lines is *inchHorz* * *Spacing.* For each line, we check to see if it is a heavy line: If it is, a wider PENSIZE is set. If *heavyFlag* is 0, no heavy lines at all are wanted; otherwise, we set the pen for a heavy line.

The *heavy* counter is then incremented by 1. The starting point for the vertical line is offset from *l* (the left margin), and its y coordinate is *t,* the top of the grid. The QuickDraw LINE routine (not to be confused with BASIC's LINE statement) is used to draw the line. Remember that the coordinates given to this routine are *relative* to the pen position and, since the line is vertical, the relative x coordinate is 0; that is, we want it to be the same as the pen's x position. The y coordinate is the value of the variable *high,* the height of the grid.

When the FOR...NEXT loop exits, one more line is needed, because we started the loop at 0; that is, on the left margin. If any vertical heavy line interval other than 0 was specified, this last line is drawn as a

heavy line, thus serving as the right border of the grid. The expression *vHeavy = 0* is used to set the correct pen size without another IF statement being needed. (There's always a tradeoff between using relatively cryptic code like this versus the complexity of further nesting of IF...THEN statements.) In case you're wondering how the left border heavy line was obtained, the first line on the left would also have been a heavy line, since *0 MOD hHeavy* would have given 0 the first time through the loop.

The horizontal lines are drawn in exactly the same fashion, except of course that this time the starting x coordinate (the left margin, or *l*) will remain constant, while the y coordinate is offset from the top margin (*t*).

After DrawGraph is done, the grid has been printed on the printer as well as displayed on the screen, since the printer file had been opened for output. This file is now closed, and the Output window is set back to what it was before the Print option was chosen.

Suggestions for MacGrid

A relatively simple thing to do would be to add edit fields for printing labels or other text on your sheet of graph paper—perhaps at the bottom. Some things you might want to have appear are: a title for whatever is going to be plotted on the paper, your name, a page number, the number of lines per inch horizontally and vertically, and the units being represented on the grid (that is, degrees, kilograms, or whatever). You will probably want to create a routine to handle these edit fields if you decide to add more than one or two, so the edit screen won't get too crowded. You might also want to have a separate routine print the text after DrawGraph is done (but before you close the printer file).

Another useful enhancement might be to set the pen pattern to some pattern that would give a dotted line for the minor divisions and a solid black line for the major divisions, instead of varying only the thickness of the lines.

MacGrid program listing

```
'*************************************************************
'                          MacGrid
'                Make Graph paper on your Imagewriter.
'*************************************************************

  '******************************************** INITIALIZATION
  DIM params(7)
  false = 0 : true = NOT false
  top = 0 : height = 1 : left = 2 : wide = 3
  wind2L = 16 : wind2T = 55
  wind2W = 479 : wind2H = 270
  inchHorz = 80                          '80 pixels/inch horizontally
  inchVert = 72                          '72 pixels/inch vertically

  WINDOW 1, "MacGrid", (4,28) - (506,332), 4
  GOSUB TitleScreen                      'draw title screen

  MENU 6, 0, 1, "MacGrid"                'install MacGrid menu
  MENU 6, 1, 1, "Grid Setup"
  MENU 6, 2, 1, "Print"
  MENU 6, 3, 1, "Instructions"
  MENU 6, 4, 0, "-"
  MENU 6, 5, 1, "Quit to BASIC
  MENU 6, 6, 1, "Quit to Desktop"
  ON MENU GOSUB MenuEvent : MENU ON

'********************************************** MAIN PROGRAM
  WHILE true : WEND

'********************************************** MENU EVENTS
MenuEvent:
  MENU 6, 0, 0
  item = MENU(1)
  ON item GOSUB GridSetup, Printit, Instructions, , BasQuit, DeskQuit
  CLS : GOSUB DrawGraph
  MENU 6, 0, 1
  RETURN

GridSetup:              '_____________________________ set up grid parameters
  GOSUB OpenWindow
  CALL TEXTFONT(1)
  PRINT
  PRINT "    Edit the parameters to produce the grid you want.  Enter fractions as"
  PRINT "either their decimal or fraction value.  All values are in inches except"
  PRINT "the heavy line values which are an increment of the corresponding grid"
  PRINT "spacing."
```

INIT 1

INIT 2

MAIN

ME 0

ME 1

```
    CALL TEXTFONT(0)
    GOSUB SetEdit
    eField = 1: EDIT FIELD eField
    BUTTON 1, 1, "OK", (wind2W - 75, wind2H - 50) - (wind2W - 5, wind2H - 30)
    BUTTON 2, 1, "Cancel", (wind2W - 75, wind2H - 25) - (wind2W - 5, wind2H - 5)
    xit = false
    WHILE NOT xit
      diag = DIALOG(0)
      IF diag = 1 THEN btn = DIALOG(1) : GOSUB XitBtn
      IF diag = 2 THEN eField = DIALOG(2)
      IF diag > 5 THEN eField = (eField MOD 8) + 1 : EDIT FIELD eField
    WEND
    WINDOW CLOSE 2
    RETURN
```

ME 2

```
Printit:                '_____ print grid on Imagewriter
    crntwindow = WINDOW(0)
    OPEN "Lpt1:" FOR OUTPUT AS #1
    WINDOW OUTPUT #1
    GOSUB DrawGraph
    CLOSE#1
    WINDOW OUTPUT crntwindow
    RETURN
```

ME 3

```
Instructions:           '_____ display instructions
    WINDOW 2, , (16,55) - (495,325), 2
    PRINT
    PRINT "   MacGrid gives you the capability to print out a grid with whatever"
    PRINT "spacing you want on a single sheet of paper."
    PRINT "   Set up the parameters for the grid with the 'Grid Setup' menu.  All values"
    PRINT "are entered in inches except the Heavy lines.  The top and left margins are"
    PRINT "the distance from the top left corner of the printer to the top left corner of"
    PRINT "the grid.  Because you can adjust the paper in the printer, the distance from"
    PRINT "the corner of the sheet of paper will be somewhat different."
    PRINT "   Horizontal and vertical spacing is the distance between individual lines"
    PRINT "on the grid (i.e., 1/10 gives you 10 lines per inch)."
    PRINT "   'Heavy Line Interval' is the grid line multiple on which a heavy line will"
    PRINT "be drawn (i.e., if the spacing is 1/10 inch and 'Heavy Line Interval' is 10,"
    PRINT "then a heavy line will be drawn every inch).  If this value is 0 then no"
    PRINT "heavy lines will be drawn.";
    CALL INITCURSOR
    BUTTON 1, 1, "Continue", (190,240) - (280,260)
    WHILE DIALOG(0) <> 1 : WEND
    BUTTON CLOSE 1 : WINDOW CLOSE 2
    RETURN
```

ME 4

```
BasQuit:                _____ quit to BASIC
    MENU RESET
    END
```

ME 5

```
DeskQuit:          '_____ quit to Mac Desktop
  MENU RESET
  SYSTEM

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
```

SR 1

```
SetEdit:           '_____ set up parameter edit boxes
  meX = 10 : meY = 100
  RESTORE EdData
  FOR n = 0 TO 7
    READ m$
    mX = meX + (n MOD 2) * 240 : mY = meY + INT(n / 2) * 30
    CALL MOVETO(mX, mY + 12) : PRINT m$;
    num = params(n) : GOSUB Numberize
    EDIT FIELD n + 1, n$, (mX + 140, mY) - (mX + 210, mY + 15), , 2
  NEXT n
  RETURN
```

SR 2

```
XitBtn:            '_____ either button 'OK' or 'Cancel' has been hit
  xit = true
  IF btn = 1 THEN GOSUB ReadEdit
  RETURN
```

SR 3

```
ReadEdit:          '_____ read parameter edit fields
  FOR n = 0 TO 7
    m$ = EDIT$(n + 1)
    WHILE LEFT$(m$,1) = " " : m$ = RIGHT$(m$, LEN(m$) - 1) : WEND
    WHILE RIGHT$(m$,1) = " " : m$ = LEFT$(m$, LEN(m$) - 1) : WEND
    m = VAL(m$) : m1 = 0
    j = INSTR(m$," ")

    IF j = 0 THEN NoInt
    m1 = VAL(LEFT$(m$, j - 1))
    m$ = RIGHT$(m$, LEN(m$) - j)
    m = VAL(m$)
NoInt:
    j = INSTR(m$,"/")
    IF j <> 0 THEN m = m / VAL(RIGHT$(m$, LEN(m$) - j))
    params(n) = m + m1
  NEXT n
  RETURN
```

SR 4

```
Numberize:         '_____ given number, returns N$ which is num w/fractions
  n1 = INT(num) : n2 = num - n1 : n$ = ""
  IF n1 <> 0 OR num = 0 THEN n$ = RIGHT$(STR$(n1), LEN(STR$(n1)) - 1)
  IF n2 = 0 THEN RETURN
```

```
    FOR n4 = 2 TO 16
      n3 = n2 / (1 / n4)
      IF n3 = INT (n3) THEN Fraction
    NEXT
    n$ = n$ + RIGHT$(STR$(n2), LEN(STR$(n2)) - 1)
    'n$ = RIGHT$(STR$(num), LEN(STR$(num)) - 1)
    RETURN
Fraction:
    n3 = INT(n2 / (1 / n4))
    n$ = n$ + STR$(n3) + "/" + RIGHT$(STR$(n4), LEN(STR$(n4)) - 1)
    RETURN
```

SR 5

```
DrawGraph:              '_____________________ draw graph with given parameters
    vSpacing = params(4) : vHeavy = params(5)
    hSpacing = params(6) : hHeavy = params(7)
    t = params(top) * inchVert : l = params(left) * inchHorz
    wid = params(wide) * inchHorz
    high = params(height) * inchVert

    CALL PENNORMAL : heavy = 0                          'draw vertical lines
    FOR n = 0 TO wid STEP inchHorz * hSpacing
      heavyFlag = (hHeavy AND (heavy MOD hHeavy = 0))
      IF heavyFlag THEN CALL PENSIZE(2,1) ELSE CALL PENNORMAL
      heavy = heavy + 1
      CALL MOVETO(l + n, t)
      CALL LINE(0,high)
    NEXT n
    IF hHeavy THEN CALL PENSIZE(2, 2 + (vHeavy = 0)) ELSE CALL PENNORMAL
    CALL MOVETO(l + wid, t) : CALL LINE(0,high)

    CALL PENNORMAL : heavy = 0                          'draw horizontal lines
    FOR n = 0 TO high STEP inchVert * vSpacing
      heavyFlag = (vHeavy AND (heavy MOD vHeavy = 0))
      IF heavyFlag THEN CALL PENSIZE(1,2) ELSE CALL PENNORMAL
      heavy = heavy + 1
      CALL MOVETO(l, t + n)
      CALL LINE(wid,0)
    NEXT n
    IF vHeavy<>0 THEN CALL PENSIZE(2 + (hHeavy=0), 2) ELSE PENNORMAL
    CALL MOVETO(l, t + high) : CALL LINE(wid,0)
    RETURN
```

SR 6

```
TitleScreen:            '_____________________ display opening screen
    RESTORE TitleParams
    FOR n = 0 TO 7 : READ params(n) : NEXT
    CALL TEXTSIZE(36) : CALL TEXTFONT(0)
    CALL MOVETO(175,50) : PRINT "MacGrid"
```

```
    CALL TEXTSIZE(12)
    CALL MOVETO(160,90) : PRINT "Design your own graph paper."
    CALL TEXTFONT(1)
    FOR ti = 1 TO 5
      GOSUB DrawGraph
      IF ti <> 5 THEN params(6) = params(6) / 2 : params(4) = params(4) / 2
      FOR t = 1 TO 1000 : NEXT
    NEXT ti
    CALL MOVETO(160,130) : PRINT "The MacGrid menu is now active."
    RETURN

OpenWindow:                 '_____ open second window
    WINDOW 2, , (wind2L,wind2T) - (wind2L + wind2W, wind2T + wind2H), 2
    RETURN

TitleParams:
    DATA 2, 2, .5, 5, 2, 4, 2, 4

EdData:
    DATA "Top Margin:", "Total Height:", "Left Margin:", "Total Width:"
    DATA "Vertical Spacing:", "Heavy Line Interval:"
    DATA "Horizontal Spacing:", "Heavy Line Interval:"
```

SR 7

DAT 1

DAT 2

MacGraph

There are several data base and financial-analysis packages for the Macintosh that can produce assorted fancy graphs and charts. Our MacGraph utility can't do everything that these expensive commercial programs can, but it provides a lot of their power at a cost of only a couple of hours of typing. With MacGraph, you first enter numeric data with an easy-to-use

data editor that supports all the standard Macintosh editing functions. Data can be saved to disk files or reloaded from disk, and MacGraph can even read data from standard text files in Microsoft BASIC input format. Once you have entered your data, you can provide labels and then create four different graphs: line, bar, pie graphs with percentages, and pie graphs with actual values.

What's more, graphs created in MacGraph can be transferred to a standard application like MacWrite or MacPaint via the Clipboard, or by saving a screen image to disk. This means you can incorporate your graphs in reports made with a word processor, or use MacPaint to add more elaborate labels, shading, and so on.

Another advantage of MacGraph is that once you've learned how its various functions work, you can modify them to suit your taste. If you decide you want an additional kind of chart, you can write code to produce that chart and simply add it to the menu. You won't have to write a data editor or file routines, since they're already written for you. If that expensive software package doesn't quite do what you want it to do, you're probably stuck with it—but MacGraph can become your all-purpose, expandable business-graphics toolkit!

How to use MacGraph

For our example MacGraph application, we'll create the (fortunately) fictitious Trailing Edge Software Company and trace its fortunes over the past year by graphing its sales (in thousands of dollars) for each of four quarters.

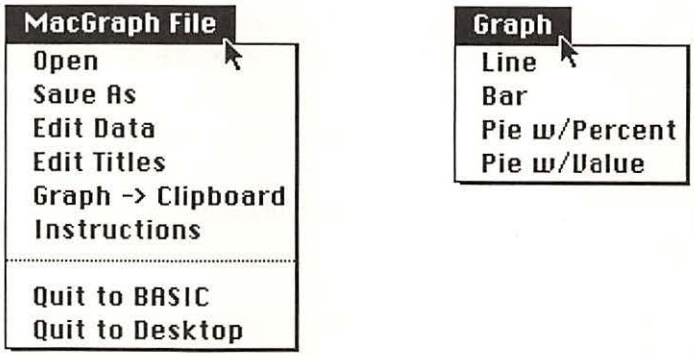
It seems that Trailing Edge started out as a fairly successful computer-game company, writing such classics as Bit Byter and Afternoon Madness (no relation to this book!) for the popular 8-bit home computers. It sold $120,000 worth of these games in the first quarter and then, emboldened by this modest success, adapted them to the Macintosh. Riding the growing tide of Mac popularity, Trailing Edge sold $210,000 worth of games in the second quarter. In the third quarter, the company added educational software, trivia games, and a real-time simulation of white-water rafting to its list and saw $348,000 worth of sales rung up in computer stores across the land.

In the last quarter, alas, disaster struck. Trailing Edge was acquired in a hostile takeover engineered by a Tibetan lama who had experienced a vision of millions of Macintoshes being turned into automatic prayer wheels. To finance this venture, he released Trailing Edge's most unusual (and, lamentably, final) product: Yak Attack, an arcade game in

which the player tries to lead a herd of balky yaks up the north slope of Mount Everest. Trailing Edge posted only $48,000 worth of sales in the last quarter and filed for bankruptcy shortly thereafter.

Entering data

When you run MacGraph, a title screen (shown in Figure 1) informs you that the program is ready and its two special menus are now active. These two menus appear to the right of the regular Macintosh and BASIC menus, and contain these options:



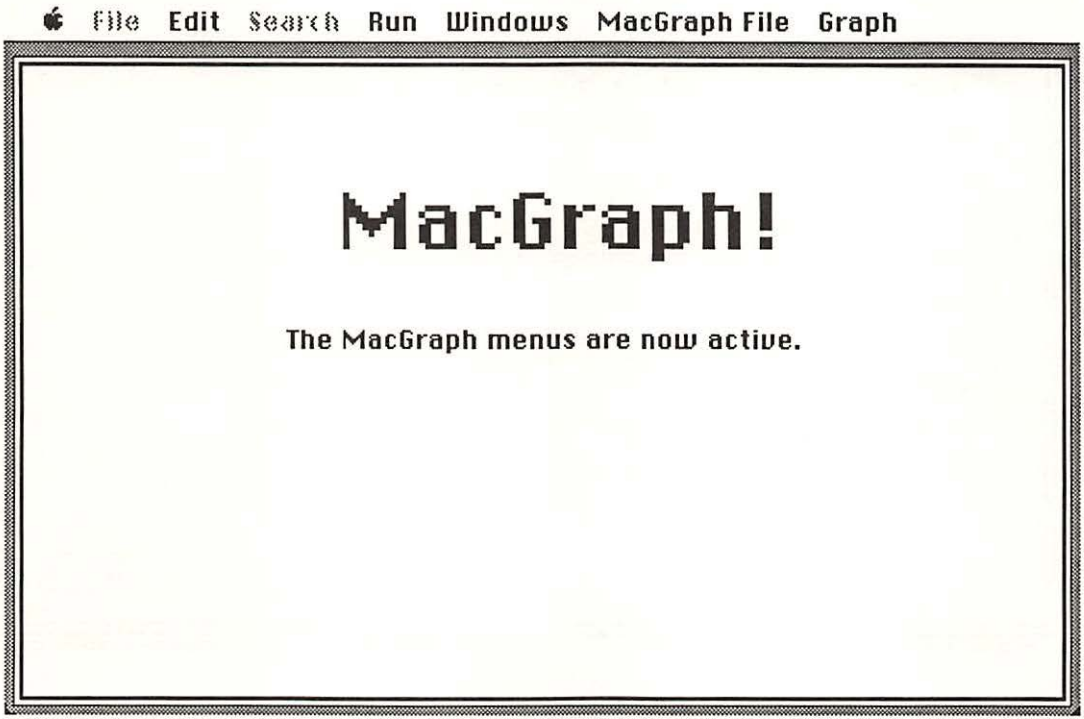


FIGURE 1. *The MacGraph title screen*

Before we can produce graphs and charts, of course, we must get some numbers and words into the computer for MacGraph to work with. To enter the numbers for your graph, simply choose Edit Data from the MacGraph File menu, which produces a screen with a grid like that shown in Figure 2. An insertion point appears in box 1 (in the upper left corner of the grid), ready for your first number.

If you've been using a Macintosh for very long, you already know everything there is to know about using MacGraph's data editor, because it simply uses Microsoft BASIC's field-editing functions to provide all the standard Macintosh editing capabilities. You can cut, copy, and paste just as though you were editing icon names in the Finder, for example. Clicking on a box makes the insertion point appear in the middle of that box, and pressing the Tab or Return key moves it right (and down, if necessary) one box. You can simply enter your numbers, correct them if needed, and leave a blank box (or one with a negative number) to mark the end of your data. There are 40 boxes in all, which means there is room for 40 data points on your graph—enough for many types of charts.

You need to keep a few things in mind when entering data for a graph. First, MacGraph can graph only positive numbers. Pick units for

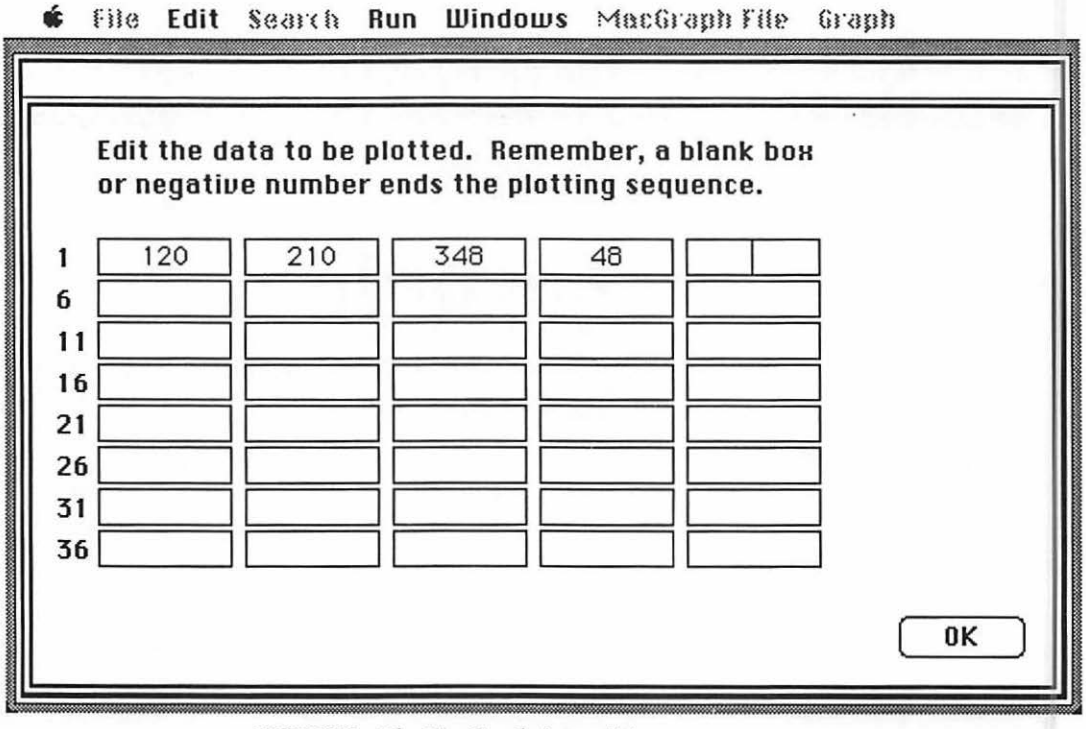


FIGURE 2. *The MacGraph data-editing screen*

your measurements that will be meaningful and not involve overly large numbers. For our Trailing Edge example, we picked thousands of dollars in sales as our unit; if we were doing Apple or IBM, we probably would have picked a larger unit. You *don't* have to worry about scaling your graph (making sure all values from the smallest to the largest fit on the chart): MacGraph does that for you.

After entering the data, simply click the OK button in the lower right corner; the data will stay in memory until they are changed.

Saving and loading data

Since you may plan to use your data in a later session (and perhaps edit it further), you'll probably want to save it to a disk file. To do this, simply choose Save As from the MacGraph File menu. A standard file dialog box will appear, and you'll be asked for the file name under which to save the data. You can load a previously saved data file from disk by choosing Open from the same menu and clicking on the name of the file you want.

In order for MacGraph to use a file, it must either consist of data entered through the MacGraph data editor, or it must be a *text* file in which there is only a series of numbers separated by commas (as they would be typed in response to an INPUT statement), or a list of numbers each on a separate line. You can create the file in BASIC's List window, but be sure to save it with the Text option. You can also copy lists of numbers from a word-processed document, or have them generated by a BASIC program, as long as you make sure that this format is followed.

Labeling your graph

A graph or chart with only numbers isn't very useful, since you wouldn't be able to tell whether it represents the gross national product of Outer Slobbovia or the number of Macintoshes owned by Fortune 500 companies. To add labels to describe your numbers, choose Edit Titles from the MacGraph File menu, which causes the screen shown in Figure 3 on the following page to appear. Using the same editing functions as the data editor, you can enter a title for the graph, a label for the vertical axis, and a label for the horizontal axis. In Figure 3 you can see what we entered for our Trailing Edge example, and in Figures 4 through 7 you can see how these titles appear on the finished charts. The names entered here, though, will not be kept with the data if the data is saved and must be re-entered each time the program is run.

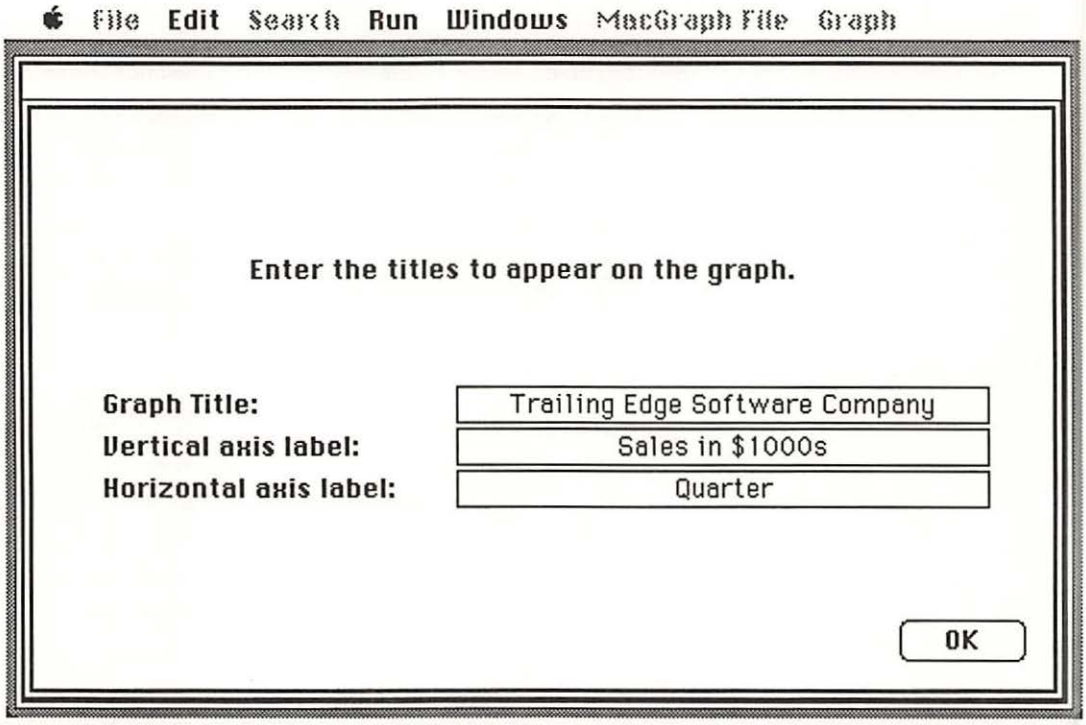


FIGURE 3. *The MacGraph label-editing screen*

Producing graphs

Now that you've entered the numbers and titles, you're ready to produce graphs. The Graph menu offers the following four options:

- A *line graph*, which plots the data points at the appropriate vertical and horizontal coordinates and connects them with a line (see Figure 4). Note that MacGraph simply numbers the horizontal axis from 1 to the total number of data points (in our example, 4 for the 4 quarters). The numbers along the vertical axis are automatically calculated to fit the range of data values provided. We'll show you how this works later.
- A *bar graph*, with the data represented as vertical bars equally spaced along the horizontal axis. The same numbers and titles used for line graphs are also used with bar graphs, as you can see in Figure 5.

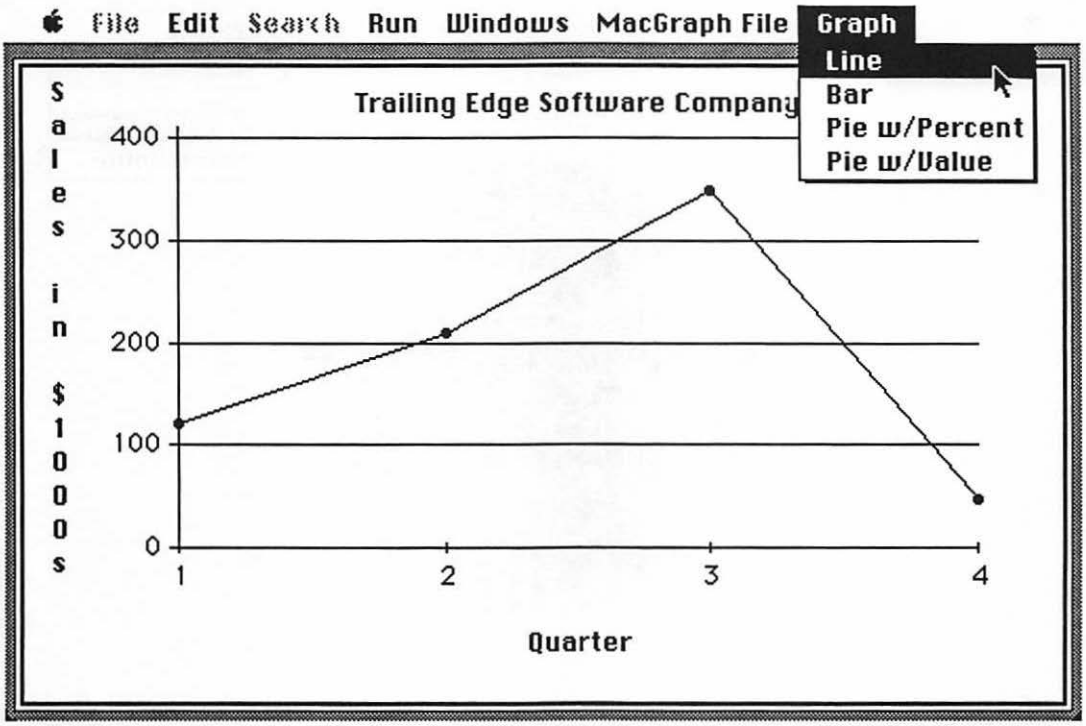


FIGURE 4. *A line MacGraph*

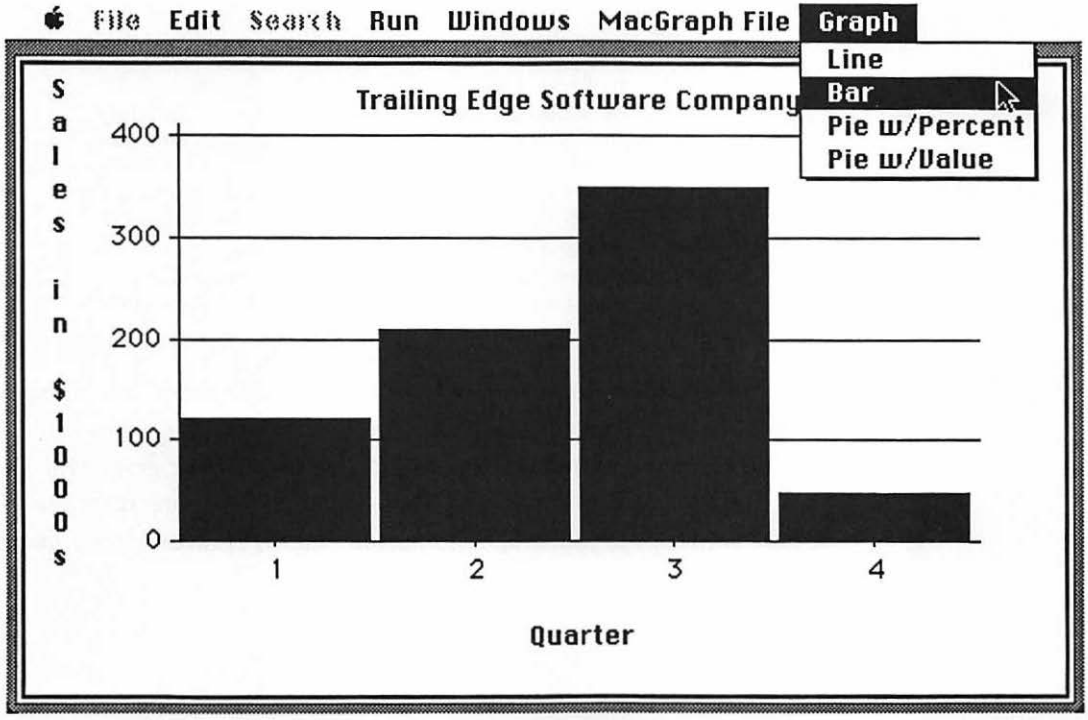


FIGURE 5. *A bar MacGraph*

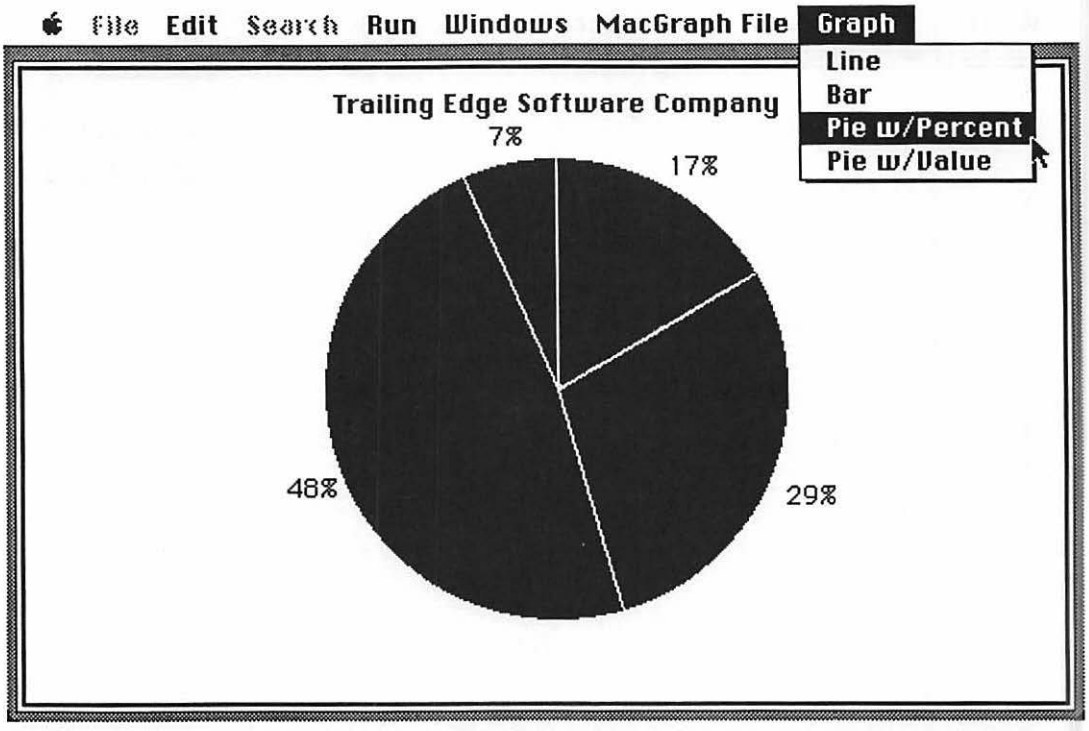


FIGURE 6. *A pie MacGraph with percentages*

- A *pie graph,* with the slices labeled with percentages based on the data points (see Figure 6). The first data point starts at the "twelve o'clock" position, and the slices are read clockwise. Note that on this and the other pie graph only the graph title appears, since there are no axes. The data values are normalized so the slices add up to 360 degrees. As you may have noticed in our example, percentages may not add up to exactly 100 percent, due to rounding each percentage to a whole number.
- A *pie graph,* with the actual data values instead of percentages (see Figure 7). Other than that, it's the same as the preceding graph.

To produce a graph, simply choose the appropriate option from the Graph menu. If you haven't either entered or loaded some data, a message will inform you that there is no data; otherwise your graph will appear. You can then use the normal Macintosh screen-printing functions to make a hard copy of your graph (Command-Shift-4) or save a screen image to disk (Command-Shift-3).

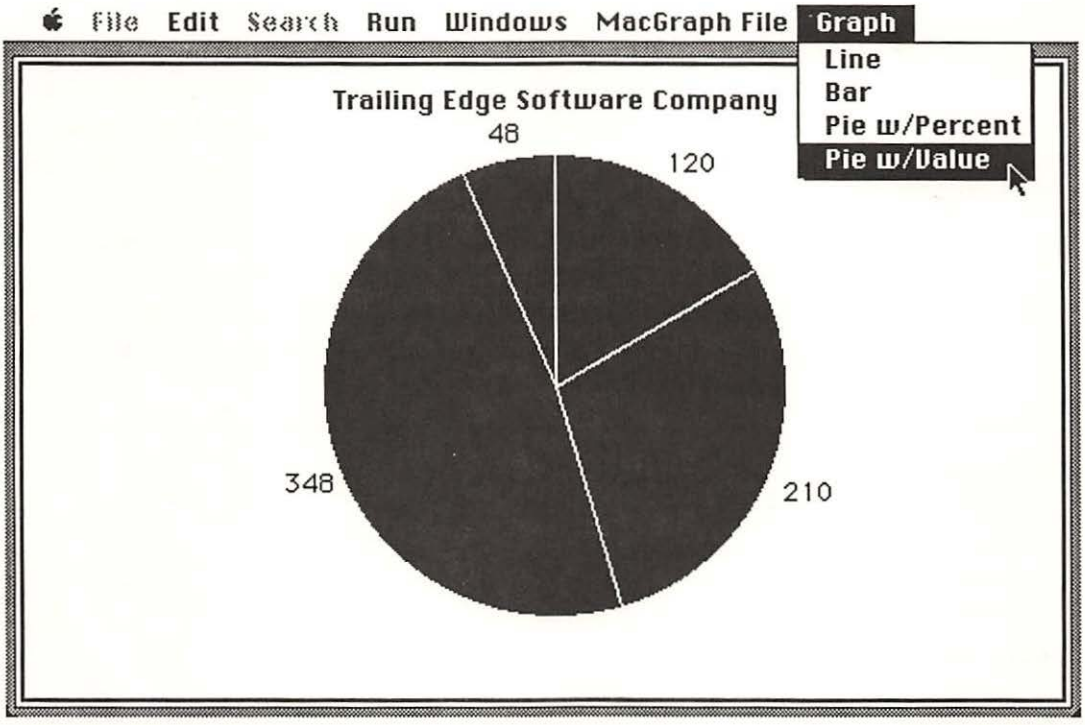


FIGURE 7. *A pie MacGraph with values*

Saving graphs to the Clipboard

If you want to combine your graph with another document or to use another application to add text and/or visual embellishments to your graph, simply choose Graph –> Clipboard from the MacGraph File menu. The graph currently shown on the screen will then be copied to the Clipboard, where it can be pasted into documents created with other applications.

Because a graph can be a little larger than the MacPaint window, part of the image on the Clipboard may be eliminated if it is pasted into a MacPaint document. You can get around this by using the key sequence Command-Shift-3 to save an image of the screen on disk as a MacPaint document. You can then open the document in MacPaint and clean it up, making whatever additional changes you desire.

The MacGraph File menu also provides the standard options found in most *Midnight Madness* programs: Quit to BASIC, Quit to the Mac Desktop, and Instructions.

How the program works

MacGraph is entirely menu-driven, which makes its structure very easy to understand. An "idle loop" simply runs until interrupted by a menu selection. When studying the program listing, pay particular attention to the use of edit fields for handling entry of data and labels. If you haven't used edit fields before, you'll find that they make it very easy to get data from the user by providing editing facilities that would otherwise require many lines of code to implement. We'll also cover the basics of charting data in the line, bar, and pie formats. A pseudocode description of MacGraph is shown in Figure 8.

Initialization	
initialize data array and constants	**Init 1**
define Output window	
create and enable MacGraph menus	**Init 2**
display title screen	**Init 3**
initialize data array (**InitData**)	SR 7
Main Program	**Main**
(endless loop interrupted by menu events)	
Menu Events	
MenuEvent:	**ME A0**
disable Graph and File menus	
find number of menu selected	
get number of item within menu	
if Graph menu selected, draw pertinent graph (**DrawGraph**)	ME B0
if not, process file menu item selected	
re-enable menus	
FOpen: open a file and get data for editing	**ME A1**
ask for file name	
open secondary window (**OpenWindow**)	SR 8
open file, read data	
convert negative numbers read to positive	
if too many numbers in file for data array, display message	
close window (**CloseWindow**)	SR 9
SaveAs:	**ME A2**
ask for file name for saving data	
save current data in file	
EditData: edit the data list	**ME A3**
open secondary window (**OpenWindow**)	SR 8
print instructions	
calculate locations of edit fields and open them with data	
handle editing in fields (**EditFields**)	SR 6
convert string data in fields to numbers for data array	
close window (**CloseWindow**)	SR 9

(continued)

FIGURE 8. *Program outline*

Titles: edit graph titles	**ME A4**
open secondary window (**OpenWindow**)	SR 8
display instructions	
open edit fields	
handle editing in fields (**EditFields**)	SR 6
save graph title names	
close window (**CloseWindow**)	SR 9
ClipGraph: copy current graph to Clipboard	**ME A5**
save picture string comands	
open and save picture string to Clipboard	
Inst: display instructions	**ME A6**
open secondary window (**OpenWindow**)	SR 8
display instructions	
create button and wait for click to continue	
close window (**CloseWindow**)	SR 9
BasQuit: quit to BASIC	**ME A7**
DeskQuit: quit to Mac Desktop	**ME A8**
DrawGraph:	**ME B0**
if no data in array, print message (**NoData**)	
on menu event in Graph menu, branch to appropriate subroutine:	
LineGraph:	**ME B1**
draw graph frame (**DrawFrame**)	SR 3
draw line graph	
print number on axis if there's room (**DrawYTick**)	SP 1
BarGraph:	**ME B2**
draw graph frame (**DrawFrame**)	SR 3
draw bar graph	
print number on axis if there's room (**DrawYTick**)	SP 1
PiePercent:	**ME B3**
set flag for percentage labels	
draw pie chart (**PieGraph**)	SR 2
PieIndex:	**ME B4**
set flag for value labels	
draw pie chart (**PieGraph**)	SR 2
Subroutines	
NoData: display no data message	**SR 1**
PieGraph:	**SR 2**
define circle parameters and draw circle	
find total range of data for determining relative proportions of pie	
draw pie wedges, label for percentage or value (**DrawStr**)	SP 2

(continued)

Figure 8. Program outline (continued)

DrawFrame: draw and label graph axes	**SR 3**
find range of data and graph step (**CalcMax**)	SR 4
calculate scale, draw ticks on Y axis (**DrawYTicks**)	SR 5
print graph, vertical and horizontal titles (**DrawStr**)	SP 2
CalcMax: calculate maximum value for scaling graph	**SR 4**
DrawYticks: draw ticks and numbers up Y axis	**SR 5**
EditFields: handle field editing events	**SR 6**
InitData: initialize data array to blanks	**SR 7**
OpenWindow: open secondary window	**SR 8**
CloseWindow: close secondary window	**SR 9**
Subprograms	
DrawXNum: print axis number	**SP 1**
DrawStr: print string centered relative to current pen position	**SP 2**

Figure 8. Program outline (continued)

Initialization and menu setup

In [Init 1] two arrays are dimensioned to hold the edited data and titles. Although the program could be modified to accommodate a larger number of data points, there is a limit to the amount of information that can be shown on one graph. If you are doing mathematical graphing (plotting equations), the graph becomes more accurate as data points are added. MacGraph, however, is designed for business or other descriptive graphics, and for this purpose 40 data points are an adequate limit. Similarly, the three titles (or labels) allowed by MacGraph—the graph title and one label for each axis—will usually be enough. However, as noted, you can transfer the graph to MacPaint and add as many titles or labels as you wish.

The coordinates for a multipurpose, secondary window (*wind2*) are also specified in this part of the code. This window will be used in the data and title editors, for displaying data as it is being read from a file, and elsewhere. In MacGraph, we deal with two sorts of geometry—rectangular and circular—and the boundaries for both are defined next. First, minimum and maximum x and y coordinates are specified, as well as the total x and y range; these will be used as maximum boundaries for the line and bar graphs. Then the maximum circular boundaries and radius for

the pie graphs are defined. *pi* is defined as a double-precision constant (note the "#" following the number). Making it double precision increases accuracy in drawing and proportioning the "slices" of pie graphs.

The variable *gType*, initialized to 1, will hold the type of graph selected from the Graph menu.

The Log10 function converts the "natural" logarithm function built into Microsoft BASIC to a base-10 logarithm suitable for scaling data so it will all fit on the graph; we'll discuss this later. After this function definition comes our standard statement for setting the size for the full-screen MacGraph window.

In [Init 2], the two menus, MacGraph File and Graph, are set up. The "-" menu option specified before the quit options on the File menu actually prints a line of dashes that separate the "working" options from the quit options. When you have a lot of options on one menu, such divisions help break up the options into related groups. Note the final 0 in the menu specification for this item: This is necessary to make the dividing line inactive (not selectable as an option). Menu event-handling is then set up, with MenuEvent [ME A0] as the handler.

The title screen is drawn in [Init 3]. This screen is very simple and serves primarily to tell the user that MacGraph is now ready and that the two special menus are active. Following the drawing of the title screen, InitData [SR 7] is called to initialize the elements of the data array to -1 (the *gData* array end-of-data marker). This makes sure that the array will be read as containing no data until data is actually entered by the user.

As previously noted, the main program [Main] is an endless loop whose only purpose in life is to keep BASIC busy between menu events.

Handling menu events

The first thing MenuEvent [ME A0] does is deactivate both menus to prevent further menu events from interrupting processing of the currently selected option. The BASIC MENU(0) function then returns the number of the *menu* selected, which is assigned to the variable *menuBar*. The menu selected will be either 6 (MacGraph File) or 7 (Graph). The normal Apple and BASIC menus that are active while MacGraph is running don't concern us here, since they are automatically handled by their respective managers and thus don't result in control coming to this subroutine. (Since BASIC's File menu is inactive during operation of MacGraph, we always mean the special MacGraph File menu when we refer to the File menu in

the following sections.) The MENU(1) function is then used to obtain the number of the item selected within that menu, which is assigned (not surprisingly) to the variable *item*.

If *menuBar* isn't 7, an item on the File menu has been selected, and control goes to the label FileMenu and from there to the appropriate subroutine via the ON GOSUB statement. Since at least some of these options have to be used before any graph is plotted, let's go through the implementation of the File options first.

Opening a data file

FOpen [ME A1] is used to open a data file to obtain data for a graph. This data is then made available for editing in the data editor if desired, or the user can proceed directly to adding titles and producing graphs. The standard BASIC function FILES$ is used to obtain the file selection, which is specified as being a text file. This is the only data format that MacGraph can handle, so it is the only type of file shown in the file-selection window.

If a valid file selection is made, OpenWindow [SR 8] is called upon to open our predefined multipurpose window. Here, the window is used to display the data numbers as they are read in. After returning to [ME A1], a message telling the user that data is being read in (and the name of the file it is being read from) is displayed, and the WHILE NOT EOF loop is entered. The variable *i* is used to keep a count of the number of data items read. After 1 is added to this count, a number is read in and assigned to the variable *j*. An inner box is drawn with the LINE statement with the *bf* option, using white (30) to clear part of the screen for messages. The value of the counter *i* is checked: If it exceeds the maximum number of data items (*maxData*), a message that the data file is too large is printed, and control goes to the label TooLarge. Once this happens, the same thing will happen for any further numbers until the end of the file is reached. None of the excess numbers will be added to the data array (*gData*).

The value of the number itself (*j*) is also checked. If it is negative, it is changed to positive with the absolute value (ABS) function, and a message to this effect is displayed. A negative number *may* mark the end of data if the user entered it for that purpose when editing data, but EOF becoming *true* is what actually terminates the data-reading loop in this subroutine. In any case, negative numbers are changed to positive, since the graphs have only positive coordinates. The number is assigned to the next element of the *gData* array and printed on the screen.

The variable *dNum* (the number of data items read) is set to either the value of the counter when the WHILE loop finished, or the maximum number of data items (*maxData,* set to 40)—whichever is smaller. Then a message telling you how many items were read is displayed, and a WHILE...WEND loop is used to wait until the OK button included with the window is clicked. Since there's only one button, the loop simply checks for DIALOG(0) becoming 1, indicating a button click in the active window. When this happens, CloseWindow [SR 9] is called to do just that. Note the CLS (clear screen) statement used to clear out anything remaining in the primary MacGraph window.

Saving a data file

SaveAs [ME A2] gets a file name via the ubiquitous FILES$ function (remember to use a 0 with FILES$ when you want to get a file name to *save* a file, and use a 1 when you want to get a file name for *opening* a file). If a valid name is obtained, the elements of the data array *gData* are simply printed to the file. There is no need to check for an excess number of items here, since the program makes sure that no more than *maxData* items are accepted when data is first read into *gData* (see the previous section) or when it is edited (see the next section).

Editing data

The Edit Data option, handled by EditData [ME A3], is used to edit the data list (add and/or change data). The data may be read from a file or entered at the keyboard. The secondary window is opened, as described for the option to open a file, and the top and left boundaries of the editing grid are defined. A reminder message about ending the plotting sequence is displayed, and the flag *dataEnd* is set to *false.*

A FOR...NEXT loop is used to position, display, and edit the data. The position for each edit field (which will be used to edit one data item) is first calculated. The offset from the left boundary (*leftEd*), assigned to the variable *l,* is the item number, *n,* minus 1 (since items start with 1) times the width of an edit-field box (70) MOD 5. The MOD is used because there are five items per row: Since we're interested here in how far to the right we're going, not how far down, we want the number of boxes "left over" (the remainder) when complete groups of five boxes have been accounted for. The offset from the top boundary (*topEd*), assigned to the variable *t,* is equal to the item number minus 1 *divided by 5* (since we need to know how many complete rows to go down), times 20 (the height of an edit

box). Note this general procedure and its use of MOD and division: It allows you to draw and position any regular rectangular grid of objects.

After the position of each item is determined using these calculations, we need to know whether we've reached the beginning of a new line. If we have, we want to print one of the reference numbers (1, 6, 11, and so on) that run down the left side of the grid. If $n-1$ MOD 5 is 0, we're at the start of a new line, and the current item number n is printed in large type, located in and slightly down from the position of the first edit field in the new line. (Remember that the coordinates of the current edit field are (l,t).) Control then continues at the label NotLine, where of course we also end up if the current edit field *didn't* start a new line.

The current data item (*gData(n)*) is checked to see if it's negative. If it is, we assume the user wanted to end the data there, and the flag DataEnd is set to *true*. If the item marks the end of data, nothing (a null string) is printed; otherwise, the item is converted to a string. This is necessary so it can be edited with the EDIT FIELD statement. The EDIT FIELD statement contains the following specifications:

- The edit field ID, which in this case is the item number (*n*).
- The string expression to be edited (*n$*, which we converted from *gData(n)*.
- The specifications for the rectangle within which editing will take place. These are in the standard BASIC (x,y) - (x,y) format, where the first pair is the upper left coordinate and the second pair is the lower right coordinate. In this case, the specifications are offset from the coordinates of the field position for the current item (l,t) as previously calculated.
- The next specification, for which we put a comma (indicating the default), draws a box around the rectangle defining the edit field. It also causes the insertion point to move to the next field if the Return or Tab key is pressed.
- Finally, the parameter 2 is used to specify center justification, making user-entered numbers automatically centered in the edit fields.

If you haven't used edit fields before, they're worth discovering in more detail than we can offer here, and Chapter 14 of *Macinations* (Microsoft Press, 1985), would be a good place to start.

Once defined, all edit fields will remain active until the window is closed. Having defined an edit field for the current item, the loop continues positioning, defining, and displaying the edit fields until all 40 fields have been set up. The EDIT FIELD 1 statement that follows makes the first field the current edit field and displays the insertion point, ready for the

user to begin typing. The variable *eField,* holding the number of the edit field currently in use, is set to 1, and the variable *maxFields* (maximum number of fields to edit) is set to *maxData.* This variable is used so that the same subroutine can be used to edit the title fields, which we'll discuss in the next section.

EditFields [SR 6] is used to actually manage editing the data. It sets the flag OK to *false:* This flag will become *true* when the user clicks on the OK button, setting DIALOG(1) to 1. The WHILE...WEND loop starts by getting the value of DIALOG(0) and assigning it to the variable *diag.* If *diag* = *1,* OK is set to *true,* the loop will terminate, and the subroutine will be exited on the next pass. If *diag* = 2, the user has moved to a new edit field by clicking in that field with the mouse pointer. In this case, the current field to be edited (*eField*) is set to DIALOG(2), because this dialog function is set up precisely to return the value of the current edit field. Besides using a mouse click, the user can move to a new edit field by hitting either the Tab or Return key, so we must check for these keys. If *diag* is not 7 or 6, neither Tab nor Return was pressed by the user; control goes to the label NotTab, and nothing further need be done. Otherwise, the number of the new edit field is calculated: Using the MOD function allows the insertion point to wrap around back to the first field if it was in the last field when the key was pressed. The EDIT FIELD statement is then used to edit the new field in the manner discussed earlier.

Once the user's editing activity is completed, control returns to EditData. A loop is now used to go backwards through the edit fields to get the edited values and update the *gData* array. The loop also determines where the end of data is and thus finds the total number of data items. The string function EDIT$ is used to access the set of strings from all the edit fields in use. The string from the current field number, *n,* which starts at *maxData* (40 in the case of data fields), is assigned to *j$* and checked to see if it is null (blank). If it is, there is no data (it may be the end-of-data marker, or there may be more blank, null, or −1 fields to go), and the string "−1" is assigned. The VAL function is then used to get the numeric value of the current string. If it is negative (either because it was a null or blank or because it actually had a negative number in it), there can be *no more* than the current number of data fields, so *dNum,* the total number of data fields, is reduced by 1. The value is then put into the current element of *gData.* When the FOR...NEXT loop is finished, *dNum* contains the number of items read, and *gData* contains the numeric values of the items. The data-editing window is closed, and the option has been completed.

Editing the graph titles

Titles [ME A4] is used to edit the titles to be used on graphs generated from the current data set. The procedure followed here is very similar to that used in the data editor we've just discussed. As with that subroutine, OpenWindow is called to open the multipurpose window, and the top and left boundaries of the edit area are defined. A prompting message is then displayed via the subprogram DrawStr [SP 2]. This is used here, rather than having just a PRINT statement as in the case of the data editor, because it centers the string before printing it. As is commonly the case in our programs, formatting routines like DrawStr are often coded as subprograms rather than subroutines because the subprogram can have any string passed directly to it as a parameter rather than first having to assign the string to an agreed-upon variable.

The descriptions of the three edit fields are printed with a regular combination of MOVETO and PRINT statements because they don't have to be centered. The three edit fields are then set up by a FOR...NEXT loop. Again, they are set up by offsetting them from the top and left boundaries. EDIT FIELD is used again, too: Since there are only three edit fields here and they're directly underneath each other, the setup is much simpler than it was for the data edit fields. The array *title$* will hold the edited titles.

After *maxFields* is set to 3, EditFields [SR 6] is called to edit the fields. Note that the same subroutine was used to edit the data fields, but *maxFields* had to be changed before calling it in Titles. The flexibility of the BASIC edit-field facility allows us to get away with using one subroutine for both data and title editing. The final FOR...NEXT loop simply reads the contents of EDIT$ (where BASIC has put the results of the editing) into the corresponding elements of *title$*. CloseWindow is then called to close the window and clear the screen.

Copying a graph to the Clipboard

ClipGraph [ME A5] copies the currently drawn graph to the Clipboard so it can be transferred to other applications. The variable *dNum* is first checked to make sure there is some data currently in use from which to draw the graph. If no data is found, NoData [SR 1] is called to prompt the user to enter some. If data is present, we move to the PICTURE ON statement. This statement enables BASIC to record the graphics instructions that will be used to draw the graph in a string that can later be returned by the PICTURE$ function. The CALL SHOWPEN statement turns

the pen back on so that the graph will be drawn on the screen as well as being recorded. (The default with PICTURE ON is for the pen to be off and thus display no output to the screen.)

DrawGraph [ME B0] is called to select the type of graph to be drawn. It clears the screen and checks the value of *dNum* to make sure some data is present, prompting the user again via NoData if it cannot find data. The type of graph to be drawn is stored in the variable *gType:* It will be whatever was the last selection from the Graph menu. (We will discuss that menu and the actual mechanics of drawing the graphs in a later section.) After the graph is drawn, control returns to DrawGraph; the drawn graph is now stored in the picture string. The pen is turned back off, PICTURE OFF is issued to stop the recording of images, and the file *Clip:Picture* is opened for output. Remember that *Clip* is the standard Macintosh file name for the Clipboard and that the extension *:Picture* is needed when picture information is to be written to the Clipboard. The information in PICTURE$ is printed, and this option is complete.

Other file-menu options

We have met all the other options before; they are standard for our programs. Inst [ME A6] displays brief instructions, and BasQuit [ME A7] and DeskQuit [ME A8] return control to BASIC and the Mac desktop. When you use the quit options in your own programs, don't forget that if you've created any special-purpose menus, you'll want to include the MENU RESET statement to remove them, as we do here.

Drawing the graphs

As we've mentioned, DrawGraph [ME B0] is the point of departure for drawing the graphs. If MenuEvent determines that a selection was made from the Graph menu, the item number selected is stored in the variable *gType.* We have also noted that if the File menu-item Graph $->$ Clip is selected, DrawGraph is called to draw the graph currently specified in *gType.* No matter how it's called, DrawGraph clears the screen, checks to make sure there is data from which to draw the graph (*dNum* $<>$ *0*), and prompts the user via NoData if there is not, and then (assuming that data is present) branches to the appropriate graph routine via the *ON gType GOSUB* statement.

Note that there are basically two geometries involved in our graphs: lines and rectangles, and circles. Both types involve the process of scaling the data based on the largest and smallest data values found,

and setting boundaries for drawing the graph, but the actual drawing of the circular (pie) graphs is more complicated because of the trigonometry involved in determining sections of a circle. Let's start by examining the simplest case: the line graph.

The line graph

LineGraph [ME B1] handles the line graph. This graph requires a rectangular frame with "ticks" marking regular graduations of values along the vertical and horizontal axes. DrawFrame [SR 3] is called to produce that frame. It starts by finding the maximum value in the set of values in the data array *gData*. To do this, it simply starts with *max* set to 0, then uses a FOR...NEXT loop to compare each data value in turn to the current maximum and replaces the current maximum with the data value if the latter is larger.

DrawFrame in turn calls CalcMax [SR 4] to "scale" the data values so that both the smallest and the largest values will fit on the graph. The function Log10, defined back in [Init 1], finds the base-10 logarithm of a number; that is, the power to which 10 would have to be raised to get that number. (To be precise, it finds the highest *integer* power.) Microsoft BASIC doesn't provide this kind of log directly, but it does provide a built-in function for the "natural" logarithm. The base-10 logarithm of a number can be found by dividing the natural log of the number by the natural logarithm of 10. You might file this little fact away so you'll be able to get base-10 logs on the (admittedly infrequent) occasions when you might need them in your BASIC programming.

The first statement in CalcMax sets the variable *t* to the integer power of 10 closest to the maximum data value. This is our first rough approximation: In our example, where the largest data value is 348 (see Figure 2), *t* would be set to 10 to the second power, or 100. (Ten to the third, the next power, is 1000, which is too large.) The variable *m* is initially set to the value of *t*, and then a WHILE...WEND loop is used to repeatedly add *t* to *m* until it exceeds the maximum data value stored in *max*. In our example, we add 100 to *m* (which starts at 100) until we get 400; at this point *max*, or 348, is exceeded, so the loop stops.

An IF statement next tests to see if *max* is less than *m* * .6; we're now checking to see if we overshot and, if so, whether we've overshot enough that we want to start moving *m* (our tentative maximum) back toward *max*. If so, control branches to the label CM1, *t* is divided by 10 (in effect giving a finer scale to work with), and a WHILE...WEND loop subtracts 2 * *t* from *m* as long as *m* is greater than *max*. Since "one too many"

subtractions will have been made when the loop is exited, *2 * t* is added back to *m* to ensure that *m* will be larger than the largest data value (and thus that the data value will be within the graph). We then reach the label CM3, where *max* is set to *m*.

To use an actual example, the largest data value, 348, is larger than *m * .6*, or 240 (*400 * .6*), so *m* may not be far enough past *max* and the graph may thus be too crowded. There might be room to increase *m* by *t*, adding one more interval. The IF statement increases *m* by *t* if *m* isn't already approximately twice *t*, or a multiple of twice *t* (four times *t*, or whatever). In our example, where *m* is 400 and *t* is 100, *m / t = 4*, and *4 MOD 2 = 0*, so *m* stays at 400. Control then jumps to CM3, where *max* is also set to 400. If you check Figure 4, you can verify that 400 is the value of the top line of the graph.

After CalcMax is finished, control returns to DrawFrame, and the scale (the distance that will represent one unit of value along the y or vertical axis) is set by dividing the maximum possible extent of the y axis on the screen, *yRange*, by the *max* value calculated in CalcMax (remember, this is no longer the maximum data value; it is the largest value that would fit on the graph). If you examine the definitions back in [Init 1], you can see that *yRange* is equal to *maxY − minY − 5:* in this instance, 225 − 25 − 5, or 195. Since *max* has been set to 400, the scale is 195 / 400, or a little less than 0.5. So, using our example values, a point on the line graph (or the top of a bar on the bar graph) will be approximately half its value in pixels from the bottom of the graph.

DrawYTicks [SR 5] is now called to draw the "ticks" or numbered hatch marks that provide reference points for the values along the y axis. The subroutine first calculates the distance between hatch marks on the y axis. The starting value, *interval*, is again the largest power of 10 that is less than *max*. *max* is then divided by *interval:* If the result is less than 3, the interval is too large and not enough hatch marks and numbers will be drawn. In this case *interval* is set to *interval / 5*.

Now it's time to draw the tick marks and the numbers on the y axis. The FOR...NEXT loop will be executed one plus the maximum divided by the interval (rounded up) times. If you look back at Figure 4, you can see that there are five tick marks, numbered from 0 to 400, and 400 / 100 (or 4) + 1 is indeed 5. (We need the extra 1 because we start at 0.) We multiply *n* (the tick number) times the interval and then convert it to pixels by multiplying it by the scale. Since the y-axis screen coordinates *decrease* as we move up the axis, the quantity we've calculated is subtracted from *maxY* to get the y pixel coordinate. The LINE statement

draws a horizontal line from 4 less than *minX* to *maxX;* the fact that the line starts to the left of the y axis provides the "tick mark."

We now want to convert the number for each tick mark (*n * interval*) to a string for easy formatting and proper printing. This is done with the STR$ function, and the result is assigned to *t$*. We specify the INT of this number if the interval is over 1 in order to get rid of fractions that might have crept in when we divided *interval* by 5. Floating-point operations tend to produce values that aren't quite integers, and INT is good insurance against such mishaps when it's important to have whole-number results. The MOVETO statement positions the pen far enough to the left of the y axis (*minX*) to accommodate the length of the string in pixels, and the string is then printed. When all the tick marks, lines, and numbers have been printed, the loop is exited and control returns to DrawFrame.

DrawFrame calls DrawStr [SP 2], which centers and draws the first title (in *title$(1)*)—the title of the graph itself. The second title, which is displayed vertically along the y axis, is set up by finding the midpoint of the y axis (*minY+(maxY−minY)/2*) and then subtracting from it the length of the string in characters times the character size in pixels. This gives the starting point for displaying the string, which is then printed a character at a time by a FOR...NEXT loop that positions each character. The third title is simply displayed below the x axis by another call to DrawStr. Note that the numbers along the x axis haven't been printed yet; they will be produced as part of the actual graphing routine.

Finished at last, DrawFrame returns to LineGraph, and we're ready to draw the actual graph. First, the lengths of the line segments connecting the data points are determined; this is also the interval at which the tick marks and numbers along the x axis will be shown. Assuming there is at least one data value (*dNum > 1*), the length of a segment is the total length of the x axis (*xRange*, determined back in [Init 1]) divided by the number of data points minus one. The "minus one" is there because it takes only *dNum − 1* lines to connect *dNum* points; there are three line segments connecting the four data points in our example.

After the pen has been positioned at the graph's origin point (*minX,maxY*)—remember that *maxY* is the *bottom* of the y axis—a FOR...NEXT loop is used to draw the graph. First, the y and x coordinates for the current data point are calculated. The y coordinate is determined by multiplying the scale (determined back in DrawFrame) by the value of the current data point and then subtracting the result from the y coordinate of the last point determined. (For the first segment, the "last point" is the origin point.)

The x coordinate is determined by multiplying the line length by one less than the *number* of the current data point and then *adding* it to the x coordinate of the last point, since x coordinates increase along the graph. (Again, the "one less" is necessary because the first point is plotted on the y axis; that is, with an x coordinate of 0.) The second point is plotted with an x coordinate of *minX+lineLen,* the third point at *minX+lineLen * 2,* and so on. A LINETO statement is then used to draw the line segment and a CIRCLE statement to draw the black circle marking the data point's location. The effect of a filled black circle is obtained by drawing first a circle with radius 2 and then a circle with radius 1 within it.

Next, the corresponding tick mark along the x axis is drawn. The IF statement with MOD 5 is used to draw every fifth line twice as long for easy reference. The DrawXNum subprogram [SP 1] is called to display the reference numbers along the x axis. This subprogram takes into account a potential problem: What if you have a lot of data points? If you do, there will be too many corresponding numbers to fit along the x axis, or at least the numbers are likely to crowd and run into each other. To handle this situation, DrawXNum first checks to see if the total of the numbers it is being asked to draw is more than 20. If so, an AND with the MOD function makes it draw the number for only every fifth data point. (This doesn't happen in our example, since it has only four data points.) The calling routine is responsible for passing this maximum number to DrawXNum; this number is available as *dNum.* DrawXNum in turn calls upon DrawStr to actually draw the number, and DrawStr provides the centering. Finally, LineGraph moves the pen to the new (x,y) point, which becomes the origin for the next line segment. When the FOR loop has gone through every value of *n,* this has been completed.

The bar graph

BarGraph [ME B2] supervises the drawing of this graph. You'll be pleased to learn that most of the procedures involved in creating the bar graph have been covered in the preceding section. Again, the main graph subroutine calls DrawFrame, which then calculates the scale and calls DrawYTicks to draw the ticks and reference numbers for the y axis, exactly as in the case of the line graph.

After control returns to BarGraph, the width of the bars is calculated: It's simply the extent of the x axis (*xRange*) divided by the number of data points (*dNum*). A FOR...NEXT loop draws the bars and the x axis ticks and numbers, completing the graph. For each data point, the top of the bar (its y coordinate) is calculated in exactly the same way that the y

location of a point on the line graph was calculated. The x coordinate of the bar is calculated the same way as the x coordinate of a point on the line graph was calculated, with the difference that the bar width rather than line length is used. The bar is then drawn with a simple LINE statement with the *bf* option. The bar is drawn to slightly less than the full bar width (*barWidth* – 5) so that some white space will be left to separate the bars. The midpoint of the bar on the x axis is determined, and the tick mark is drawn on the x axis. As with the line graph, every fifth tick mark is drawn at double length. Again, DrawXNum is called to draw the numbers.

The pie graphs

Although there are two pie graph options (pie with percentages and pie with values), the only difference between the two is in the numbers used to label the slices. If pie with percent is chosen from the Graph menu, PiePercent [ME B3] is called. The subroutine sets the Boolean flag variable *percent* to *true,* then calls PieGraph [SR 2] to draw the graph. If pie with actual values (rather than percentages) is chosen from the Graph menu, PieIndex [ME B4] is called. This subroutine sets the *percent* flag to *false* and then calls PieGraph.

You might wonder why two subroutines are used whose only difference is in how they set a flag. We could have one subroutine (called simply Pie, perhaps) appear in both pie "slots" in the ON GOSUB statement in DrawGraph. The subroutine could set the *percent* flag according to the value of *gType,* the type of graph selected. This would certainly work, and it would shorten the code. However, it has the disadvantage that if someone wanted to add features to one kind of pie graph but not the other, more complicated logic would have to be put into the "general" Pie subroutine. With separate subroutines for the two kinds of pie, features can be added to either without affecting the other. Sometimes the "advantage" of saving a few lines of code is outweighed by the flexibility built into a clean design.

Now let's look at the way the pie graph is actually drawn by PieGraph. To do this, we must turn our thinking from the rectangles and straight lines of the bar and line graphs to the world of circles and arcs. That means trigonometry—not everyone's favorite pastime, we'll admit. Remember, though, that you don't really have to understand trig to use and even modify our pie-graphing routine. Since this isn't a mathematics textbook, we're not going to go heavily into detail, anyway.

The first step is quite simple. Using the boundaries for the circular chart area originally defined in [Init 1], PieGraph establishes a standard

QuickDraw rectangle and uses a PAINTOVAL statement to draw a filled circle—the pie. Next, a FOR...NEXT loop adds up all the data values in *gData*. This value, *totalUnits*, is divided into 2 * *pi*. This latter quantity, you may remember from your geometry class, is the equivalent of the circle's 360 degrees expressed in *radians*, a standard measure of angle. The unit of angle thus obtained is similar to the scale calculated for the line and bar charts: It's the angle that will represent one unit of value in the data. Next, the graph title is positioned 30 pixels above the top of the circle and drawn by a call to DrawStr. Note that (*circleX,circleY*) are the screen coordinates of the center of the circle, and that *circleR* is the radius of the circle. For pie graphs, only the first title (the overall graph title) is used, since these graphs aren't laid out on x and y axes like the line and bar charts.

Now it's time to draw the segments or "slices" of the pie. The basic method for finding the endpoint to which a given segment will be drawn uses the following rule of trigonometry: Starting from the center of the circle, and given an angle *theta*, in radians:

X coordinate of endpoint = centerX + circleR * SIN(theta)
Y coordinate of endpoint = centerY − circleR * COS(theta)

We already know the coordinates of the center of our circle (*circleX,circleY*), and its radius (*circleR*). The variable *theta* is used to keep track of the angle, which of course increases as data points are plotted as we move clockwise around the circle. The angle is initially set to 0, since the pie graph by convention starts at the twelve o'clock position. If you compare the general formula just described with the the first two statements inside the main FOR...NEXT loop, you'll see how MacGraph uses this formula to calculate an endpoint (*endPtX,endPtY*) each time through the loop. Again, the x coordinate is added to that of the center of the circle, and the y coordinate is subtracted from the center's y coordinate, because on the Mac screen y coordinate values on a circle decrease when x coordinates increase, and vice versa. (Our graph corresponds to the upper right quadrant of the traditional Cartesian grid you may remember pondering in algebra class.)

A LINE statement now draws a white line from the center of the circle to the endpoint. The next item on the agenda is to label the segment with a number, either a percentage or a value depending on the type of pie graph being generated. The same formula as just described is used, except that we use an angle, *midTheta*, which is calculated by multiplying the unit

angle by half the data value being plotted and adding it to the current value of *theta*. Since we want the number to appear exactly halfway along the arc of the pie slice, we want an angle that points at that midpoint. Also, since the numbers are printed a little way outside the circle, the radius of the circle has to be multiplied by 1.15 to get an "invisible circle" large enough for the numbers to be placed on it. Two IF statements check whether percents are wanted and formulate the string to be printed accordingly. DrawStr is called to draw the number. When the FOR...NEXT loop is exited, the complete graph has been drawn.

Suggestions for MacGraph

You can begin by using MacGraph to plot whatever kinds of data are relevant to your business, profession, or studies. Since MacGraph is quick and easy to use, you can readily translate many kinds of statistics into a visual form that's usually more comprehensible than raw numbers. You can copy some graphs to the Clipboard and incorporate them into documents produced on your word processor, or save a screen image to disk and embellish it with MacPaint.

After you've experimented with MacGraph for a while, you may want to add features to it. An easy one would be to have MacGraph save the current titles along with the data in a disk file. You could also add a routine (or write a separate BASIC program) that will "capture" a graph and shrink it, or perhaps draw several graphs on the same screen. Of course, you can also add a second line to the graph title, change the pie to a white pie with black lines, or make many other modifications.

Since the structure of wholly menu-driven programs like MacGraph is simple, it's easy to add or change one or more options without affecting the others. A bakery might provide fancier (and more expensive) pies, but with MacGraph you can bake them to your own recipes!

MacGraph program listing

```
'**************************************************************
'                          MacGraph
'                  Graph data on the screen
'**************************************************************

'************************************************** INITIALIZE
maxData = 40                              'max number of data items
DIM gData(maxData), title$(3)

pi = 3.1415926#
wind2L = 16 : wind2T = 55 : wind2W = 479 : wind2H = 270
minX = 70 : maxX = 450 : xRange = maxX - minX
minY = 25 : maxY = 225 : yRange = maxY - minY - 5
circleX = 250 : circleY = 150 : circleR = 110
false= 0 : true = NOT false
gType = 1

DEF FN Log10(x) = LOG(x) / LOG(10)          'returns Log10 value of x

WINDOW 1, , (12,34) - (500,330), 2

MENU 6, 0, 1, "MacGraph File"               'install MacGraph menus
MENU 6, 1, 1, "Open"
MENU 6, 2, 1, "Save As"
MENU 6, 3, 1, "Edit Data"
MENU 6, 4, 1, "Edit Titles"
MENU 6, 5, 1, "Graph -> Clipboard"
MENU 6, 6, 1, "Instructions"
MENU 6, 7, 0, "-"
MENU 6, 8, 1, "Quit to BASIC"
MENU 6, 9, 1, "Quit to Desktop"

MENU 7, 0, 1, "Graph"
MENU 7, 1, 1, "Line"
MENU 7, 2, 1, "Bar"
MENU 7, 3, 1, "Pie w/Percent"
MENU 7, 4, 1, "Pie w/Value"
ON MENU GOSUB MenuEvent : MENU ON         'enable menu event-handling

CALL TEXTSIZE(36): CALL TEXTFONT(0)         'draw title screen
LOCATE 2,7 : PRINT "MacGraph!"
LOCATE 3,6
CALL TEXTSIZE(12)
PRINT "The MacGraph menus are now active."
CALL TEXTFONT(1) : CALL TEXTMODE(1)
GOSUB InitData

'************************************************** MAIN PROGRAM
WHILE true : WEND                 'endless loop interrupted by menu events
```

INIT 1

INIT 2

INIT 3

MAIN

```
'********************************************************* MENU EVENTS
ME A0
MenuEvent:
   MENU 6, 0, 0 : MENU 7, 0, 0                              'disable menus
   menuBar = MENU(0)                                        'get menu number,
   item = MENU(1)                                           'and item number in that menu
   IF menuBar <> 7 THEN FileMenu
   gType = item
   GOSUB DrawGraph
   GOTO MEventEnd

FileMenu:
   ON item GOSUB FOpen,SaveAs,EditData,Titles,ClipGraph,Inst,,BasQuit,DeskQuit
MEventEnd:
   MENU 6, 0, 1 : MENU 7, 0, 1                              're-enable menus
   RETURN

ME A1
FOpen:          '_____________________________ open file and read from it
   fileName$ = FILES$(1,"TEXT")                             'get file name
   IF fileName$ = "" THEN CLS : RETURN                      'user hit Cancel button
   GOSUB OpenWindow
   CALL TEXTFONT(0)
   CALL MOVETO(108,50) : PRINT "Reading data from: "; fileName$

   OPEN fileName$ FOR INPUT AS #1
   i = 0
   WHILE NOT EOF(1)                                         'read numbers from file
      i = i + 1
      INPUT #1, j
      LINE (100,55) - (520,75), 30, bf
      CALL MOVETO(100,70)
      IF i > maxData THEN PRINT "  Data file too large!"; : GOTO TooLarge
      IF j < 0 THEN PRINT "  Negative number changed to postive."; : j = ABS(j)
      gData(i) = j
      PRINT gData(i);
TooLarge:
   WEND
   IF i > maxData THEN i = maxData
   dNum = i
   CLOSE #1

   CALL MOVETO(100,90) : PRINT dNum; " numbers found."
   WHILE DIALOG(0) <> 1 : WEND
   CALL TEXTFONT(1)
   GOSUB CloseWindow
   CLS
   RETURN

ME A2
SaveAs:         '_____________________________ save list to file
   file$ = FILES$(0,"File Name?")
   IF file$ = "" THEN NoSave
```

```
    OPEN file$ FOR OUTPUT AS #1
    FOR n = 1 TO dNum : PRINT #1, gData(n) : NEXT
    CLOSE #1
NoSave:
    CLS
    RETURN

EditData:          '_____ edit data list
    GOSUB OpenWindow
    topEd = 60 : leftEd = 30
    CALL TEXTFONT(0)
    x = 28 : y = 22
    CALL MOVETO(x,y) : y = y + 16
    PRINT "Edit the data to be plotted.  Remember, a blank box"
    CALL MOVETO(x,y) : y = y + 16
    PRINT "or negative number ends the plotting sequence."
    dataEnd = false
    FOR n = 1 TO maxData
        l = leftEd + INT((n - 1) MOD 5) * 70
        t = topEd + INT(((n - 1) / 5)) * 20
        IF (n - 1) MOD 5 <> 0 THEN NotLine
        CALL TEXTFONT(0)
        CALL MOVETO(l - 30, t + 13) : PRINT n;
        CALL TEXTFONT(1)
NotLine:
        IF gData(n) < 0 THEN dataEnd = true
        IF dataEnd THEN n$ = "" ELSE n$ = STR$(gData(n))
        EDIT FIELD n, n$, (l,t) - (l + 60, t + 15), , 2
    NEXT n
    EDIT FIELD 1 :  eField = 1
    maxFields = maxData
    GOSUB EditFields

    dNum = maxData
    FOR n = maxData TO 1 STEP -1
        j$ = EDIT$(n) : IF j$ = "" OR j$ = " " THEN j$ = "-1"
        j = VAL(j$)
        IF j < 0  THEN dNum = n - 1
        gData(n) = j
    NEXT n
    GOSUB CloseWindow
    RETURN

Titles:            '_____ edit graph titles
    GOSUB OpenWindow
    topEd = 130 : leftEd = 200
    CALL TEXTFONT(0)
    CALL MOVETO(wind2W / 2, 70)
    CALL DrawStr("Enter the titles to appear on the graph.")
    x = 30 : y = topEd + 12
```

ME A3

ME A4

```
    CALL MOVETO(x,y) : y = y + 20 : PRINT "Graph Title:";
    CALL MOVETO(x,y) : y = y + 20 : PRINT "Vertical axis label:";
    CALL MOVETO(x,y) : y = y + 20 : PRINT "Horizontal axis label:";
    CALL TEXTFONT(1)
    FOR n = 1 TO 3
      l = leftEd : t = topEd + (n - 1) * 20
      EDIT FIELD n, title$(n), (l,t) - (l + 250, t + 15), , 2
    NEXT n
    EDIT FIELD 1 : eField = 1
    maxFields = 3
    GOSUB EditFields
    FOR n = 1 TO 3 : title$(n) = EDIT$(n) : NEXT
    GOSUB CloseWindow
    RETURN
```

ME A5

```
ClipGraph:              '_____ copy graph picture to Clipboard
  IF dNum = 0 THEN GOSUB NoData : GOTO ClipEnd
    PICTURE ON
    CALL SHOWPEN : GOSUB DrawGraph : CALL HIDEPEN
    PICTURE OFF

    OPEN "Clip:Picture" FOR OUTPUT AS #1
    PRINT #1, PICTURE$;
    CLOSE #1
ClipEnd:
    RETURN
```

ME A6

```
Inst:                   '_____ display instructions
    WINDOW 2, , (16,55) - (495,325), 2
    PRINT "                    MacGraph Instructions"
    PRINT
    PRINT "   This program allows you to graph a list of positive numbers on the"
    PRINT "Macintosh screen.  It cannot plot negative numbers.  The list can be either"
    PRINT "read out of a file, or entered from the keyboard.  If you read from a file,it"
    PRINT "must be a text file with the numbers entered just as if you entered them"
    PRINT "in response to an INPUT statement: As a series separated by commas, or a"
    PRINT "list of numbers each on its own line.  You can also edit or enter the"
    PRINT "numbers using the edit boxes in the Data Edit section.  End a list of"
    PRINT "numbers by either a blank edit box or any negative number."
    PRINT
    PRINT "   Once you have entered a list of positive numbers, you can display the list"
    PRINT "as either a line graph, bar graph, or pie graph by choosing the appropriate"
    PRINT "item from the Graph menu.  In the case of the pie graph, the data are scaled"
    PRINT "so the sum of all the numbers equals 360 degrees."
    CALL INITCURSOR
    BUTTON 1, 1, "Continue", (190,240) - (280,260)
    WHILE DIALOG(0) <> 1: WEND
    BUTTON CLOSE 1 : WINDOW CLOSE 2
    RETURN
```

ME A7

```
BasQuit:                '_____ quit to BASIC
   MENU RESET
   END
```

ME A8

```
DeskQuit:               '_____ return to Mac Desktop
   MENU RESET
   SYSTEM
```

```
'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * MORE MENU EVENTS
```

ME B0

```
DrawGraph:              '_____ draw current graph
   CLS
   IF dNum = 0 THEN GOSUB NoData
   IF dNum <> 0 THEN ON gType GOSUB LineGraph, BarGraph, PiePercent,PieIndex
   RETURN
```

ME B1

```
LineGraph:              '_____ draw line graph
   GOSUB DrawFrame
   IF dNum > 1 THEN lineLen = xRange / (dNum-1) ELSE lineLen = 0
   CALL MOVETO(minX,maxY)
   FOR n = 1 TO dNum
      pointY = maxY - scale * gData(n)
      pointX = minX + lineLen * (n - 1)
      CALL LINETO(pointX,pointY)
      CIRCLE (pointX,pointY), 2 : CIRCLE (pointX,pointY), 1
      size = 2 : IF (n MOD 5) = 0 THEN size = 4
      LINE (pointX, maxY - size) - (pointX, maxY + size)
      CALL DrawYNum(pointX, maxY + 10, n, dNum)
   CALL MOVETO(pointX,pointY)
   NEXT n
   RETURN
```

ME B2

```
BarGraph:               '_____ draw bar graph
   GOSUB DrawFrame
   barWidth = xRange / dNum
   FOR n = 1 TO dNum
      barTop = maxY - gData(n) * scale
      barX = (n - 1) * barWidth + minX
      LINE (barX,maxY) - (barX + barWidth - 5, barTop), , bf
      midPt = barX + (barWidth - 5) / 2
      size = 2
      IF (n MOD 5) = 0 THEN size = 4
      LINE (midPt,maxY) - (midPt, maxY + size)
      CALL DrawYNum(midPt, maxY + 10, n, dNum)
   NEXT n
   RETURN
```

ME B3

```
PiePercent:             '_____ draw percentage pie
   percent = true
   GOSUB PieGraph
   RETURN
```

ME B4
```
PieIndex:                    '_____ draw pie with values
  percent = false
  GOSUB PieGraph
  RETURN

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
```
SR 1
```
NoData:                      '_____ tell user no data to plot
  CLS
  CALL TEXTFONT(0)
  CALL MOVETO(255,100)
  CALL DrawStr("No data to plot.  Enter data with 'Edit Data' menu.")
  CALL TEXTFONT(1)
  RETURN
```
SR 2
```
PieGraph:                    '_____ draw pie graph
  r%(0) = circleY - circleR : r%(2) = circleY + circleR
  r%(1) = circleX - circleR : r%(3) = circleX + circleR
  CALL PAINTOVAL(VARPTR(r%(0)))
  totalUnits = 0 : theta = 0
  FOR n = 1 TO dNum
    totalUnits = totalUnits + gData(n)
  NEXT
  unitAngle = (2 * pi) / totalUnits
  CALL MOVETO(circleX, circleY - circleR - 30)
  CALL TEXTFONT(0) : CALL DrawStr(title$(1))
  CALL TEXTFONT(1)
  FOR n = 1 TO dNum
    endPtX = circleX + circleR * SIN(theta)
    endPtY = circleY - circleR * COS(theta)
    LINE (circleX,circleY) - (endPtX,endPtY), 30
    midTheta = theta + (unitAngle * gData(n)) / 2
    midPtX = circleX + (circleR * 1.15) * SIN(midTheta)
    midPtY = circleY - (circleR * 1.15) * COS(midTheta)
    CALL MOVETO(midPtX,midPtY)

    IF NOT percent THEN t$ = STR$(gData(n))
    IF percent THEN t$ = STR$(CINT((gData(n) * 100) / totalUnits)) + "%"
    CALL DrawStr(t$)
    theta = theta + (unitAngle * gData(n))
  NEXT n
  RETURN
```
SR 3
```
DrawFrame:                   '_____ draw frame for bar or line graph
  max = 0                                          'first, find largest number
  FOR n = 1 TO dNum
    IF max < gData(n) THEN max = gData(n)
  NEXT n
  GOSUB CalcMax
  scale = yRange / max                             'calculate scale
  LINE (minX,minY) - (minX,maxY)
  LINE (minX,maxY) - (maxX,maxY)
  GOSUB DrawYTicks
```

```
    CALL TEXTFONT(0)
    CALL MOVETO(minX + (maxX - minX) / 2, minY - 15)
    CALL DrawStr(title$(1))
    y = minY + (maxY - minY) / 2 - INT(LEN(title$(2)) / 2) * 16
    FOR n = 1 TO LEN(title$(2))
      CALL MOVETO(minX - 60, y) : PRINT MID$(title$(2), n, 1);
      y = y + 16
    NEXT n
    CALL MOVETO (minX + (maxX - minX) / 2, maxY + 42)
    CALL DrawStr(title$(3))
    CALL TEXTFONT(1)
    RETURN

CalcMax:          '_____ calculate max value for scaling graph
    t = 10 ^ (INT(FN Log10(max)))
    m = t
    WHILE m < max : m = m + t : WEND

    IF max < (m * .6) THEN CM1
    IF ((INT(m / t) MOD 2) <> 0)  THEN m = m + t
    GOTO CM3
CM1:
    t = t / 10
    WHILE m > max : m = m - 2 * t : WEND
    m = m + 2 * t
CM3:
    max = m
    RETURN

DrawYTicks:       '_____ draw ticks and numbers up y axis
    interval = 10 ^ INT(FN Log10(max))
    IF (max / interval) < 3 THEN interval = interval / 5
    FOR n = 0 TO INT(max / interval + .5)
      j = maxY - scale * (n * interval)
      LINE (minX - 4, j) - (maxX,j)
      IF interval > 1 THEN t$ = STR$(INT(n * interval))
      IF interval <= 1 THEN t$ = STR$(n * interval)
      CALL MOVETO(minX - LEN(t$) * 8 - 4, j + 4)
      PRINT t$;
    NEXT n
    RETURN

EditFields:       '_____ edit edit fields
    OK = false
    WHILE NOT OK
      diag = DIALOG(0)
      IF diag = 1 THEN OK = (DIALOG(1) = 1)
      IF diag = 2 THEN eField = DIALOG(2)
      IF diag <> 7 AND diag <> 6 THEN NotTab
      eField = eField MOD maxFields + 1
      EDIT FIELD eField
```

SR 4

SR 5

SR 6

```
NotTab:
  WEND
  RETURN

SR 7  InitData:          '_____ initialize data array to blank
  dNum = 0
  FOR n = 1 TO maxData : gData(n) = -1 : NEXT
  RETURN

SR 8  OpenWindow:        '_____ open second window
  WINDOW 2, , (wind2L,wind2T) - (wind2L + wind2W, wind2T + wind2H), 2
  BUTTON 1, 1, "OK", (wind2W - 70, wind2H - 30) - (wind2W - 10, wind2H - 10)
  RETURN

SR 9  CloseWindow:       '_____ close second window
  WINDOW CLOSE 2 : CLS
  RETURN

SP 1  SUB DrawXNum(midX, midY, num, maxNum) STATIC      '_____ axis numbers
  IF (maxNum > 20) AND (num MOD 5) <> 0 THEN NoYnum
  CALL MOVETO(midX,midY)
  CALL DrawStr(STR$(num))
NoYnum:
  END SUB

SP 2  SUB DrawStr(temp$) STATIC      '_____ print centered string
  CALL MOVE(-LEN(temp$) * 7 / 2, 8) : PRINT temp$;
  END SUB
```

MacCursor

MacCursor is a utility that lets you design customized mouse cursors you can use in your Microsoft BASIC programs. Using a facility that's very similar to MacPaint's FatBits option, you draw your cursor with mouse clicks and define how it will interact with the screen background. Other MacCursor facilities let you see what the cursor will look like when your program

uses it, save cursor definitions on disk and retrieve them, and generate a set of DATA statements that a BASIC program can use to create the cursor without loading a disk file.

The ability to redefine the cursor shape is useful in Macintosh programs for both aesthetic and practical reasons. MacPaint, for example, uses a number of cursors that depict a paintbrush, a hand, an eraser—whatever is appropriate to the current activity. These cursors give the user an almost tactile feel for what's being done with the mouse. When you erase something in MacPaint, for example, you can almost see the eraser rubbing out the picture.

Several programs in this book use special cursors. In MacSpace, for example, the regular arrow-pointer cursor is changed to a cross-hair gunsight for aiming lasers and photon torpedoes. Programs will generally change the mouse pointer to a special shape while the mouse is in a certain area of the screen or in a window devoted to a particular function or activity. When the mouse is moved out of this area (for example, when the user wants to pull down a menu), the cursor is changed back to the standard arrow-pointer shape. You'll no doubt find the ability to define new cursor shapes useful in many ways in your Microsoft BASIC programs.

Why MacCursor?

You've probably learned that Microsoft BASIC uses the Macintosh QuickDraw routine SETCURSOR to show the cursor in a specified pattern or shape. This pattern, as well as other cursor characteristics, must be stored in an array that is passed to the routine when it is called.

You can think of cursors as occupying a matrix that is 16 pixels square: Each row of 16 pixels in the cursor pattern is represented by a 16-bit integer, and there are 16 rows in all. In defining a cursor, the pattern of 1s and 0s corresponding to the black and white pixels in each row must be converted to a number and assigned to the corresponding element of the array. In addition to the 16 numbers that define the cursor pattern, 16 more numbers representing the *mask*—the pattern that determines how cursor pixels will interact with the existing screen pixels under them—must also be determined and put into the array. (It's called a mask because you can think of it as a grid superimposed over the cursor grid, and, like a

party mask, it affects the way the cursor will be seen.) Finally, the y and x coordinates of the "hot spot" (the part of the cursor read as the actual mouse-pointer location) must be specified in the array.

Defining a cursor by hand is an extremely tedious process. After drawing a cursor pattern on graph paper, you have to convert each of its 16 lines to a hexadecimal or decimal integer to be stored in the cursor information array as elements 0 through 15. (BASIC won't take binary numbers directly.) The 16 lines of the mask also have to be converted and stored as elements 16 through 31. Finally, the hot spot's y and x coordinates must be stored as elements 32 and 33, respectively. You'd probably put all these numbers in DATA statements and have your program read them into the array with a FOR...NEXT loop. Then you'd have to write a program to display the cursor, and chances are you'd find mistakes in transcription or conversion and perhaps things that didn't come out the way you wanted them to. You'd then have to go back and change the drawing or the binary numbers and their conversion to values in the DATA statements and try again.

MacCursor greatly simplifies the process of creating a cursor. You just draw the cursor in a 16- by 16-pixel FatBits-like grid and let the program take care of the arithmetic conversion—a sensible division of labor. As you create the magnified cursor pattern, you can bring it over to a special play area and see what it actually looks like in real-size screen pixels against a black or white background. An important feature of MacCursor lets you save your custom cursors as disk files and load them into your own programs or back into MacCursor for further editing. MacCursor can also generate the DATA statements necessary to produce a particular cursor. If you save these statements on the Clipboard, you can paste them into your BASIC programs to create "stand-alone" cursor initialization routines.

How to use MacCursor

When you run MacCursor, you see the screen shown in Figure 1 on the next page. This screen has two main areas: a work, or definition, area to the left, where you create your new cursor, and a play, or test, area to the right, where you can see what the currently defined cursor looks like in its actual size against a black or white background. We've defined a sample cursor shaped like a mechanical pencil that we'll discuss shortly.

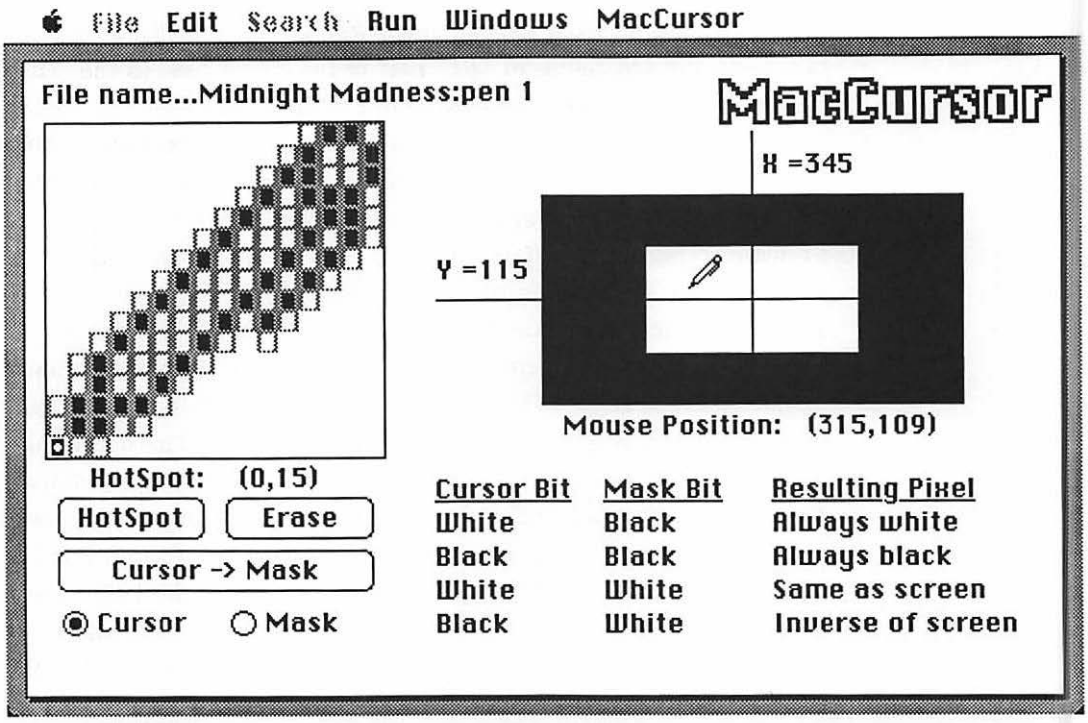


FIGURE 1. *The MacCursor screen with a cursor defined as a mechanical pencil*

At the top of the screen you can see a new pull-down menu that's called MacCursor.

The options available on this menu are *Load* (a cursor definition file from disk), *Save* (a cursor file to disk), *Copy* (cursor DATA statements) *to Clipboard, Instructions, Quit to BASIC,* and *Quit to Desktop.* Choosing Instructions gives a brief summary of how to create, test, and save a cursor.

An option for creating a cursor is not needed, because that's MacCursor's *default* activity. If you're not asking to load, save, or copy a cursor or to exit the program, MacCursor assumes that you're working on defining a cursor and going back and forth between drawing and testing it.

To define a cursor, move the mouse pointer within the box on the left side of the screen. Think of this box as being divided into 256 little squares—16 across and 16 down—representing the 16- by 16-pixel grid that makes up a cursor. Wherever you want the cursor to have a pixel turned on (displayed as black), click the mouse button. You can draw a whole line of black pixels by dragging the mouse (this takes a bit of practice). If you want to erase a black pixel, move the pointer over the pixel and click the mouse button to turn it off (turn it back to white). To erase the whole cursor image, click on the Erase button below the work area. If you've used MacPaint's FatBits, you'll recognize this way of working.

You need to specify the hot-spot location, the one pixel of the 256 that make up the cursor grid that will be established as the actual mouse-pointer location. You do this by clicking on the HotSpot button below the drawing area and then clicking on the pixel you want to designate as the hot spot. The coordinates of the hot-spot location are displayed just below the work area, and the hot-spot pixel itself has a little dot drawn in its center. You can reset the hot spot at any time by simply repeating this process. The best location for the hot spot depends upon what the cursor is supposed to represent. The tip of a pen is its "business end," so we picked one pixel at the tip of our pen cursor to be our hot spot. A gunsight cursor might have its hot spot in the center of its cross hairs, while an icon of a hand might have its hot spot in one of its fingers, and so on.

After you've drawn the cursor pattern itself, you may want to add a cursor mask. As mentioned, the purpose of the mask is to define how the cursor will act on different backgrounds. For example, by surrounding black cursor pixels with white mask pixels, a white outline will surround your icon and allow it to stand out on a black background.

To create a mask, first click on the round Mask button at the bottom left of the screen; thereafter, all the pixels you click on in the work area will be outlined in grey and become part of the mask (until you click the Cursor button). You can reverse a mask pixel by clicking on it again. If you click on a black cursor pixel, it becomes, in effect, *both* a cursor and a mask bit. But it's important to understand that there is a difference between cursor pixels and mask pixels, even though both appear in the work area at the same time. The difference is that cursor bits and mask bits are stored in separate sections of the cursor array. The information in the bottom right corner of the screen summarizes the relationship between the state of the cursor bits, the state of the mask bits, and the resulting pixels on the screen. Experiment with different mask/cursor arrangements to see how they interact with each other and the background. The purpose

of the mask part of a cursor is to define how the cursor should act on different backgrounds. For example, by surrounding black cursor bits with white mask bits you can make the outline of your icon appear on either a black or white background.

Sometimes you might want the mask pixels and the cursor pixels to be exactly the same, so that the cursor won't change shape on different backgrounds. We've provided the large Cursor −> Mask button below the work area for that purpose. Clicking on this button copies all the cursor bits into the mask so that the two shapes coincide.

Since the image you're creating here is a considerably "blown up" version of an actual cursor, it's not always easy to guess what your new cursor will look like when it's in use, not to mention how the mask will affect it. To see an actual-size representation, move the mouse pointer to the play area on the right side of the screen. As the pointer enters the black rectangle, your new cursor appears.

To get some practice, define our pen cursor example by clicking on the pixels shown in black. Click on the HotSpot button and put the hot spot in the pixel shown with the little white dot in the black square. Click on the Mask button and turn on all the mask pixels shown in gray outline.

Test the cursor by moving the pointer into the black rectangle in the play area. You should see a black pen with a white outline. Move the cursor to the inner white rectangle, and a black pen with no outline appears. This behavior is caused by the mask. If a pixel is a white mask pixel but not a black cursor pixel (the outermost and center rows in our example), it is always white, as the relationship table in the bottom right corner of the screen shows. When the pen is displayed against a white background, the mask pixels are invisible, but when the background is black, they form a white outline around the pen and a white rectangle inside it. Since the black pixels that make up the pencil itself are also mask pixels, they're always displayed in black regardless of the background (again, check the table). Thus you always see the black bits against a white background, either a white screen background or a white background created by the other mask bits.

While you're testing the cursor, the current pointer position in screen pixel coordinates is also displayed below the play area. The X and Y reference lines drawn through the play area help you note distances between the hot spot and other parts of your cursor and see how the cursor relates to the mouse-pointer coordinates.

When you've gone back and forth between drawing and testing the cursor and are satisfied with it, pull down the MacCursor menu and

choose Save from it. A dialog box asks you for the name of the file in which to save your cursor.

To load a saved cursor for further work, choose the Load option from the menu. You'll be given a standard file dialog box showing all the cursor files that are on the disk; just click on the name of the file containing the cursor you want.

Using the cursor in your BASIC programs

There are two ways you can use a cursor created with MacCursor in a BASIC program. The first is to save the cursor as a disk file as we just described. Your program should dimension an integer array to hold the cursor information; for example, *cursor(33)*. Your subroutine for setting up the new cursor would open the disk file and read the information into the cursor array (see our LoadCursor subroutine, marked [ME 1] in the program listing at the end of the chapter). To make the new cursor appear on the screen, simply use the statement:

```
CALL SETCURSOR(VARPTR(cursor(0)))
```

where *cursor* is the name of your cursor information array. To restore the normal pointer cursor, *CALL INITCURSOR*. That's all there is to it! Of course, the purpose and design of your program will determine when and where the new cursor (or cursors) will be used.

The second way of using MacCursor cursors in a BASIC program is to choose the Copy to Clipboard option after creating or loading a cursor. The information needed to define the cursor is copied to the Clipboard as a series of DATA statements containing a decimal integer for every cursor array element, complete with a comment to identify them. You can then start a new BASIC file (or load an existing program) and paste this information into the program. After that, you dimension an integer array for the cursor information as previously described, code a loop to READ the DATA statements into the array, and use CALL SETCURSOR and CALL INITCURSOR in the same way as before. The listing in Figure 2 on the next page shows the essentials for using our example pen cursor as a set of DATA statements: This program simply sets up and displays the pen cursor until the mouse button is pressed.

Why would you want to use this method instead of just loading a cursor from disk? Well, programs often get copied from disk to disk, and if you use a disk file, you have to remember to copy the cursor-definition file(s) along with the program file. Should you want to sell or distribute the

```
'_____ sample cursor-reading program

  DEFINT a-z
  DIM cursorInfo(33)
  FOR n = 0 TO 33 : READ cursorInfo(n) : NEXT
  CALL SETCURSOR(VARPTR(cursorInfo(0)))          'set to pen cursor
  WHILE MOUSE(0) = 0 : WEND                      'wait for button press
  CALL INITCURSOR                                'restore arrow-pointer

'_____ cursor data from MacCursor

DATA 6 , 9 , 25 , 46 , 70
DATA 138 , 276 , 552 , 1104 , 2208
DATA 4352 , 8704 , 9216 , 30720 , 24576
DATA -32768 , 15 , 31 , 63 , 127
DATA 255 , 511 , 1022 , 2044 , 4088
DATA 8176 , 16288 , 32512 , 32256 ,-1024
DATA -2048 , 24576 , 15 , 0
```

FIGURE 2. *Using a cursor defined in MacCursor in a BASIC program*

program, you may not want to or be able to include a disk with the cursor or other graphics information file(s) on it. Putting the cursor information in the program code itself takes up a bit more space but enables the program to stand alone. On the other hand, having code in your program that reads a disk file makes it easy to create and test new cursors simply by saving them under a particular file name and having the program load them. It also allows you to have different BASIC programs access standard cursors. You could even make a library of cursors and put them all in one big disk file. Perhaps the best approach is to have code in your program that first looks for a particular cursor-definition file and loads it if present; if the file isn't found, the cursor is read from a set of DATA statements. We've taken this approach with cursor and other graphics data in some of the game programs in this book to give you the best of both worlds.

How MacCursor works

MacCursor's general structure is based on the idea that the user is always in one of two places: the work (or definition) area, editing cursor pixels, or the play (or test) area, viewing the new cursor. The QuickDraw SETCURSOR routine is used to show the new cursor, while INITCURSOR is used to change it back to the standard pointer (arrow) cursor. As the cursor is defined, three kinds of information are updated in the *cursor* array: the bit patterns indicating the state of every pixel in the array, the bit patterns for the cursor mask, and the y and x coordinates of the hot spot.

One major loop handles each of the areas, and the status is set to the other area as soon as the user leaves either one. Additionally, at any time the user may choose a menu item or press one of the five buttons below the work area. Since all menu items and buttons are independent, they are simply processed by the MenuEvent [ME 0] and ButtonEvent [BE 0] routines as they are encountered.

Understanding how this program works will give you a good grasp of how bit patterns are represented and used. Since many QuickDraw routines use arrays of bit patterns, you'll be well equipped for using these routines in your programs. We'll also show the advantages of using subprograms rather than subroutines for certain functions. A program outline showing the program structure in more detail is shown in Figure 3.

Initialization	
initialize arrays and constants	**Init 1**
define mouse location functions	**Init 2**
create and enable MacCursor menu	**Init 3**
set up output window	**Init 4**
set up initial screen (**DrawScreen**)	SR 2
show hot spot in work area (**ShowHotSpot**)	SR 5
create and enable buttons	**Init 5**
Main Program	
WHILE (endless loop interrupted by menu and button events)	
WHILE pointer in play area	**Main 1**
get pointer position (**GetMouse**)	SR 10
if not in play area, change to work area (**SetWork**)	SR 9
if pointer has moved, show new position (**ShowMousePos**)	SR7
WEND	
WHILE pointer not in play area	**Main 2**
get pointer position (**GetMouse**)	SR 10
if pointer in work area and button down, find corresponding bits and reverse their color/state	
while button down, keep changing bits under pointer (**AffectBits**)	SR 3
if pointer now in play area, reset to play area (**SetPlay**)	SR 8
WEND	
WEND	
Menu Events	
MenuEvent: transfer control to appropriate subroutine	**ME 0**
LoadCursor: load cursor from disk	**ME 1**
SaveCursor: save cursor to disk	**ME 2**
CopyToClip: copy cursor as DATA statements to Clipboard	**ME 3**
Instructions: show instructions	**ME 4**
then redraw screen (**RedrawCursor**)	SR 1

(continued)

FIGURE 3. *Program outline*

BasQuit: quit to BASIC	**ME 5**
DeskQuit: quit to Mac Desktop	**ME 6**
Button Events	
ButtonEvent: transfer control to subroutine	**BE 0**
HotSpot: change location of hot spot	**BE 1**
EraseCursor: erase work area	**BE 2**
BitMode: change between cursor and mask drawing	**BE 3**
CursToMask: make mask same as cursor	**BE 4**
Subroutines	
RedrawCursor:	**SR 1**
redraw screen (**DrawScreen**)	SR 2
update FatBits work area (**ShowFat**)	SR 4
show hot spot location (**ShowSpot**)	SR 6
redisplay hot spot coordinates (**ShowHotSpot**)	SR 5
DrawScreen:	**SR 2**
draw whole screen (except FatBits in work area)	
AffectBits:	**SR 3**
WHILE button is still down:	
get new pointer position	
if pointer in work area:	
reverse corresponding bit	
update cursor array, either cursor or mask	
show FatBit or gray mask outline (**ShowFat**)	SR 4
WEND	
ShowFat: show FatBit for cX and xY	**SR 4**
ShowHotSpot: show with text and graphics where hot spot is	**SR 5**
ShowSpot: invert dot on bit where hot spot is located	**SR 6**
ShowMousePos: show current mouse position	**SR 7**
SetPlay: show what new cursor looks like	**SR 8**
SetWork: reset to regular mouse pointer	**SR 9**
GetMouse: get current mouse status and location	**SR 10**
Subprogram	
PrintPair: print pair of numbers in parentheses	**SP 1**

Figure 3. Program outline (continued)

Initializing screen areas and location functions

All numeric variables in this program are integer (*DEFINT A-Z*). Two main arrays are dimensioned in [Init 1]. The *cursor* array will contain the information the program needs when calling the Macintosh SETCURSOR routine to show a newly defined cursor. This information will also be loaded from or saved to disk as a cursor definition. Figure 4 shows the relationship between the *cursor* array and the cursor and mask patterns.

As the diagram shows, elements 0 through 15 of the *cursor* array contain the actual data that describes how each pixel of the cursor will be displayed. They correspond to rows 0 through 15 in the cursor-definition work area. Recall that each row has 16 positions (small rectangles) representing the pixels in the cursor; and that since the Macintosh represents integers internally as 16-bit binary numbers (with decimal values of −32768 through 32767), we can use the 16 individual bit positions in one integer element of the *cursor* array to represent one row of pixels in the cursor or mask.

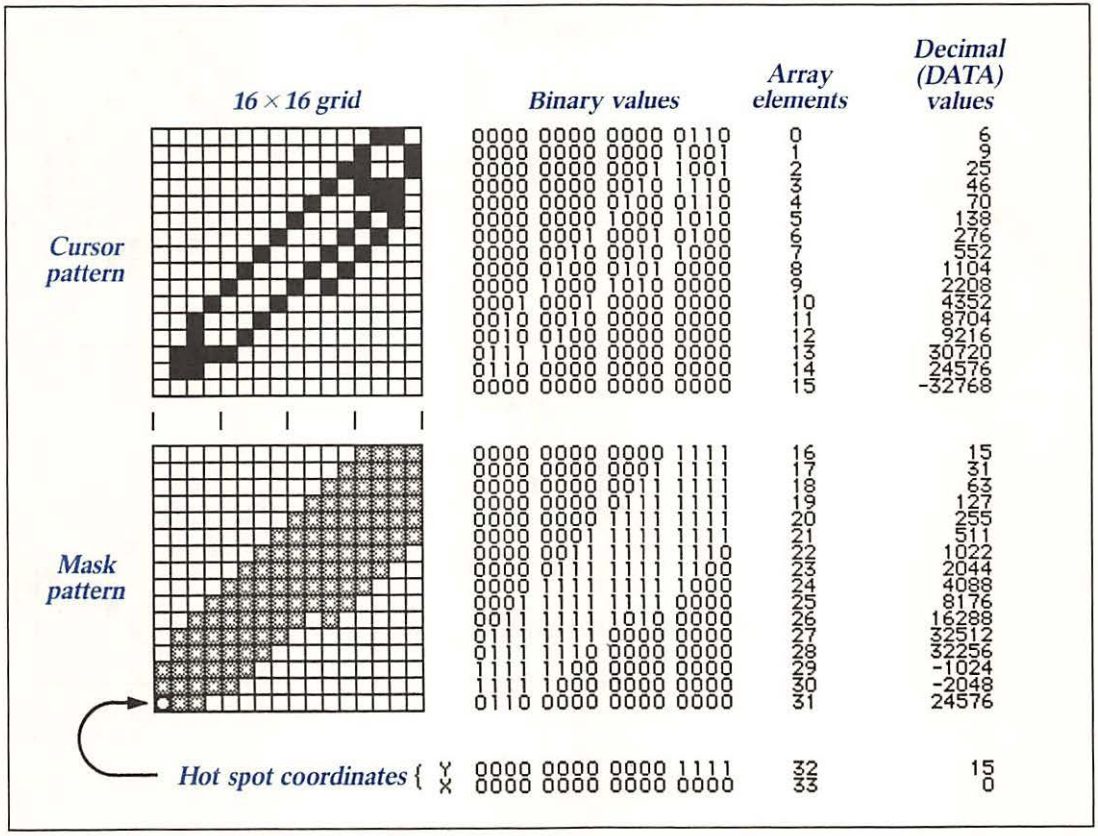


FIGURE 4. *Cursor and mask pixel, bit patterns, and the cursor array*

For example, let's suppose we want the first row, row 0, to have the last four pixels to the right displayed as black. In the binary representation of this row, a 1 is used to indicate a pixel that is black, while a pixel that is white is shown as a 0. Thus, the binary number 0000000000001111 would represent the current state of this row. To make the two center pixels in the next two rows black, the binary value 0000000110000000 would be used for each of these two rows. We have drawn these pixels in black, as shown in Figure 4.

Figure 5 shows some more sample cursor patterns. As a useful exercise, define one of these with MacCursor, then choose the Copy to Clipboard option from the MacCursor menu. Print out the resulting DATA statements and verify the way these values relate to the cursor, mask, and hot-spot values.

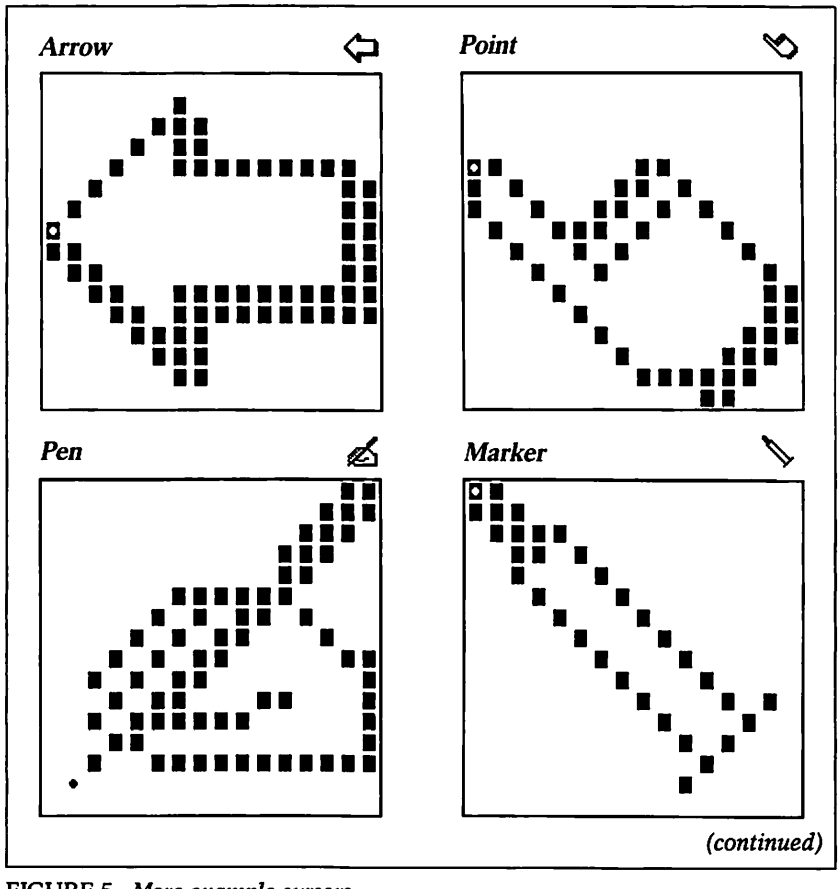


FIGURE 5. *More example cursors*

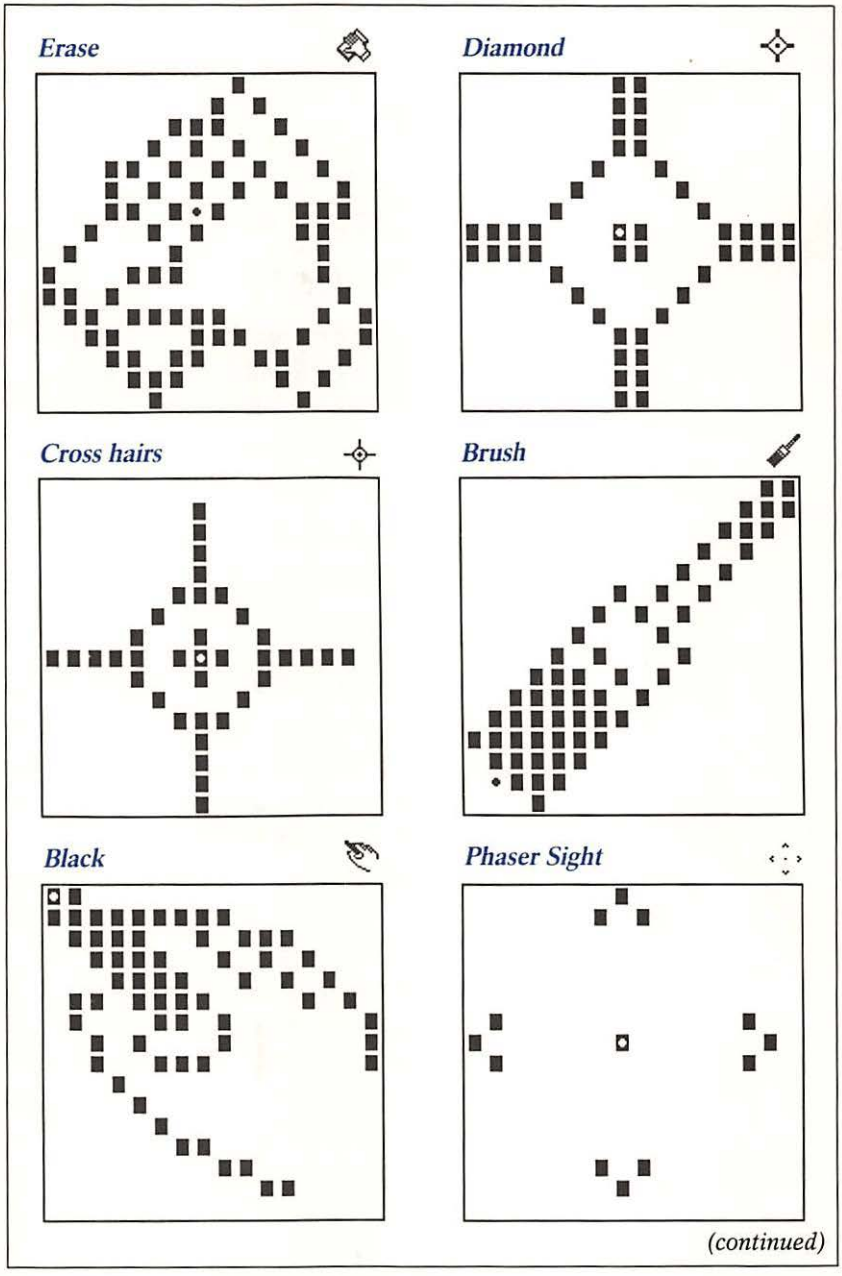


Figure 5. More example cursors (continued)

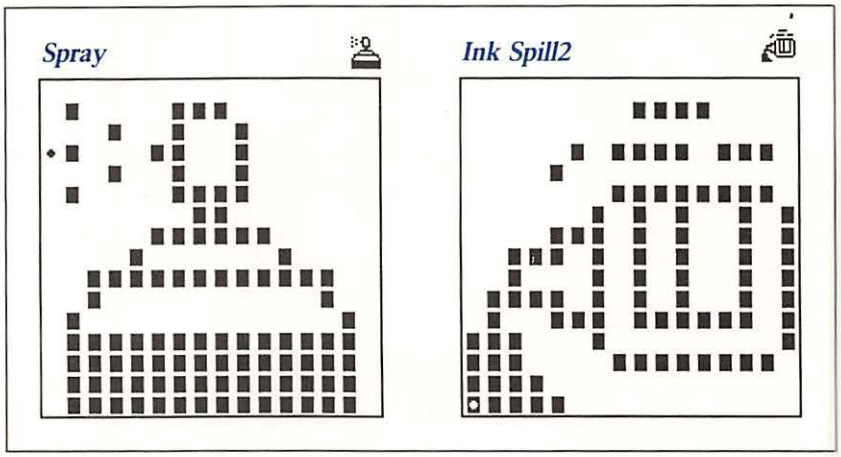


Figure 5. More example cursors (continued)

As the user makes changes by clicking the mouse button with the pointer over different pixel positions, MacCursor updates the *cursor* array by setting each corresponding bit to a 1 if a pixel has been made black or a 0 if it has been made white (erased).

The same scheme is used to represent the mask pixels as they are defined. As we have noted, the mask bit patterns go into elements 16 through 31 of the *cursor* array, and the hot-spot y and x coordinates (relative to the 16-by-16 grid, not the screen) go into elements 32 and 33.

The other main array in MacCursor is the *bitTable* array. This will be used in updating the *cursor* array. Note that this array is initialized in [Init 1] so that each of its elements has only one of its bits set. The first element, *bitTable(0)*, is set to &H8000. If you haven't encountered this kind of notation before, the &H warns you that this is a hexadecimal number. &H8000 corresponds to binary 1000000000000000, or 2 raised to the fifteenth power (2^{15}). The FOR...NEXT loop that follows sets the next element, *bitTable(1)*, to 2 to the fourteenth power (15 – 1), which is binary 0100000000000000, and each of the next elements to the next lower power of 2. Thus element 0 has only its first (counting from the left) bit set, element 1 has only its second bit set, and so on. Later, the elements in the *bitTable* array will be used with logical operators to turn bits in the *cursor* array on or off. We'll get into the gory details later.

The next thing the program initializes is the pattern used to draw gray borders around the mask pixels. As you may recall, a pattern is defined rather like a cursor, except that it has only four lines. The bit patterns for the lines are stored in the four elements of the *gray* array.

Also in [Init 1], three areas of the screen have their coordinates defined as constants: the work area on the left side of the screen, the outer (black) rectangle in the play area on the right side of the screen, and the inner (white) rectangle within the black one. Note the technique of defining coordinates in terms of previously defined ones. The cross hair where the X and Y reference lines meet has its coordinates derived simply by adding the left and right x coordinates of the play area and dividing by two, then doing the same for the y coordinates.

Three functions are defined in [Init 2]. InBits tells us whether the mouse pointer is in the work area, and InPlay does the same for the play area. The screen coordinates passed to the functions are simply checked to see whether they're within the appropriate borders. We'll describe BitOn later when it's used. As you've seen if you've looked at some of our games, functions that return logical values like these do are very useful because they can be used directly in a test (such as IF...THEN) to perform the appropriate action.

In [Init 3] the MacCursor menu is set up, and menu events are enabled by the ON MENU GOSUB statement. The MenuEvent subroutine [ME 0] handles all menu events. The Output window is specified next [Init 4], and then the startup screen is drawn. First DrawScreen [SR 2] is called to draw the boxes for the work area and the play area, including the inner white rectangle for the latter. It also displays the X and Y crosshair reference lines and prints the various text labels needed.

A neat little trick is used here to print the "*X*=" and "*Y*=" labels for the reference lines: The values of their respective coordinates (*hX* and *hY*) are converted to strings and then printed after being formatted with the RIGHT$ function. This makes for a tidy display by eliminating unnecessary digits like leading zeroes and trailing spaces that BASIC would otherwise throw at you.

Next, ShowHotSpot [SR 5] is called to display the current location of the hot spot just below the work area. *cursor(33)*, the x coordinate, is printed before *cursor(32)* so the screen will display the more usual (x,y) order. To print the coordinates, ShowHotSpot calls a little *subprogram*, PrintPair [SP 1], which is another example of string formatting—and also of the usefulness of subprograms. If we used a subroutine rather than a subprogram, we'd have to assign the string we're working with to the global string variable the subroutine is expecting to manipulate. We then might have to assign the formatted string back to the variable being used by the calling routine. With a subprogram, we simply pass the name of the string variable in parentheses after the *CALL PrintPair;* the subprogram

processes it, and we get a properly formatted pair of coordinates without having to use any assignment statements. Again note that numbers to be printed behave better when they're converted to strings and then manipulated with string functions than if they're left as numbers.

After printing the hot-spot coordinates, ShowHotSpot calls ShowSpot [SR 6]. This subroutine gets the position in the work area that corresponds to the hot-spot coordinates and inverts a dot there to mark it.

Control now comes all the way back to [Init 5], which sets up the five buttons under the work area and enables dialog handling. The subroutine ButtonEvent [BE 0] will (surprise!) handle button events.

The main program

The main program is an endless loop that is exited only by one of two Quit menu events, [ME 5] or [ME 6]. We'll describe later how each menu event and each button event is processed. First, though, let's look at MacCursor's default activity, which is handled by getting the mouse-pointer position and determining which of two activities the user is engaged in: drawing the cursor or mask by clicking bits on and off in the work area, or "playing with" or testing the cursor in the play area. Initially it is assumed that the mouse pointer is in the work area and that the user wants to define the cursor before defining the mask. Thus, *inPlayArea* and *affectMask* are set to false in [Init 1] prior to the beginning of the main program, and control falls through to the loop at [Main 2].

Work area activity

The WHILE...WEND loop in [Main 2] handles the cursor-drawing activities. First, the mouse-pointer position is checked by calling GetMouse [SR 10]. This subroutine returns the mouse state in *status*. Then an IF...THEN statement checks for the mouse button being down *(status < 0)* and the mouse being in the work area, the latter check being made with the InBits function defined in [Init 2]. If the mouse button is down and the mouse pointer is in the work area, the user wants to change the cursor pixel represented by the little rectangle under the pointer. In preparation for doing that, the specific bit that corresponds to the pointer location is found by dividing the mouse x and y coordinates by the size of the little rectangles (10).

Manipulating cursor pixels and bits

Now we're ready for some fairly complicated bit manipulation. It would be tempting to use a two-dimensional array and store the states of the cursor and mask bits in it, but using a whole array element to store the on/off (1/0, black/white) value of one pixel would waste a lot of memory. Applications dealing with areas of the screen larger than 16 by 16 pixels would soon run out of memory. Also, the Macintosh SETCURSOR routine, like many other QuickDraw routines, expects an array of binary bit patterns. Thus, it makes more sense to work directly with the bit patterns, even though they're harder to understand at first.

To make what follows clearer, let's assume that the user has clicked on the fourth rectangle from the left in row 2. This rectangle has an x coordinate (*cX*) of 3 and a y coordinate (*cY*) of 1, since the coordinates start with 0. (Remember that these are coordinates in the 16-by-16 work area and are derived by division from the mouse pointer's screen coordinates.) Since the user wants to reverse the color of this pixel, we want to "flip" the bit that represents the pixel to its opposite state. In other words, if it's a 1 we want to make it a 0, or vice versa.

The BitOn function defined in [Init 2] will return a true value if the bit (or pixel) under the mouse pointer is a 1 (that is, if it's black). If you look back at [Init 2], you'll see that BitOn compares the value of the *cursor* array element for the row the bit is in (*cY*) with the *bitTable* element for the column the bit is in (*cX*)—in this case *bitTable(3)*. Recall that we set up *bitTable* so that each element has only one bit—the bit corresponding to the column number, counting from the left with 0—set to 1 [Init 1], so *bitTable* element 3 has the bit pattern 0001000000000000. *cursor* array element 1 may have any combination of 1s and 0s, but we're interested only in the bit at *cY*, which we can represent as X, or 000X000000000000.

Another complication is that the pixel under the pointer may be part of either the cursor itself or the mask. This is why, when BitOn is called, the value of the cryptic expression *16 * −affectMask* is added to the value of *cY*. If the user has clicked on the Mask button, *affectMask* will be *true* (−1). Since −(−1) = 1, and 16 * 1 = 16, the value of *cY* will have 16 added to it, offsetting it into the Mask portion of the cursor array. Otherwise, if the user has not clicked the Mask button, *affectMask* will be *false* (0) and *cY* will stay in the cursor area of the array (elements 0 through 15).

The AND logical operator is used to make the comparison between the *cursor* array element and the *bitTable* element. With AND, if the two bits being compared are both 1, the result is 1, but if one of the bits is a 0, the result is 0. So, if the X bit in the *cursor* array element is 1, the AND leaves it 1 because the comparison bit in *bitTable(3)* is also 1; if it is 0, the AND leaves it 0.

If, after the AND comparison has been done and the BitOn function returns true indicating the bit is 1 (black), we set *turnOn* to *false* so we can flip the bit to 1 (white). If BitOn returns false indicating the bit is 0, we set *turnOn* to *true* so we can flip it to 1. We have finally gotten the effect we wanted, and we're ready to change the bit, and therefore the pixel, to its opposite state.

We realize that all of this can be heavy going for those of you who haven't dealt with binary numbers or assembly language. If what's happening still isn't clear to you, we suggest rereading our description of the *cursor* and *bitTable* arrays, the description of the cursor routines and logical operators in the Microsoft BASIC manual, and Chapter 15, "QuickDraw," in *Microsoft Macinations* (Microsoft Press, 1985).

After *turnOn* has been set, AffectBits [SR 3] is called. This subroutine is a loop that will run as long as the mouse button is being held down in the work area. This feature allows the user to draw a line across the work area by dragging the mouse. AffectBits gets the mouse-pointer location and checks to make sure the pointer is still in the work area. If it's not, the subroutine returns control to the main program loop. Otherwise, the procedure we've just discussed is followed to get the location of the mouse pointer in the work area and offset *cY* if the program is in the mask-definition mode.

As you recall, we've already determined whether we need to set the pixel to black or white and have set *turnOn* accordingly. If *turnOn* is *true* (that is, the bit is 0), AffectBits now sets the bit to 1 (black) by ORing it with the number from *bitTable,* which we've learned has this bit set to 1. If you OR a 0 with a 1 you get a 1, since OR results in 1 if either bit is a 1, so this bit in the *cursor* array element corresponding to the row becomes a 1.

If *turnOn* is *false* (that is, the bit is 1), we want to turn the 1 off (make it a 0). The way we chose to do this is to AND it with a 0, since 1 AND 0 gives you 0 (remember, AND needs both bits to be 1 to result in 1). How do we make sure we are ANDing it with a 0?

We guarantee that there'll be a 0 bit in the corresponding position of the *bitTable* number if you NOT the *bitTable* number. The NOT logical

operator reverses the state of every bit in the number. Since the *bitTable* number has a 1 in the position we're interested in, the result of the NOT gives a number with a 0 in that position. That number, when ANDed with the *cursor* array number, makes the latter's bit a 0 (a white pixel).

After updating the information in the *cursor* array, AffectBits calls the ShowFat (for "show FatBit") subroutine [SR 4] to update the work area display using appropriate QuickDraw routines. ShowFat gets the boundaries for the rectangle of the graphic to be drawn and stores them in the graphics rectangle array *r*. If the bit for the pixel is now a 1 and if it belongs to the mask (*cY*) is offset by 16), a call to FILLRECT fills the rectangle with the gray pattern. Otherwise, the rectangle is erased with a call to ERASERECT.

Next, the graphics boundary is drawn a little smaller on each side and BitOn is again checked, this time to see if the corresponding cursor bit is on. If it is, the PAINTRECT call draws the black rectangle representing the pixel. If the pixel is supposed to be white, an ERASERECT erases the rectangle. The rectangle for the cursor bit is a little smaller than the one used for the mask bit, so a gray border remains if the pixel is also a mask pixel. Since a pixel that is represented in the work area can be a cursor and/or a mask pixel, two rectangles are therefore needed in order to show the right combination.

If the current location is also the location of the hot spot, the hotspot circle needs to be redrawn, so ShowSpot [SR 6] is called to accomplish that. We've already described how this subroutine works.

Control now returns to the WHILE...WEND loop in AffectBits, and changes continue to be processed as long as the mouse button is down. When the mouse button is no longer down, control returns to the outer *NOT inPlayArea* loop at [Main 2], and the mouse is checked until the button is pushed again or the mouse pointer is moved into the play area. This latter situation is determined by checking the function InPlay at the bottom of the loop. When this function returns a true value, SetPlay [SR 8] is called. SetPlay sets *inPlayArea* to *true* and finally calls the QuickDraw SETCURSOR routine to display the cursor as it is currently defined in the *cursor* array.

Since *inPlayArea* is now *false*, control goes all the way back to the top of the main program loop. Since the outermost WHILE...WEND loop will continue indefinitely until we choose Quit from the MacCursor menu, the loop for *inPlayArea* is executed.

Play area activity

While the mouse pointer is in the play area, the pointer position is obtained via GetMouse. If the InPlay function returns a *false* value, SetWork [SR 9] sets the variable *inPlayArea* to *false* and restores the standard pointer (arrow) cursor by a call to the Macintosh INITCURSOR routine. Next, if the pointer position has changed, ShowMousePos [SR 7] is called to show the current mouse-pointer position by printing its coordinates using the PrintPair subprogram. Control then falls through the bottom of the WHILE...WEND loop, and the *WHILE NOT inPlayArea* loop we discussed in the last section is executed again.

Button events

Button events (the user clicking on any of the five buttons below the work area) are handled by the ButtonEvent subroutine [BE 0], which first checks the DIALOG(0) function to make sure a button press rather than some other kind of dialog event has occurred. If a button press has occurred, the MacCursor menu bar is dimmed so the user can't try to make a menu selection while the button selection is being processed. The first two buttons, which involve fairly time-consuming procedures, are also deactivated and dimmed for the same reason.

If the HotSpot button was pressed, HotSpot [BE 1] is called. This subroutine first calls ShowSpot [SR 6] to erase the current hot-spot circle after getting its screen coordinates from *cursor(32)* and *cursor(33)* and converting them to the corresponding FatBits work-area coordinates. The coordinates of the former hot spot are then erased from the display below the work area by printing a string of blanks over them. A WHILE...WEND loop next waits for the mouse button to be pressed, indicating where the user wants to put the new hot spot. When the button is pressed, the InBits function is checked to see if the pointer is in the work area: If it isn't, a beep is sounded and control goes back up to the WHILE...WEND loop to wait for another button press. If the pointer is in the work area when the button is pressed, the pointer coordinates are converted to their corresponding cursor coordinates (by now, a familiar operation), which are then placed in *cursor(33)* and *cursor(32)* to update the *cursor* array. A second WHILE...WEND loop waits until the user has stopped pressing the mouse button if the user hasn't released the button yet. A sound then indicates that the hot spot has been set, and ShowHotSpot [SR 5] is called to show the new hot spot. Control returns to ButtonEvent, where the menu and buttons are reactivated before return to the main program loop.

The next button that could have been pressed is the Erase button. If it's pressed, EraseCursor [BE 2] is then called. This subroutine uses a FOR...NEXT loop to set the elements of the *cursor* array (except the coordinates of the hot spot) to 0, clearing out the bit pattern that defines the cursor and mask. DrawScreen [SR 2] is then called. This subroutine redraws all the screen except the pattern that was in the work area. Next, EraseCursor calls ShowHotSpot [SR 5] to draw the circle representing the current hot-spot position, and control then returns to ButtonEvent [BE 0].

The other three button events are quite simple. The Cursor and Mask buttons control whether the cursor or the mask is currently being edited. Clicking on either button calls BitMode [BE 3]. This subroutine uses the BUTTON statement with a 2 to show the button that was clicked as being selected (with a black circle in its center). Since the Cursor and Mask buttons are numbers 3 and 4, subtracting the pressed button from 7 gets you the other button, which is shown as blank (not selected) by a BUTTON statement with a 1. The value of the Boolean variable *affectMask* is set to *true* (or −1) if button 4 (Mask) was pressed; otherwise it is set to *false* (or 0). Remember that an expression like *pressed* = *4* is itself Boolean, since it will be either true or false, so the value of such an expression can be assigned to a variable.

The last button event occurs when the user clicks on the Cursor −> Mask button, which calls the CursToMask subroutine [BE 4]. This simply uses a loop to copy elements 0 through 15 of the *cursor* array into elements 16 through 31 (the mask elements). RedrawCursor [SR 1] is then called. This subroutine first calls DrawScreen [SR 2] to redraw all the screen except the pattern that was in the work area. RedrawCursor redraws the cursor pattern in the work area with two nested FOR...NEXT loops. The outer loop takes one row (one work-area y coordinate) and the inner loop takes one column (one work-area x coordinate) at a time from the current row; thus the whole grid is processed bit by bit.

The BitOn function is used to check whether either the cursor bit or the mask bit at a given location is a 1. If it is, ShowFat [SR 4] is called to draw the appropriate representation. Since in this case RedrawCursor was called by EraseCursor, the bits in the *cursor* array have been set to 0, so ShowFat erases (fills with white) all the little rectangles in the work area. Finally, RedrawCursor calls ShowHotSpot [SR 5] to draw the circle representing the current hot-spot position, and control then returns to CursToMask. The latter has nothing more to do, and so control goes back to ButtonEvent [BE 0].

After any button event has been processed, ButtonEvent [BE 0] concludes by reactivating the menu bar and the buttons so the user can make a new menu or button selection if desired. Whatever activity was interrupted by the event now resumes.

Menu events

There are six possible menu events, all handled by MenuEvent [ME 0]. This subroutine deactivates the menu, calls the appropriate subroutine, and then reactivates the menu. The events and their subroutines need only brief discussion.

LoadCursor [ME 1] gets the name of a file containing the cursor definition via the FILES$ function. FILES$ is used with the file attribute *"Curs,"* so that only cursor file names will appear in the FILES$ dialog box. The file is opened, its contents are read into the *cursor* array, and RedrawCursor [SR 1] is then called to show the cursor.

SaveCursor [ME 2] uses FILES$ to ask for a file name, opens this file, sets its file attribute to *"Curs"* and saves the contents of the *cursor* array in it. Again, RedrawCursor must be called to redraw the cursor, because part of it was obliterated by the file dialog box.

CopyToClip [ME 3] opens the Macintosh Clipboard file (as text), prints an identifying comment, and then prints the values of the elements of the *cursor* array as decimal integers in a series of DATA statements. Every fifth data value (when n *MOD* $5 = 0$) has a carriage return and the word DATA printed to start a new line. The "" is a null string required by the syntax of the PRINT# statement: If you were printing to the screen, you could use just PRINT by itself to print a carriage return.

Instructions [ME 4] prints a window with brief instructions on how to use MacCursor. It uses INITCURSOR to restore the normal cursor, then creates a Continue button. The instructions are shown until that button is pressed. The button and the window are then closed, and the screen is redrawn via RedrawCursor.

There's a lesson behind the call to RedrawCursor. If the instructions were selected at the start of the session, there's nothing in the work area, but it's unwise to assume that a menu event will be selected only at a particular time. The user might want to review the instructions at any time, and something may therefore be in the work area. Whenever you

activate a menu or a button, you as programmer are responsible for properly handling the selection(s) represented and restoring the user to the expected environment afterward. Here, this means making sure that the user does not lose whatever may have been in the work area.

BasQuit [ME 5] and DeskQuit [ME 6] are our standard exit routines. Note that they close the two buttons and reset the menu to restore the normal BASIC- or Macintosh-desktop environment and free up the memory used for the menu and buttons.

Suggestions for MacCursor

Since we've given you a lot of material to digest in this chapter, we'll simply suggest that you create some cursors and experiment with them. You may find it useful to add FatBits-like features to your own programs by using routines similar to ours. For example, you could write a program that would allow a user to create a custom graphics character set, edit it, and save and load it from disk.

MacCursor program listing

```
'*****************************************************************
'                          MacCursor
'                   Creates custom cursors
'*****************************************************************

'************************************************** INITIALIZE
DEFINT A-Z
DIM r(3)                              'used for temporary rectangle storage
DIM gray(3)                           'gray pattern for QuickDraw
DIM cursor(33)                        'cursor data
DIM bitTable(15)                      'bit array lookup table

bitTable(0) = &H8000                  'set one bit in each element of bitTable
FOR n = 1 TO 15
  bitTable(n) = 2 ^ (15 - n)
NEXT

FOR n = 0 TO 3                        'initialize gray pattern
  gray(n) = &HAA55
NEXT

false = 0 : true = NOT false          'logical constants
inPlayArea = false : affectMask = false

bX1 = 10 : bY1 = 30                   'coordinates for cursor box
bX2 = bX1 + 159 : bY2 = bY1 + 159
pX1 = 245 : pY1 = 65                  'coordinates for play area
pX2 = 445 : pY2 = 165
hX = (pX1 + pX2) / 2                  'coordinates for cross-hairs
hY = (pY1 + pY2) / 2

                                      'InBits returns true if (fX,fY) is in work area
DEF FN InBits(fX,fY) = (fX >= bX1 AND fX <= bX2 AND fY >= bY1 AND fY <= bY2)
                                      'InPlay returns true if (fX,fY) is in play area
DEF FN InPlay(fX,fY) = (fX >= pX1 AND fX <= pX2 AND fY >= pY1 AND fY <= pY2)
                                      'BitOn returns true if bit at (fX,fY) in cursor is ON
DEF FN BitOn(fX,fY) = ((cursor(fY) AND bitTable(fX)) <> 0)

MENU 6, 0, 1, "MacCursor"             'add MacCursor menu to menu bar
MENU 6, 1, 1, "Load"
MENU 6, 2, 1, "Save"
MENU 6, 3, 1, "Copy to Clipboard"
MENU 6, 4, 1, "Instructions"
MENU 6, 5, 0, "-"
MENU 6, 6, 1, "Quit to BASIC"
MENU 6, 7, 1, "Quit to Desktop"
ON MENU GOSUB MenuEvent : MENU ON     'enable menu event trapping
```

INIT 1

INIT 2

INIT 3

INIT 4

```
  WINDOW 1, "", (10,28) - (502,332), 4                    'define window
  GOSUB DrawScreen                                        'set up initial screen
  GOSUB ShowHotSpot
                                                          'define buttons
```

INIT 5

```
  BUTTON 1, 1, "HotSpot", (bX1 + 5, bY2 + 20) - (bX1 + 75, bY2 + 40)
  BUTTON 2, 1, "Erase", (bX1 + 85, bY2 + 20) - (bX1 + 155, bY2 + 40)
  BUTTON 3, 2, "Cursor", (bX1 + 5, bY2 + 70) - (bX1 + 75, bY2 + 90), 3
  BUTTON 4, 1, "Mask", (bX1 + 85, bY2 + 70) - (bX1 + 155, bY2 + 90), 3
  BUTTON 5, 1, "Cursor -> Mask", (bX1 + 5, bY2 + 45) - (bX1 + 155, bY2 + 65)
  ON DIALOG GOSUB ButtonEvent : DIALOG ON          'enable button event trapping

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * MAIN PROGRAM
```

MAIN 1

```
  WHILE true                        'only way out is by BasQuit or DeskQuit menu event
    WHILE inPlayArea                                      'while pointer is in play area
      GOSUB GetMouse
      IF NOT FN InPlay(mX,mY) THEN GOSUB SetWork
      IF mX <> oldX OR mY <> oldY THEN GOSUB ShowMousePos
    WEND
```

MAIN 2

```
    WHILE NOT inPlayArea                          'while the pointer isn't in play area
      GOSUB GetMouse
      IF status > -1 OR NOT FN InBits(mX,mY) THEN NotDown
      cX = INT((mX - bX1) / 10)                                  'pointer is in work area
      cY = INT((mY - bY1) / 10)                                'find which bit pointer is on
                                                    'set turnOn to opposite of current bit
      turnOn = NOT FN BitOn(cX, cY + 16 * -affectMask)
      GOSUB  AffectBits                                    'affect each bit under pointer
NotDown:
      IF FN InPlay(mX,mY) THEN GOSUB SetPlay
    WEND                                                   'end while not in play area
  WEND

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * MENU EVENTS
```

ME 0

```
MenuEvent:
  MENU 6, 0, 0                                                        'disable menu
  item = MENU(1)
  ON item GOSUB LoadCursor, SaveCursor, CopyToClip, Instructions, , BasQuit, DeskQuit
  MENU 6, 0, 1
  RETURN
```

ME 1

```
LoadCursor:          '_____________________________________ retrieve saved cursor
  file$ = FILES$(1,"TEXT")                                  'list only "TEXT" file types
  IF file$ = "" THEN NoLoad                                 'user clicked on Cancel button
  OPEN file$ FOR INPUT AS #1
  FOR n = 0 TO 33
    INPUT #1, cursor(n)
  NEXT
  CLOSE #1
```

```
NoLoad:
  GOSUB RedrawCursor
  RETURN
```

ME 2

```
SaveCursor:          '_____ save array to disk file
  file$ = FILES$(0, "File name?")
  IF file$ = "" THEN NoSave
  OPEN file$ FOR OUTPUT AS #1
  NAME file$ AS file$, "TEXT"                    'use "TEXT" file type
  FOR n = 0 TO 33
    PRINT #1, cursor(n)
  NEXT
  CLOSE #1
NoSave:
  GOSUB RedrawCursor
  RETURN
```

ME 3

```
CopyToClip:          '_____ copies DATA statements to Clipboard
  OPEN "CLIP:TEXT" FOR OUTPUT AS #1
  PRINT #1, "'_____ cursor data from MacCursor"
  FOR n = 0 TO 33
    IF (n MOD 5) = 0 THEN PRINT #1, "" : PRINT #1, "Data "; ELSE PRINT #1, "," ;
    PRINT#1, cursor(n);
  NEXT
  PRINT #1, ""
  CLOSE #1
  RETURN
```

ME 4

```
Instructions:        '_____ show user some instructions
  WINDOW 2, , (16,55) - (495,325), 2
  PRINT "                    Instructions for MacCursor"
  PRINT
  PRINT " Design a cursor by defining the following three cursor components:"
  PRINT "  1. Define the shape of a cursor by selecting 'Cursor' and clicking bits "
  PRINT "     in the work area."
  PRINT "  2. Design a mask for the cursor shape by selecting 'Mask'.  As mask "
  PRINT "     bits are turned on, they will appear as gray frames around their"
  PRINT "     corresponding cursor bits."
  PRINT "  3. Select 'HotSpot' and click  on a bit of the cursor to place the hot "
  PRINT "     spot."
  PRINT "
  PRINT "    The rules governing the final appearance of the masked cursor are "
  PRINT "  listed at the bottom right corner of the screen.  Try out your "
  PRINT "  developing cursor in the black and white play area.  A cursor may be "
  PRINT "  saved to a disk file or to the Clipboard as DATA statements."

  CALL INITCURSOR
  BUTTON 1, 1, "Continue", (190,240) - (280,260)
  WHILE DIALOG(0) <> 1 : WEND
  BUTTON CLOSE 1 : WINDOW CLOSE 2
  GOSUB RedrawCursor
  RETURN
```

```
BasQuit:                '_____________________________________ quit to BASIC
  FOR n = 1 TO 5 : BUTTON CLOSE n : NEXT
  MENU RESET
  END

DeskQuit:               '_____________________________________ quit to Mac Desktop
  FOR n = 1 TO 5 : BUTTON CLOSE n : NEXT
  MENU RESET
  SYSTEM

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * BUTTON EVENTS
ButtonEvent:
  IF DIALOG(0) <> 1 THEN NotButton                    'wasn't button event, ignore it
    pressed = DIALOG(1)
    MENU 6, 0, 0 : BUTTON 1,0 : BUTTON 2,0
    ON pressed GOSUB HotSpot, EraseCursor, BitMode, BitMode, CursToMask
    MENU 6, 0, 1 : BUTTON 1,1 : BUTTON 2,1
  NotButton:
  RETURN

HotSpot:                '_____________________________ change location of hot spot
  GOSUB ShowSpot                                    'erase current hot spot (XOR)
  CALL MOVETO(bX1 + 20, bY2 + 15)
  PRINT "                    "; :                   'erase hot spot numbers
NotHot:
  WHILE MOUSE(0) > -1 : WEND                        'wait for mouse button press
  IF NOT FN InBits(MOUSE(1), MOUSE(2)) THEN BEEP : GOTO NotHot

  iX = INT((MOUSE(1) - bX1 - 1) / 10)               'calc. cursor coordinates
  iY = INT((MOUSE(2) - bY1 - 1) / 10)               'from current pointer position
  cursor(33) = iX : cursor(32) = iY                 'set hot spot
  WHILE MOUSE(0) < 0 : WEND                         'in case user holds down button too long
  SOUND 5000,1
  GOSUB ShowHotSpot                                 'show new hot spot
  RETURN

EraseCursor:            '_____________________________ clear out old cursor
  FOR n = 0 TO 31 : cursor(n) = 0 : NEXT            'clear out array
  file$ = ""                                        'clear filename
  GOSUB DrawScreen                                  'and refresh screen
  GOSUB ShowHotSpot
  RETURN

BitMode:                '_____________________ set bitmode to either cursor or mask
  BUTTON pressed,2                                  'set pressed button on
  BUTTON 7 - pressed, 1                             'and other button off
  affectMask = (pressed = 4)
  RETURN
```

ME 5

ME 6

BE 0

BE 1

BE 2

BE 3

BE 4
```
CursToMask:                 '_____ copy cursor to mask
  FOR n = 0 TO 15
    cursor(n + 16) = cursor(n)
  NEXT
  GOSUB RedrawCursor
  RETURN

'********************************************** SUBROUTINES
```

SR 1
```
RedrawCursor:               '_____ use array to redraw screen and work area
  GOSUB DrawScreen                                    'redraw screen
  FOR cY = 0 TO 15                                    'and set individual bits
    FOR cX = 0 TO 15
      IF FN BitOn(cX,cY) OR FN BitOn(cX, cY + 16) THEN GOSUB ShowFat
    NEXT cX
  NEXT cY
  x = cursor(33) : y = cursor(32)
  IF FN BitOn(x,y) OR FN BitOn(x, y + 16) THEN GOSUB ShowSpot
  GOSUB ShowHotSpot
  RETURN
```

SR 2
```
DrawScreen:                 '_____ draw whole screen except fatbits in work area
  CLS
  CALL TEXTFONT(0)
  CALL TEXTMODE(1) : CALL TEXTSIZE(24) : CALL TEXTFACE(8)
  CALL MOVETO(330,30) : PRINT "MacCursor"
  CALL TEXTMODE(0) : CALL TEXTSIZE(12) : CALL TEXTFACE(0)
  CALL MOVETO(8,20) : PRINT "File name..." file$
  LINE (bX1 - 1, bY1 - 1) - (bX2 + 1, bY2 + 1), , b          'bit border
  LINE (pX1, pY1) - (pX2, pY2), , bf                  'display black section
  LINE (pX1 + 50, pY1 + 25) - (pX2 - 50, pY2 - 25), white, bf   'also white
  LINE (hX, pY1 - 30) - (hX, pY2)                     'cross-hairs
  LINE (pX1 - 50, hY) - (pX2, hY)
  CALL TEXTMODE(1)
  CALL MOVETO(hX + 5, pY1 - 10) : PRINT "X ="; RIGHT$(STR$(hX), 3)
  CALL MOVETO(pX1 - 50, hY - 10) : PRINT "Y ="; RIGHT$(STR$(hY), 3)
  CALL MOVETO(pX1 + 10, pY2 + 15)
  PRINT "Mouse Position: "
  CALL MOVETO(0,210) : CALL TEXTFACE(4)
  PRINT TAB(25) "Cursor Bit" TAB(35) "Mask Bit" TAB(45) "Resulting Pixel"
  CALL TEXTFACE(0)
  PRINT TAB(25) "White" TAB(35) "Black" TAB(45) "Always white"
  PRINT TAB(25) "Black" TAB(35) "Black" TAB(45) "Always black"
  PRINT TAB(25) "White" TAB(35) "White" TAB(45) "Same as screen"
  PRINT TAB(25) "Black" TAB(35) "White" TAB(45) "Inverse of screen";
  CALL TEXTMODE(0)
  RETURN
```

SR 3
```
AffectBits:                 '_____ while mouse button is down, track it and affect bit
'under current pointer position: if turnOn is true then set to 1, else set to 0
  WHILE MOUSE(0) < 0
    x = MOUSE(1) : y = MOUSE(2)
    IF NOT FN InBits(x,y) THEN NotInBox
```

```
    cX = INT((x - bX1) / 10)
    cY = INT((y - bY1) / 10) : tY = cY
    IF affectMask THEN tY = tY + 16                    'affecting mask bits
                                                       'first, affect bit in cursor array
    IF turnOn THEN cursor(tY) = cursor(tY) OR bitTable(cX)
    IF NOT turnOn THEN cursor(tY) = cursor(tY) AND NOT bitTable(cX)
    GOSUB ShowFat
NotInBox:
  WEND
  RETURN

ShowFat:              '_____ show fatbit for cX and xY                    SR 4
  r(0) = 10 * cY + bY1 : r(1) = 10 * cX + bX1
  r(2) = r(0) + 10 : r(3) = r(1) + 10
  IF FN BitOn(cX, cY + 16) THEN CALL FILLRECT(VARPTR(r(0)), VARPTR(gray(0)))
  IF NOT FN BitOn(cX, cY+16) THEN CALL ERASERECT(VARPTR(r(0)))

  r(0) = r(0) + 1 : r(1) = r(1) + 2
  r(2) = r(2) - 1 : r(3) = r(3) - 2
  IF FN BitOn(cX,cY) THEN CALL PAINTRECT(VARPTR(r(0)))
  IF NOT FN BitOn(cX,cY) THEN CALL ERASERECT(VARPTR(r(0)))
                                                   'if this is where hot spot is, then draw dot
  IF cX = cursor(33) AND cY = cursor(32) THEN GOSUB ShowSpot
  RETURN

ShowHotSpot:          '_____ show with text & graphics where hot spot is  SR 5
  CALL MOVETO(bX1 + 20, bY2 + 15)
  PRINT "HotSpot:   ";
  CALL PrintPair(cursor(33), cursor(32))
  GOSUB ShowSpot
  RETURN

ShowSpot:             '_____ invert dot on bit where hot spot is          SR 6
  r(0) = cursor(32) * 10 + bY1 + 3 : r(1) = cursor(33) * 10 + bX1 + 3
  r(2) = r(0) + 4 : r(3) = r(1) + 4
  CALL INVERTOVAL(VARPTR(r(0)))
  RETURN

ShowMousePos:         '_____ show current mouse position                  SR 7
  CALL MOVETO(pX1 + 10 + WIDTH("Mouse Position:   "), pY2 + 15)
  CALL PrintPair(mX,mY)
  RETURN

SetPlay:              '_____ show what new cursor looks like              SR 8
  inPlayArea = true
  CALL SETCURSOR(VARPTR(cursor(0)))
  RETURN

SetWork:              '_____ reset to regular mouse pointer               SR 9
  inPlayArea = false
  CALL INITCURSOR
  RETURN
```

SR 10

```
GetMouse:                '_____ get current mouse status and location
   status = MOUSE(0)
   oldX = mX : oldY = mY                              'save old mouse values
   mX = MOUSE(1) : mY = MOUSE(2)
   RETURN
```

SP 1

```
SUB PrintPair(num1,num2) STATIC                       'print pair of numbers in parens
   temp1$ = STR$(num1)
   temp2$ = STR$(num2)
   PRINT "(" RIGHT$(temp1$, LEN(temp1$) - 1) ",";
   PRINT RIGHT$(temp2$, LEN(temp2$) - 1) ")";
   END SUB
```

MacConvert

No, MacConvert won't change your religion: What it will *do is convert your Microsoft BASIC 1.0 programs for the Mac to the enhanced, version 2 series. "What's the point?" you might ask. That question is best answered by comparing the two versions of BASIC. Once you understand version 2's improvements you'll want MacConvert in your arsenal of utility programs.*

A little BASIC history

When Microsoft first brought out BASIC for the Macintosh, it chose to present a version that mimicked those it had developed for earlier computers, such as the IBM PC and Apple II. These versions had been in use for several years, and although they were popular, they lacked certain features that make other languages such as Pascal so appealing.

Probably the single biggest drawback of earlier versions of BASIC is their requirement that each line in the program be preceded by a number. This necessity presents several problems. First, it's a nuisance to type in a number for each program line and then keep track of all these numbers, because if you insert a line into an existing segment of code, you have to make sure the number falls in the right place. (Although some versions of numbered BASICs offer automatic line numbering, they don't always solve the problem: If you set up a special routine to start at line 3000, and BASIC renumbers the program, you may find that it now starts at line 2095 or 3015, which really plays havoc with GOSUB and GOTO statements that must specify line numbers.)

But besides the mechanical difficulties presented by numbered BASICs, they suffer from a fundamental *conceptual* flaw, which is that they don't convey much information about what tasks specific sections of the program perform. The statement *IF NOT TRUE THEN GOSUB 2350*, for example, doesn't tell us very much, other than that a test is being performed and a subroutine of some sort will be called if the result is false. On the other hand, the statement *IF NOT true THEN GOSUB RecoverFromError* describes what kind of activity will be performed if the result of the test is false.

Microsoft solved these problems with the version 2 series of BASIC by eliminating line numbers. Now we can use labels to describe modules of code and write true structured programs. However, thousands of useful and entertaining programs exist that were written with line-numbered BASICs, and Microsoft knew that many users of BASIC 2 would want to run these as well. So, Microsoft made BASIC 2 "backwards compatible" by allowing it to run programs that use line numbers. However, this doesn't solve the real problem of line-numbered BASIC programs, which we just described, or allow us to easily modify them for our own individual needs.

We *could* go through an original line-numbered program and convert the line numbers to alphanumeric labels. Unfortunately, this involves more than simply deleting all the line numbers. We would have to

find all the statements that refer to a line number, such as GOTOs and GOSUBs, assign a label to that number, and replace the number referred to with the label. We would have to make sure that all references throughout the program to the same number were given the same label; that is, we would have to build a "symbol table" with each number and its corresponding label, and search the table each time a reference was encountered. Finally, we'd have to attach the labels to the lines that are referred to elsewhere in the program, and then delete the line numbers from all of the lines. You probably agree that as useful as the new labels would be, it wouldn't be worth the effort, unless you happen to enjoy editing code for hours and hours.

Well, MacConvert provides a solution to the problem of converting these old programs to the new label format. This utility will take a program written in version 1 of Microsoft BASIC for the Macintosh and write out a new version with all the necessary labels substituted for line numbers. You'll still have to edit the program, because MacConvert does create rather boring labels like LABEL1, LABEL2, and so on. However, MacConvert does enough of the dirty work to make translating your old programs an attractive proposition, especially if you intend to make further additions or modifications to them in the future.

What if you don't have any programs written in version 1? MacConvert can still be useful to you. Many programs written in other versions of Microsoft BASIC that also use line numbers (such as BASIC-80 for CP/M systems), and even "cousins" like Applesoft BASIC, can be typed into your Macintosh "as-is" and converted to the numberless label format. Also, if you have BASIC programs on disk for another computer, you can transmit them to your Macintosh via a modem or serial line, for instance, and convert them as well.

Obviously, the amount of work you'll have to do to get the original program to actually run on the Macintosh depends on how different its BASIC syntax is from Microsoft BASIC for the Macintosh. However, the MacConvert conversion would be an important first step that would make it easier for you to see the program's structure, which would definitely aid in the adaptation of the program to the Macintosh. If the Mac is your first computer, you may not realize that thousands of useful and entertaining program listings can be found in books and magazines for the Apple II, for example. MacConvert can help you tap this vast and varied reservoir of almost free software!

How to use MacConvert

There are a number of steps involved in using MacConvert. You need to get your program ready by putting it into a form that MacConvert can read, then run MacConvert, and then make whatever additional changes are necessary to run the program with version 2. The following sections show you how. For those of you who don't have an old BASIC 1.0 program lying around, an actual program example is included.

Preparing your program for conversion

Before you use MacConvert, you must get the BASIC program you want to convert into a form that MacConvert can read. If the program is a Microsoft BASIC version 1.0 program on disk, it should be ready for conversion. If the program is listed in a book or magazine, simply run BASIC 2, choose New from the File menu to open a new file, and type in the listing, line numbers and all. If the program exists on disk for another type of computer, you'll have to transmit the program to the Mac using a modem or serial line and a telecommunications program.

When you've finished entering the program, choose Save from the File menu; when the dialog box appears, click the Text button at the bottom left of the window. This is important: A program file (other than a BASIC 1.0 file saved under that version of BASIC) must be of "text" type for it to be converted by MacConvert. BASIC 2's default is the "compressed" type, so you have to remember to select Text if you're typing in and saving a program under version 2. It's also a good idea to save a backup copy using the Save As option to protect against mishaps.

If the disk containing MacConvert is close to full, you should either free up some more space on that disk, or transfer MacConvert to a disk with more space on it. MacConvert needs about as much available space as the program file to be converted contains, because it creates a temporary file as part of its processing. This file will be deleted automatically after processing, however.

Using MacConvert

When you start MacConvert, the title screen shown in Figure 1 appears. The title BASIC 1 appears in the upper left corner of the screen, then scrolls toward the MacConvert rectangle at the top center of the screen, and emerges as BASIC 2 to the right of the rectangle. This bit of animation is part of our desire to use some Madison Avenue techniques to catch your eye, and to show graphically what the utility does: converting BASIC 1 (or

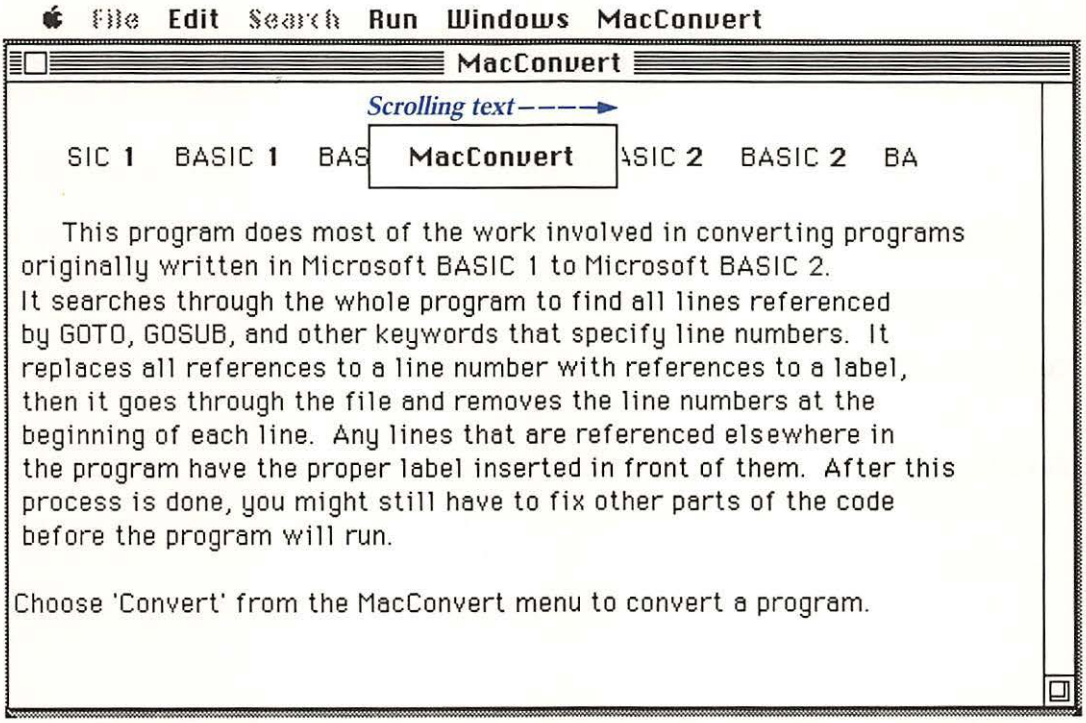


FIGURE 1. *The MacConvert title screen*

to some extent, non-Mac versions of BASIC) to BASIC 2. You'll also see a brief summary of what the program does, along with the instruction to choose Convert from the MacConvert menu to convert a program.

When you pull down the MacConvert menu, you'll see that the options available are Convert, Instructions, Quit to BASIC, and Quit to Desktop. The Instructions option is dim because the instruction text is already on the screen. When you choose Convert from the menu, a dialog box appears asking for the name of the file containing the program you wish to convert. (If the file you want to work with *doesn't* appear in the list of files in the dialog box, it isn't stored as a BASIC 1 or text-type file; refer back to the preceding section to find out how to get the program into a text-type format.)

Once you've selected the file to convert to BASIC 2, the conversion proceeds without any further input on your part. As you can see in Figure 2 on the next page, MacConvert keeps you informed of the progress of the conversion by showing you which of the two passes it is in and which line it is working on. We'll see what MacConvert is actually doing in each of the passes when we explore how the program works.

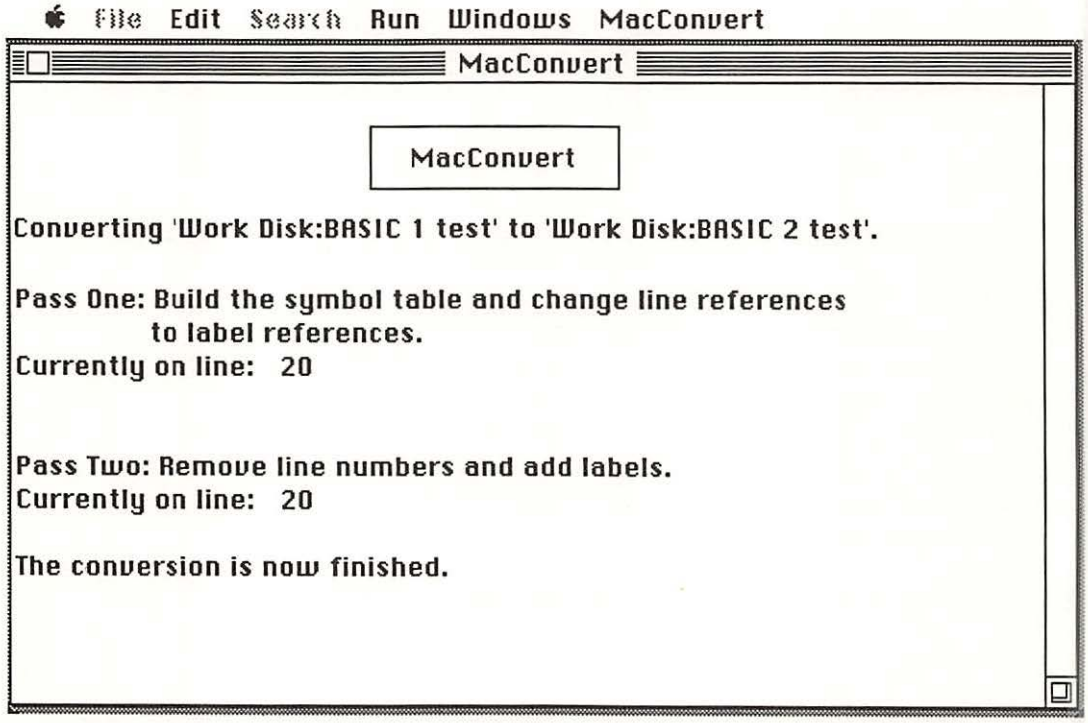


FIGURE 2. *The MacConvert "in progress" screen*

Converting an example program

In case you don't have an "old-fashioned" BASIC program handy for conversion, we've invented the sample program in Figure 3 as it might appear in the BASIC list window for you to practice with. It's the sort of little program that might have appeared in *Mighty Mite's Journal of Amazing 8K Basic Games,* a mythical publication of the latter 1970s. As a product of those benighted times, it of course contains line numbers. The job of this program is to create a personality for a role-playing game. It asks the player for the name of the character, and then asks whether the character is to be a fighter or a mage (wizard). If the character is a fighter, the subroutine at line 100 randomly determines and then prints the fighter's strength: Otherwise, the program assumes the character is a mage and calls the subroutine at line 200 to determine and print the mage's intelligence. (As we all know from classic fantasy, fighters have no brains and wizards can barely lift their wands!)

```
10 REM Role Playing Personality Program
20 CLS: RANDOMIZE TIMER
30 INPUT "What's your character's name ", N$
40 INPUT "Do you want your character to be a Fighter or Mage (F/M)", A$
50 GOSUB 400 : REM Get character land
70 IF UCASE$(A$) = "F" THEN GOSUB 100 ELSE GOSUB 200
80 PRINT: INPUT "Want to do another?", A$
90 IF A$ = "Y" OR A$ = "y" THEN 30 ELSE 299
100 REM Get fighter strength    <=== First subroutine
110 STRENGTH = INT (18 * RND(1)) + 1
120 PRINT "Warrior "; N$; " of "; LAND$; " has a strength of "; STRENGTH
130 RETURN
200 REM Get Mage intelligence <=== Second subroutine
210 INTELLIGENCE = INT(18 * RND(1)) + 1
220 PRINT "Mage "; N$; " of "; LAND$; " has an intelligence of "; INTELLIGENCE
230 RETURN
299 END
400 REM Determine character home
410 LAND = INT(RND(1) * 4 + 1)
420 ON LAND GOTO 430,440,450,460
430 LAND$ = "Sardinia" : RETURN
440 LAND$ = "Thrace" : RETURN
450 LAND$ = "Cythera" : RETURN
460 LAND$ = "Nome" : RETURN
```

FIGURE 3. *The line-number example program*

After typing in this little gem and saving it with the text option, we ran MacConvert and then printed the resulting file shown in Figure 4 on the next page. We think you'll agree that the converted version has a clearer structure. The indention of the code following each label helps you see the distinct blocks of code. The first major block, designated LABEL4, is revealed to be an infinite loop, since it ends with a THEN LABEL4. In the original program, you'd have to look back and find line 30 to see where control returns after a character has been created, and it would take a moment or two to realize what's happening.

We'd probably want to edit the listing to give meaningful names to the labels. LABEL4 could become CreateACharacter, while the subroutine LABEL2 could be called MakeFighter, and that at LABEL3 could become MakeMage. We could use BASIC's Replace option from the Search menu to search and replace all occurrences of a given string, such as LABEL3, to make sure that all references to a given label get changed.

```
    REM Role Playing Personality Program
    CLS: RANDOMIZE TIMER
LABEL4:
    INPUT "What's your character's name  ", N$
    INPUT "Do you want your character to be a Fighter or Mage (F/M)", A$
    GOSUB LABEL1 : REM Get character land
    IF UCASE$(A$) = "F" THEN GOSUB LABEL2 ELSE GOSUB LABEL3
    PRINT: INPUT "Want to do another?", A$
    IF A$ = "Y" OR A$ = "y" THEN LABEL4 ELSE LABEL5
LABEL2:
    REM Get fighter strength     <=== First subroutine
    STRENGTH = INT (18 * RND(1)) + 1
    PRINT "Warrior "; N$; " of "; LAND$; " has a strength of "; STRENGTH
    RETURN
LABEL3:
    REM Get Mage intelligence <=== Second subroutine
    INTELLIGENCE = INT(18 * RND(1)) + 1
    PRINT "Mage "; N$; " of "; LAND$; " has an intelligence of "; INTELLIGENCE
    RETURN
LABEL5:
    END
LABEL1:
    REM Determine character home
    LAND = INT(RND(1) * 4 + 1)
    ON LAND GOTO LABEL6,LABEL7,LABEL8,LABEL9
LABEL6:
    LAND$ = "Sardinia" : RETURN
LABEL7:
    LAND$ = "Thrace" : RETURN
LABEL8:
    LAND$ = "Cythera" : RETURN
LABEL9:
    LAND$ = "Nome" : RETURN
```

FIGURE 4. *The program in Figure 3, after processing by MacConvert*

How MacConvert works

The program outline for MacConvert is shown in Figure 5. The structure follows a not-uncommon pattern of doing all the work in menu events, with the main program being simply an endless loop that is interrupted by menu events as they come up. Exiting is accomplished through our standard quit selections (Quit to BASIC and Quit to Desktop).

Before we get into the details of how each of the sections of this program works, it's important for you to think about the underlying techniques that we will be using. The techniques revolve around the idea of

building a table of references, or *symbol table*, by searching for certain key phrases or commands. When the commands or phrases are found, the line that they are in is *parsed*. What this means is that the relevant components of the line are separated. This way, the keyword and the line number that it refers to are identified, and anything else in the line is ignored. The referenced line number is checked to see if it has already been saved in the table of references: If it has, it is associated with a label; if it hasn't, it is then assigned a new label which is saved in the symbol table.

```
Initialization
  initialize data array and constants for graphics                    Init 1
  initialize data array and constants for file conversion
  define Output window and scrolling information (InitScrollInfo)     Init 2 (SR 9)
  create and enable MacConvert menu
  display title screen and instructions (ShowConvert, Instructions)   SR 11, ME 2

Main Program                                                          Main
  WHILE (endless loop interrupted by menu events)
    WHILE user does not choose Convert from menu
      scroll title string in window (ScrollOnce)                      SR 10
    WEND
    do conversion (Convert)                                           SR 1
  WEND

Menu Events
  MenuEvent:                                                          ME 0
    disable menu
    branch to appropriate subroutine
    re-enable menu

    ConvertMenu: set conversion flag                                  ME 1

    Instructions: display instructions                                ME 2

    BasQuit: quit to BASIC                                            ME 3

    DeskQuit: quit to Mac Desktop                                     ME 4

Subroutines
  Convert: convert file                                               SR 1
    disable menu items
    get names of source and destination files
    open source and temp files for conversion
    do first pass (PassOne)                                           SR 2
    close files
    open temp and destination files
    do second pass (PassTwo)                                          SR 4
    close files
    display message that conversion is complete, kill temp file
    re-enable menu items
```

(continued)

FIGURE 5. *Program outline*

```
PassOne: build symbol table and change line references          SR 2
  display message
  WHILE not end of source file
    increment and display line number
    read line of text
    check for each key word (CheckWord)                         SR 3
    print converted line to temp file
  WEND

CheckWord: check text line for key words                        SR 3
  WHILE there is a line number following key word
    scan line for key word (SkipSpaces, ExtractNum)             SR 6, 7
    add number to symbol table (AddSymbol)                      SR 8
    replace number with appropriate label
  WEND

PassTwo: do second pass of translation                          SR 4
  display message
  WHILE not end of temp file
    increment and display line number
    read line of text
    extract the line number (ExtractNum)                        SR 6
    if in symbol table, attach corresponding label to line (OutputLabel)  SR 5
    print converted line to destination file
  WEND

OutputLabel: send label to output file                          SR 5

ExtractNum: extract number from string                          SR 6

SkipSpaces: skip spaces in line of text                         SR 7

AddSymbol: add line number to symbol table                      SR 8

InitScrollInfo: initialize scrolling information                SR 9

ScrollOnce: scroll words to right one time                      SR 10

ShowConvert: show "MacConvert" inside box                       SR 11

ClearBottom: clear bottom of screen                             SR 12
```

Figure 5. Program outline (continued)

The symbol table in MacConvert consists of the two arrays, *lines!* and *symbol$*, where each of the line numbers and corresponding labels created by MacConvert is stored. This symbol table is then used to build the new list of code. With this in mind, let's take a closer look at how MacConvert works.

Initialization of graphics

Most of the initialization in [Init 1] concerns the scrolling that will be used to show BASIC 1 being "converted" to BASIC 2 on the screen. The idea behind the program scrolling is to "slice" the phrases *BASIC 1* and *BASIC 2* into a number of "frames" that will be used to give the appearance of motion to the frames as they are scrolled. The strings *BASIC 1* and *BASIC 2* each contain 34 frames, as defined by the statement *frameNum = 33*, and they're stored in the arrays *num1Pict%* and *num2Pict%*. The array *pen%*, which has two elements, 0 and 1, positions the pen for printing text.

The next set of arrays and constants is involved with the actual conversion of the file to BASIC 2. The temporary file called *MacCnvrt.???* in the listing is used to hold the results of the first conversion pass; that is, MacConvert creates a temporary file so that it does not have to erase the original source file. This way, you can still compare the final results with the original file. This is a safety precaution: If you forget to make a backup before you start, you might wind up in trouble if MacConvert erased your original file without creating this temporary file to fall back on.

What kind of trouble could you be in? There are a number of things that could go wrong. A power failure, a defective disk, not enough room on the disk, and hardware problems happen from time to time. There are a couple of problems that are unique to conversion efforts in particular. These occur when the computer you are using doesn't have enough memory to work with (this can happen with the 128K Macintosh), or the program to be converted is too large, causing the array indexes for the symbol table and line numbers to go out of bounds.

The array *symbol$* will hold the symbol-table labels, while the array *lines!* will hold the corresponding line numbers. (Remember that the exclamation point indicates a single-precision integer variable.) Since line numbers in Microsoft BASIC for the Mac only go up to 65529, a single-precision integer has enough room for any line number. We use them in MacConvert to save memory. We have dimensioned the arrays to allow for a maximum of 500 lines in the original program to be converted, which should be plenty for most BASIC line-numbered programs you're likely to encounter. If you ever do need more, or you get an array-bounds error when you try to convert a program, you can redimension the arrays to a higher number. Be aware, though, that you'll eventually run into memory problems on a 128K Mac if you redimension the arrays too high.

Since it's very unlikely that every line in the program will reference another line, you may be wondering why the symbol table has room

for as many labels as there are lines. Well, it's safer not to make assumptions about what a "typical" program to be converted will look like. If MacConvert could handle up to 500 lines of code but only 100 labels, we'd have to document this, and then you would have to count line-number references! As it is, in extreme circumstances the most you might have to do is estimate the number of *lines* in the program, which is much easier than counting up all the line-number references—indeed, many word processors will count the lines in a file for you. In most cases, of course, you won't have to worry about the number of lines or references in the program.

The number of BASIC keywords and an array *key$* to hold their names is specified in [Init 1]. Using this setup, and the CheckWord subroutine [SR 3], it wouldn't be hard to add another keyword. For example, if you wanted to convert from a BASIC that has CALL statements to line numbers, you could do this with only a few changes to the code. You may have noticed that the ON GOTO and ON GOSUB keywords aren't included in the six keywords in *key$*—good for you! These will be handled using a little trick we'll explain later.

The string *validDigits$* will be used for determining which characters in a line constitute a line number. The string *passOK$* consists of those characters that should be skipped over when parsing (determining the components of) the line. These characters are the space, the horizontal tab, and the line feed. (The horizontal tab is often put in source code to indent lines, while the line feed continues a line on the next screen line. The Output window's type, size, and position are set in [Init 2] and the window is given the title MacConvert.

The SCROLL statement

Next, InitScrollInfo [SR 9] is called to set up the opening scrolling display at the top of the screen. Although this piece of code doesn't have any real effect on the conversion process, it reveals the operation of the SCROLL statement. This subroutine starts innocuously enough by printing BASIC 1 at the left of the MacConvert box, with the *1* in boldface type. But some very interesting things start to happen when the FOR...NEXT loop GETs *frameNum* frames of the string BASIC 1 and stores the successive frames in the array *num1Pict%*. Let's look at the first two frames to see how this works in action.

The first time through the loop, the index (*n*) is 0. Note that the constant *hSep* has a value of 2. If you substitute these values into the GET statement, you'll find that the first frame has (10,10) as the coordinates

for its upper left corner, and (12,25) for the lower right corner. (GET, you'll recall, needs these two corners to define the screen image to be stored in the array.) This frame is therefore two pixels, or *hSep* pixels wide, and 25 – 10, or 15 pixels high. The next time through the loop, the index (*n*) becomes 1, so the next frame has (12,10) as its upper left corner (the constant *hSep* was set to 2, and $1 \times 2 = 2$). The lower right corner is now at (14,25); if you compare these coordinates with those obtained the last time around, you'll see that this is the next two-pixel-wide frame to the right. The loop continues until the whole string on the screen has been divided into frames and stored away. The same procedure is followed to get the frames for the string BASIC 2 on the right side of the MacConvert box. These frames are saved in the *num2Pict%* array. We'll see how these two sets of frames are used for scrolling when we look at ScrollOnce [SR 10], just as soon as we start looking at the main program loop.

InitScrollInfo's final task is to define the rectangles within which BASIC 1 and BASIC 2 will be scrolled. They are the same size, and on opposite sides of the MacConvert rectangle in the top center of the screen. When you watch the title screen in action, BASIC 2 doesn't appear to emerge from the MacConvert rectangle until BASIC 1 has disappeared into it and has had enough time to reach the other side. To do this, we have to scroll just BASIC 1 a certain number of times before we start scrolling BASIC 2. The number of times to scroll BASIC 1 is equal to the distance from the left side of BASIC 1's scrolling rectangle to the left side of BASIC 2's rectangle, divided by the width of one frame, or *hSep*. That's the value assigned to the variable *justOne*.

Finishing the title screen

Since this program will be menu driven, the MacConvert pull-down menu is created next. Menu events will be handled by MenuEvent at [ME 0]. In preparation for the main program, the rest of the title screen needs to be shown, and the scrolling started. ShowConvert [SR 11] starts by drawing the MacConvert box. Note that the subroutine uses coordinates derived from the coordinates of the two scrolling boxes on either side of it. The word MacConvert is then displayed inside the center box. After ShowConvert is finished, Instructions [ME 2] is called to display the text of the program description. It disables the Instructions option, since that function is now in progress, and calls ClearBottom [SR 12] to clear out the area where the text progress messages will be displayed. When ClearBottom is finished processing, control returns to Instructions, and the text is printed in the cleared-out window.

ClearBottom makes sure that any text left over from other functions (such as the conversion status display with pass and line numbers) is erased. To do this, it employs the Macintosh ERASERECT routine. You'll probably recall that routines of this kind need to be passed an array whose elements are the top, left, bottom, and right boundaries of the rectangle in which the action will take place. ClearBottom gets the boundary for the top of the rectangle (*tRect%(0)*) by adding 10 to the value of *oneRbot,* the bottom of the right scrolling window (either window would do, since they're at the same height). The left side of the rectangle is the left side of the screen, or 0. The bottom is the height of the Output window, returned by the WINDOW(3) function, minus the top of the window in *tRect%(0).* The right boundary is the width of the Output window, returned by WINDOW(2). Since these latter two dimensions will vary with the size of the Output window, this procedure ensures that the correct area will be erased regardless of the window's size. Specifying dimensions in this way requires a little more care and thought, but makes for a more versatile and easier-to-modify program.

The main program

We've now reached the main program [Main]. We've already pointed out that this is just an endless loop, since it tests WHILE *true,* and *true* has a value of −1 ("NOT false," or NOT 0). The inner WHILE...WEND loop checks the value of *convertFlag,* which is initially *false,* to see whether the user has selected Convert from the MacConvert menu. If not, ScrollOnce [SR 10] will be called.

This subroutine first uses a SCROLL statement with the upper left and lower right coordinates of the first scrolling rectangle (the one with BASIC 1), the width of a frame (*hSep*), and a 0. These parameters, in effect, tell SCROLL: "Within the rectangle specified, scroll everything 2 pixels to the right, but don't scroll anything up or down (because the change in the y direction is 0)."

This works fine, but if that's all we did, the words would simply disappear to the right as they were scrolled. This is because the SCROLL routine doesn't "wrap around"; that is, graphics that disappear to the right don't automatically reappear on the left. Therefore, we have to restore one frame of our string to the left every time a frame disappears on the right. This is done, as you've probably guessed, by GETting the frame corresponding to the one that disappeared from our array of stored frames (in this case, *num1Pict%*), and PUTting it in the rectangle in the leftmost position. Before we arrived at the main program, *num1* and *num2* were set to

33, the last frame; so the first time through this loop frame 33, the rightmost one, disappears and then we put it back on the left side of the rectangle. The number of the frame to be restored is then reduced by 1, so that next time through the loop frame 32 will disappear and be replaced to the left. If this number goes below 0, it is set back to 33 to start over again.

Until scrolling has happened *justOne* times (that is, long enough for the words BASIC 1 to appear to go into the MacConvert box and begin moving out the other side), "just region one" will be scrolled by each call to ScrollOnce. (Recall that *justOne* was determined in the initialization section of the program.) After that, both regions will be scrolled each time the subroutine is called. The code for scrolling region two (BASIC 2) is therefore controlled by an IF...THEN statement that checks to see if *justOne* has been exceeded: If it has, it's time to start scrolling the BASIC 2 rectangle as well. ScrollOne will be called, and both regions will continue to scroll, until Convert is selected and *convertFlag* becomes *true*. When this happens, we finally get down to the real business of the program, the file conversion.

File conversion

File conversion is handled by Convert [SR 1], which "masterminds" this two-stage process. The subroutine starts by disabling the Convert and Instructions menu items so the conversion process won't be interrupted by them once it has begun. The bottom of the screen is cleared by calling ClearBottom, which we've already discussed. The name of the file to be converted is obtained from the user via the FILES$ function. Only two types of files are eligible for conversion, and thus will have their names shown in the selection box: standard Macintosh text files, and files with type "MSBA," which were created by BASIC 1. If the user doesn't select a file name, the conversion is canceled and control returns to the main program. The name of the file to be converted is assigned to *infile$* by the FILES$ function.

Next, the versatile FILES$ function is called upon again and asks for the name of the file name for the converted file to be saved under. This name is assigned to *outfile$*. If no valid name is given, the conversion routine is exited. After this second dialog box disappears, a call to ShowConvert restores the MacConvert animation area.

The file to be converted is now opened for input, and the temporary file, *MacCnvrt.???*, whose name is in *tempFile$*, is opened for output. The first pass will read the input file and write it with modifications to the temporary file.

Pass One

PassOne [SR 2] is called to perform the first pass of the conversion. As you can see in Figure 2, after the message for Pass One is displayed, MacConvert prints out a number representing how many lines it has read (20 in Figure 2). Note that these are simply numbers in sequential order: The first line is 1, the second 2, and so on. Don't confuse them with the line numbers given to the lines in the program being converted. The Macintosh GETPEN routine is called to save the pen location in *pen%* so the line number can be printed later on in the right place.

The loop beginning WHILE NOT EOF performs the actual work of Pass One. The variable *count,* containing the number of the current line, is incremented, and that number is printed on the screen at the saved pen location. The line is read into the variable *text$* using the LINE INPUT statement, and its length is checked. If the length is 0, the line is simply a blank line (that is, just a carriage return), and control then jumps to the label NextLine. This kind of line needs no processing, so it's simply counted and printed in the output file. If the line is not blank, it must be checked against the six keywords that might be followed by one or more line numbers. The FOR...NEXT loop's last action is to call CheckWord [SR 3] to check each of these keywords.

CheckWord checks for the presence of the keyword in *key$(key).* Since the loop in PassOne calls the keyword when the values in *key* are from 1 to 6, the loop will check all six keywords, one per call. The position of the keyword as returned by the INSTR (in-string) function is assigned to the variable *found.* A WHILE...WEND loop tests the value of *found.* If this position is 0, the keyword was not found, control falls through the bottom of the loop, and CheckWord returns to PassOne.

If the keyword was found (*found* > *0*), we need to look for a number or numbers following the keyword. The variable *chrPos* is set to *found* (the position of the first character of the keyword) plus the length of the keyword. This makes *chrPos* "point to" the character position just after the keyword. An inner WHILE...WEND loop is then used to look for numbers. First, SkipSpaces [SR 7] is called. This has a WHILE...WEND loop that looks at the characters starting at the current position of *chrPos,* and advances the pointer to the right (by incrementing *chrPos*) as long as the character encountered is in *passOK$;* that is, it's a blank, horizontal tab, or line feed. If a character that is not one of those is encountered, or the end of the line is reached without encountering a valid character, SkipSpaces returns to CheckWord.

As an aside, the procedure that we are describing here is called *parsing,* and is very similar to what BASIC does when it runs a program: It looks at each line of code and determines if it is a valid statement. If it is, BASIC then checks to see if there are any BASIC commands which transfer control to another section of the program, and if there are, it determines where that control gets transferred to.

After returning from SkipSpaces, *chrPos* is now at the first character position of what might be a number following the keyword. (It doesn't *have* to be a number, of course. For example, if the keyword is THEN, the statement might read *IF p = 1 THEN 1000,* but it might instead be *IF p = 1 THEN PRINT P$.*)

Since what we're interested in is line-number references in the BASIC statements, ExtractNum [SR 6] is called to see if there's a number. It first calls SkipSpaces; the first time ExtractNum is called for a given line, SkipSpaces will already have been called, and SkipSpaces will return immediately, but if ExtractNum is called a second or subsequent time for the same line, it will probably have to skip over spaces or other characters to get to the next number. This happens with ON GOTO or ON GOSUB statements, which are followed by two or more line numbers. ExtractNum uses a WHILE...WEND loop to scan the characters starting at *chrPos* (stored as *iStart*) to see if they are valid digits. As long as valid digits are found, the counter variable *i* is incremented. When the end of the line or a character other than a valid digit is found, control drops through the bottom of this loop with the variable *i* now equal to the original *chrPos* plus the length of the number found.

If *i* is still equal to *iStart,* there was no number, so ExtractNum sets the "number's" value to −1 and its length to −1, and returns. Otherwise, the length of the number is *i − chrPos,* and the value of the number (which, being a line number, is an integer), is found by extracting the number string. This number string, which starts at *chrPos* and is *i − chrPos* characters long, is extracted from *text$.* It is evaluated by applying the VAL function to it. This value is assigned to *numVal.* Next, *numLen* is added to *chrPos* to move the "pointer" to the character following the number, and control jumps to the label ExtLExit (skipping over the "not a number" code), and ExtractNum returns to CheckWord.

If the length of the "number" is −1, or its value is 0, CheckWord "knows" that no number was found, or it was 0, so control jumps to the label NotNum, and then back to the top of the WHILE *changeNums* loop in CheckWord to look for more numbers. (The reason we don't want to generate a label for 0 is that it has a special use; for instance, in statements like

ON ERROR GOTO 0, which disables error trapping.) If a number is found, the variable *lineNumber* is assigned the value in *numVal*. AddSymbol [SR 8] is called to add this line number to the symbol table. The symbol table consists of two arrays: *lines!*, which contains line numbers, and *symbol$*, which contains the corresponding labels created by MacConvert.

First, the elements of the *lines!* array, which are line numbers corresponding to previously assigned labels, are checked to see if the newly found line number is already there. Only the elements up to the current value of *labels*—the number of labels placed in the symbol table so far—need to be checked. If the number is found in *lines!*, then the label is one that already exists in *symbol$(check)*; this label is assigned to *symbol$* and AddSymbol returns to CheckWord. If the number was not found in the *lines!* array, a new label must be assigned and the number and label must be recorded in the symbol table. This is done by adding 1 to the total labels (*labels*), and creating a new label by concatenating (combining) the string LABEL with a string made from the current value of *labels*. The string is extracted starting from its second character by MID$ because STR$ precedes numbers it converts with a leading space (if positive). We don't want this space, since labels can't have spaces in them. The result is that if, for example, we've just added the twentieth label, the label LABEL20 will be added to the symbol table by putting it in the *symbol$* array. The corresponding line number is put in the *lines!* array. AddSymbol is now finished, and control returns to CheckWord.

Next, the line number found in the original code is replaced by the label established for it. *temp$* is assigned the part of the line (*text$*) up to just before where the line number was found, and *symbol$*, containing the label, is added to it. (Remember that this label is either a previously used one found by AddSymbol, or a new one added by it.) The part of *text$* containing the text following the line number is then concatenated with *temp$* to make a new *text$* containing the label in place of the line number. Finally, *chrPos* is updated so it points to the character position following the label, which is the next character that needs to be checked.

Next, the part of *text$* starting at the position where a keyword was last found (*lastFnd*) is checked for the word ON. This is necessary for dealing with the added complication of the ON GOTO and ON GOSUB statements, which have multiple line numbers following them. If the keyword currently being considered by CheckWord isn't 3 or 4 (GOTO or GOSUB), or *ON* wasn't found, we're not dealing with one of these ON statements. (We have to check for both keyword 3 or 4 and *ON* so we can eliminate other kinds of ON statements like ON DIALOG or ON MOUSE.)

If the statement wasn't ON GOTO or ON GOSUB, control is sent to the label NoOn, and then back up to the top of the *changeNums* loop.

If we do have an ON GOSUB or ON GOTO, only the first number in its number list has been taken care of, so SkipSpaces is called to get to the next number. If the first "not OK" character reached by SkipSpaces wasn't a comma, then the end of the number list has been reached, and control goes to the label NoMore and then down to the WEND and back up to the WHILE *changeNums* loop. If a comma was found, 1 is added to *chrPos* to skip past it. The flag *changeNums* is set to *true,* so when control falls through the remaining labels and back up to *changeNums,* the whole loop will be executed again and the next number will be processed.

If control has returned to the top of the WHILE *changeNums* loop with no number having been found, or the number was 0, or only one number was processed (that is, a keyword other than ON GOTO or ON GOSUB), *changeNums* is *false,* and control drops through to the bottom of CheckWord's main loop. The variable *lastFnd* is set to *found* (the starting position of the last keyword), and the next instance of the keyword is searched for and its position is assigned to *found.* Control then goes to the top of the main loop: If a keyword was found, *found* is greater than 0, and the whole process of looking for numbers and handling possible ON GOTOs and ON GOSUBs is gone through again. If a keyword is not found this time, CheckWord is finished, and control is returned to PassOne.

"Whew!" we hear you say. "If all those operations were needed to check just one line, are we ever going to get to the end of this program?" A word of cheer is in order now: We're just about done with PassOne. After the line is checked for each keyword by the FOR...NEXT loop, the possibly modified line is printed to the output file. The WHILE NOT EOF loop continues until all the lines in the input file have been checked and processed as required. Control then returns to Convert, and the input and output files are closed. The temporary file created by PassOne is opened for input for Pass Two [SR 4], and the file name specified by the user is opened for the final output from Pass Two.

Pass Two

PassTwo [SR 4] is now called to perform Pass Two of the conversion process. You'll be happy to learn that its operation is considerably less complicated than that of PassOne. PassTwo starts by printing a message describing its activity on the screen. (When a lengthy process is going on, it's important to inform the user about what is going on and the amount of progress made.)

A WHILE...WEND loop reads through the input file, which is the temporary file containing the results of PassOne. The value of *count* (the number of the line being processed), is displayed in the same way used in PassOne: A line is read from the temporary file, and its length is checked. If the length is 0, the line is just a carriage return, and doesn't have a line number, so control jumps to the label NextLine2, the line is printed, and we go back to the top of the WHILE...WEND loop to get the next line. Otherwise, the line has a number and the line number has to be removed. Additionally, if this line number is referred to by any other part of the program, the appropriate label has to be attached to it. ExtractNum is called upon to get the value of the line number. If the value returned by ExtractNum is −1, no line number was found, so control then jumps to the label NotLineNum, the line is printed, and we go back to the top of the main loop to get the next line.

If a number was found, an inner WHILE...WEND loop checks the symbol table (the part in the *lines!* array containing referenced line numbers) to see if the line number has been referenced. If it is found, OutputLabel [SR 5] is called to print the corresponding label to the output file. A colon is appended first, since labels themselves, as opposed to references to them, must end in a colon. The label is then printed on its own line in the output file. This helps it stand out from the section of code to which it is attached. The flag *checking* is set to *false* and control drops through the bottom of the WHILE *checking* loop.

If the label is not found in the symbol table by the time the value of *check* exceeds the number of labels, control drops through the WHILE *checking* loop. You can see that whether a label is found and output or not, we eventually get past the loop and reach the statement that removes the line number from the line of code. Since ExtractNum left the *chrPos* pointer just past the line number, we get rid of the number by adding four spaces to the part of the line starting at *chrPos*. This has the effect of indenting all the lines in the output file four spaces, again helping us visualize the blocks of code with their associated labels. We then reach the statement that prints the modified line, and return to the outer loop to get the next line. When the last line has been read, PassTwo and the conversion process are finished. Control returns to Convert.

Convert closes the files used in PassTwo, prints a message saying that the conversion is finished, and KILLs the temporary file so it isn't left cluttering up the disk. Control now returns to the main program in [Main].

ConvertFlag is set to *false,* control goes back to the top of the endless loop, and because *convertFlag* is *false,* the scrolling loop is started up again, to continue until another menu event is selected.

We've already mentioned how the description is printed, and you're familiar with how the two quits (Quit to BASIC and Quit to Desktop) work, so it's not necessary to go into those menu events. In other words, we're finished!

Suggestions for MacConvert

MacConvert is an example of a class of programs known as *preprocessors.* What this term describes are programs that, like MacConvert, make specific changes to another program. Another, more general term is *filters.* The logic behind filter programs is basically the same as that for preprocessors, except that they make a wider range of modifications to files.

Now that you understand the structure of a preprocessing program, you might want to write a filter or preprocessor program of your own. For example, you could create a filter program that would make changes to a word-processed document file that your word processor can't handle, such as stripping out special control characters before you sent the file via modem, or converting ASCII files back to your word processor's format. An example of a preprocessor you might create is a program that would allow you to alter other programs to include structures not available in the language you are using. For example, although Microsoft BASIC for the Macintosh doesn't have a CASE statement (a multiway branching structure that can handle several tests at once), you could write a preprocessor that would accept such a statement and convert it to the appropriate sequence of IF...THEN...ELSE or ON...GOTO statements.

MacConvert program listing

```
'*****************************************************************
'                          MacConvert
'              Convert MS BASIC 1 programs to MS BASIC 2
'*****************************************************************

'************************************************** INITIALIZE
INIT 1
IF FRE(0) < 22000 THEN CLEAR , 22000
false = 0 : true = NOT false
DIM pen%(1)
                                    'variables used to scroll words sideways
frameNum = 33                       'number of frames  for each word to scroll
hSep = 2                                          'width of each frame
DIM num1Pict%(20,frameNum)          'has hSep wide frames of 'BASIC 1'
DIM num2Pict%(20,frameNum)          'has hSep wide frames of 'BASIC 2'
DIM tRect%(3)                                     'temporary rectangle

                                    'variables used in actual conversion of file
tempFile$ = "MacCnvrt.???"                        'temporary file name
DIM symbol$(500)                                  'symbol table labels
DIM lines!(500)                     'and lines they correspond with

keyWords = 6                    'words that may have line numbers after them
DIM key$(keyWords)
key$(1) = "THEN"
key$(2) = "ELSE"
key$(3) = "GOTO"                              'these must stay as index 3 and 4
key$(4) = "GOSUB"
key$(5) = "RESTORE"
key$(6) = "RESUME"

validDigit$ = "0123456789"                    'all valid characters in line number
passOK$ = " " + CHR$(10) + CHR$(9)                'all valid to skip over

INIT 2
WINDOW 1, "MacConvert", (2,40) - (508,337), 1
GOSUB InitScrollInfo                'initialize what is needed to scroll sideways

MENU 6, 0, 1, "MacConvert"                        'install MacConvert menu
MENU 6, 1, 1, "Convert"
MENU 6, 2, 1, "Instructions"
MENU 6, 3, 0, "-"
MENU 6, 4, 1, "Quit to BASIC"
MENU 6, 5, 1, "Quit to Desktop"
ON MENU GOSUB MenuEvent : MENU ON

GOSUB ShowConvert
GOSUB Instructions
num1 = frameNum : num2 = frameNum
```

```
'********************************************************* MAIN PROGRAM
  WHILE true
    WHILE NOT convertFlag
      GOSUB ScrollOnce
    WEND
    GOSUB Convert
    convertFlag = false
  WEND

'********************************************************* MENU EVENTS
MenuEvent:
  MENU 6, 0, 0                                          'disable menu bar
  MENU 6, 2, 1                                  'enable Instruction option if disabled
  item = MENU(1)
  ON item GOSUB ConvertMenu, Instructions, , BasQuit, DeskQuit
  MENU 6, 0, 1
  RETURN

ConvertMenu:          '_____________________________ Convert has been chosen
  convertFlag = true
  RETURN

Instructions:         '_____________________________ display instructions
  MENU 6, 2, 0                                              'disable option
  CALL TEXTFONT(1)
  GOSUB ClearBottom
  LOCATE 5,1
  PRINT "     This program does most of the work involved in converting programs"
  PRINT " originally written in Microsoft BASIC 1 to Microsoft BASIC 2."
  PRINT " It searchs through the whole program to find all lines referenced"
  PRINT " by GOTO, GOSUB, and other keywords that specify line numbers.  It"
  PRINT " replaces all references to a line number with references to a label,"
  PRINT " then it goes through the file and removes the line numbers at the"
  PRINT " beginning of each line.  Any lines that are referenced elsewhere in"
  PRINT " the program have the proper label inserted in front of them.  After this"
  PRINT " process is done, you might still have to fix other parts of the code"
  PRINT " before the program will run."
  PRINT
  PRINT "Choose 'Convert' from the MacConvert menu to convert a program."
  RETURN

BasQuit:              '_____________________________ user wants to quit to BASIC
  MENU RESET
  CLEAR
  END

DeskQuit:             '_____________________________ user wants to quit to Mac Desktop
  MENU RESET
  CLEAR
  SYSTEM
```

MAIN

ME 0

ME 1

ME 2

ME 3

ME 4

```
'********************************************************** SUBROUTINES
SR 1  Convert:              '_____________________________________ convert file
        MENU 6, 1, 0                              'disable Convert menu item,
        MENU 6, 2, 0                              'and Instructions menu item
        GOSUB ClearBottom

        inFile$ = FILES$(1,"TEXTMSBA")            'open either text or BASIC 1 files
        IF inFile$ = "" THEN CancelCnvrt

        outFile$ = FILES$(0,"Save converted file as?")
        IF outFile$ = "" THEN CancelCnvrt

        CLS : GOSUB ShowConvert
        CALL TEXTFONT(0) : CALL TEXTMODE(0)
        LOCATE 5,1 : PRINT "Converting '" inFile$ "' to '" outFile$ "'."
        PRINT
        OPEN inFile$ FOR INPUT AS #1
        OPEN tempFile$ FOR OUTPUT AS #2
        GOSUB PassOne                     'PassOne copies from source to temp file
        CLOSE #1 : CLOSE #2

        OPEN tempFile$ FOR INPUT AS #1
        OPEN outFile$ FOR OUTPUT AS #2
        GOSUB PassTwo                     'PassTwo copies from temp file to final file
        CLOSE #1 : CLOSE #2

        PRINT : PRINT "The conversion is now finished."
        KILL tempFile$                    'make sure temp file isn't left around
      CancelCnvrt:                        'user wanted to cancel this run
        GOSUB ShowConvert
        MENU 6, 1, 1                      're-enable Convert menu option,
        MENU 6, 2, 1                      'and Instruction option
        RETURN

SR 2  PassOne:              '_____________________________ first pass of translation
      ' This reads the whole source file.  It builds a symbol table of all the
      ' line numbers that are referenced ('GOTO 10') and at the same time
      ' replaces referenced line numbers with labels ('GOTO LABEL43');
      ' it writes the entire file out to a temporary file.
        PRINT "Pass One: Build the symbol table and change line references"
        PRINT "          to label references."
        PRINT "Currently on line: ";
        CALL GETPEN(VARPTR(pen%(0)))
        count = 0
        WHILE NOT EOF(1)
          count = count + 1
          CALL MOVETO(pen%(1),pen%(0)) : PRINT count
          LINE INPUT #1, text$
          IF LEN(text$) = 0 THEN NextLine
          FOR key = 1 TO keyWords
            GOSUB CheckWord               'check line against each keyword
          NEXT
```

```
NextLine:
    PRINT #2, text$
  WEND
  PRINT
  RETURN

CheckWord:              '_____________________________ check text$ for keywords
  found = INSTR(1, text$, key$(key))
  lastFnd = 1
  WHILE found <> 0                                    'while keyword is in line
    chrPos = found + LEN(key$(key))

    changeNums = true                                 'execute next loop at least once
    WHILE changeNums                                  'this loop for ON GOSUB 10, 20, 30 etc.
      changeNums = false
      GOSUB SkipSpaces
      numStart = chrPos                               'save char at which num starts

      GOSUB ExtractNum                                'get number if there
      IF numLen = -1 OR numVal = 0 THEN NotNum        'don't change if not num
      lineNumber = numVal : GOSUB AddSymbol           'add to sym table
                                                      'next two lines replace number with label string
      temp$ = LEFT$(text$, numStart - 1)  + symbol$
      text$ = temp$ + MID$(text$, numStart + numLen, LEN(text$))
      chrPos = numStart + LEN(symbol$)

      temp = INSTR(lastFnd + 1, text$, "ON")
      IF NOT (key = 3 OR key = 4) OR temp = 0 THEN NoOn   'any ON GOSUBs?
      GOSUB SkipSpaces                                'is either ON GOSUB or ON GOTO: change all

      IF MID$(text$, chrPos, 1) <> "," THEN NoMore
      chrPos = chrPos + 1
      changeNums = true                               'set to true so will keep going down list

NoMore:                                               'no more numbers in list
NoOn:                                                 'not ON GOSUB or ON GOTO
NotNum:                                               'either wasn't number, or was '0': don't change
    WEND                                              'until changeNums = false
    lastFnd = found
    found = INSTR(found + 1, text$, key$(key))
  WEND
  RETURN

PassTwo:                '_____________________________ second pass of translation
' Pass two reads out of the temporary file.  It gets the line number of
' each line it reads and searches the symbol table to see if that line
' number is in it.  If it is there, then the label that corresponds to that
' line number is inserted before the line.  In either case, the line is
' stripped of its line number and written to the final output file.
  PRINT
  PRINT "Pass Two: Remove line numbers and add labels."
```

```
    PRINT "Currently on line: ";
    CALL GETPEN(VARPTR(pen%(0)))
    count = 0
    WHILE NOT EOF(1)
      count = count + 1
      CALL MOVETO(pen%(1),pen%(0)) : PRINT count
      LINE INPUT #1, text$
      IF LEN(text$) = 0 THEN NextLine2
      chrPos = 1: GOSUB ExtractNum
      IF numLen = -1 THEN NotLineNum

      check = 1 : checking = true
      WHILE checking
        IF numVal <> lines!(check) THEN NotSame
        GOSUB OutputLabel
        checking = false
NotSame:
        check = check + 1
        IF check > labels THEN checking = false
      WEND
      text$ = SPACE$(4) + MID$(text$, chrPos, LEN(text$))
NotLineNum:
NextLine2:
      PRINT #2, text$
    WEND
    RETURN

SR 5
OutputLabel:          '_____ send label to output file
    temp$ = symbol$(check) + ":"
    PRINT #2, temp$
    RETURN

SR 6
ExtractNum:           '_____ extract number from string
'Given:  text$, chrPos
'Return: numVal = int value, numLen = # of chars
'Side affect: chrNum to point to the next char in text$
    GOSUB SkipSpaces
    i = chrPos : iStart = chrPos
    WHILE i <= LEN(text$) AND INSTR(1, validDigit$, MID$(text$, i, 1))
      i = i + 1
    WEND
    IF i = iStart THEN NoNumber
    numLen = i - chrPos
    numVal = VAL(MID$(text$, chrPos, i - chrPos))
    chrPos = chrPos + numLen                          'move past number
    GOTO ExtLExit
NoNumber:
    numVal = -1 : numLen = -1
ExtLExit:
    RETURN
```

SR 7

```
SkipSpaces:                    '_____ move chrPos along text$ while it points to
                                                              'char in passOK$
  WHILE chrPos <= LEN(text$) AND INSTR(passOK$, MID$(text$, chrPos, 1))
    chrPos = chrPos + 1
  WEND
  RETURN
```

SR 8

```
AddSymbol:                     '_____ add line number to symbol table
  FOR check = 1 TO labels
    IF lines!(check) = lineNumber THEN symbol$ = symbol$(check) : RETURN
  NEXT
  labels = labels + 1
  symbol$ = "LABEL" + MID$(STR$(labels), 2, LEN(STR$(labels)))
  symbol$(labels) = symbol$
  lines!(labels) = lineNumber
  RETURN
```

SR 9

```
InitScrollInfo:                _____ initialize what is needed to scroll sideways
' Each word to scroll is divided into FrameNum frames, or pictures of hSep
' pixels wide.  The words are written on the screen, then the frames are
' read back into picture rectangle.
  CLS
  CALL MOVETO (10,20) : PRINT "BASIC ";
  CALL TEXTMODE(1) : CALL TEXTFACE(1)                  'bold, OR onto screen
  PRINT "1"
  FOR n = 0 TO frameNum                          'get frameNum frames from screen
    GET (10 + n * hSep,10) - (10 + (n + 1) * hSep, 25), num1Pict%(0,n)
  NEXT

  CLS
  CALL TEXTFACE(0) : CALL MOVETO (10,20) : PRINT "BASIC ";
  CALL TEXTFACE(1) : PRINT "2"
  CALL TEXTMODE(0) : CALL TEXTFACE(0)                  'change back to normal
  FOR n = 0 TO frameNum                        'get FrameNum frames from screen
    GET (10 + n * hSep, 10) - (10 + (n + 1) * hSep, 25), num2Pict%(0,n)
  NEXT

  CLS                          'set up corners of rectangle to scroll BASIC 1 through
  oneRleft = 30 : oneRtop = 30
  oneRright = 170 : oneRbot = 30 + 15
                                'and corners of rectangle to scroll BASIC 2 through
  twoRleft = 290 : twoRtop = 30
  twoRright = 430 : twoRbot = 30 + 15
                               'justOne is how many times just BASIC 1 is scrolled
  justOne = (twoRleft - oneRleft) / hSep
  RETURN
```

SR 10

```
ScrollOnce:                    _____ scroll words to right one time
  SCROLL (oneRleft,oneRtop) - (oneRright,oneRbot), hSep, 0
  PUT (oneRleft,oneRtop) - (oneRleft + hSep, oneRbot), num1Pict%(0,num1), OR
  num1 = num1 - 1
  IF num1 < 0 THEN num1 = frameNum
```

```
    IF times < justOne THEN NotTwo              'haven't scrolled enough: don't do BASIC 2
    SCROLL (twoRleft,twoRtop) - (twoRright,twoRbot), hSep, 0
    PUT (twoRleft,twoRtop) - (twoRleft + hSep, twoRbot), num2Pict%(0,num2), OR
    num2 = num2 - 1
    IF num2 < 0 THEN num2 = frameNum
    times = justOne
NotTwo:
    times = times +1
    RETURN

SR 11
ShowConvert:                '_____________________ show word 'MacConvert' inside box
    LINE (oneRright + 1, oneRtop - 10) - (twoRleft - 1, oneRbot + 5), , b
    CALL TEXTFONT(0) : CALL TEXTMODE(1)
    CALL MOVETO(oneRright + 20, oneRtop + 10) : PRINT "MacConvert"
    RETURN

SR 12
ClearBottom:                '_____________________ clear bottom of screen
    tRect%(0) = oneRbot + 10 : tRect%(1) = 0
    tRect%(2) = WINDOW(3) - tRect%(0)
    tRect%(3) = WINDOW(2)
    CALL ERASERECT(VARPTR(tRect%(0)))
    RETURN
```

MacAnimate

Most of you, we're sure, have probably spent some time with MacPaint, and perhaps with other applications that allow you to create precise drawings with the "FatBits" option. After doing all the work of creating them, have you ever wished that your pictures could come to life and move around on the screen? If you have, MacAnimate is for you!

Animation is the process by which inanimate objects are manipulated so they appear to move. If you hold a strip of movie film up to the light you will see that it's made up of separate "frames" of images that change slightly from frame to frame. When played through a projector they give the impression of movement because the film runs fast enough to fool the eye into seeing a continuous flow of images. Another factor that contributes to the relative quality of the animation is the degree of change from one frame to the next. If the two views are radically different, the animation appears "choppy." For example, if in one frame a man's hand is by his side and in the next frame he's holding it straight out, when the film is projected it will appear that he jerked his hand up in a sudden spasm.

MacAnimate lets you create "frames" of images with a Frame Editor that uses the familiar FatBits picture-editing functions. You can create up to 12 different frames (18 with a 512K Fat Mac). Using a Sequence Editor, you then specify the order in which they are to appear. Finally, you can see your frames animated and control the speed and direction of the animated image. It's easy to make changes in the frames or the sequence, and then run the new animation. Both your frames and your sequence can be saved to or loaded from the disk.

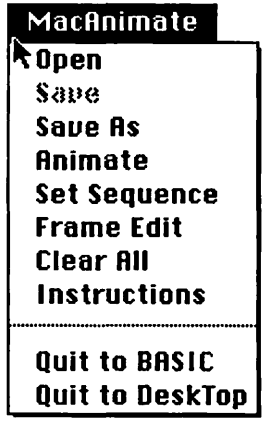
Those of you using version 2.1 of Microsoft BASIC on a 128K Mac will be disappointed to learn that MacAnimate is too large to run with the new version. This is because version 2.1 uses more of the Mac's memory than version 2.0, and the system of overlays presented here won't quite fit into a Slim Mac. The program will run nicely under version 2.0, though, and if you have a Fat Mac, you won't have a problem with either version.

The MacAnimate code features two important programming concepts: the manipulation of graphics stored in *bit arrays* and the use of *overlays*. Bit arrays allow graphics to be stored in a minimum of memory space, making it possible to have enough frames in memory to make animation feasible. The use of overlays allows more memory to be reserved for graphics while simultaneously permitting execution of the several sets of subroutines required to implement MacAnimate's many features. In effect, overlays allow your Mac to be as "fat" as you need it to be.

How to use MacAnimate

Let's go through the steps involved in creating an animated drawing. We'll demonstrate the process by creating and animating a helicopter with front and rear propellers.

After starting MacAnimate, you'll see the title screen shown in Figure 1. The MacAnimate menu controls all the steps in the animation process with these choices:



If you choose Instructions from the menu, you're presented with the window shown in Figure 2 on the next page, which provides a general description of the menu choices.

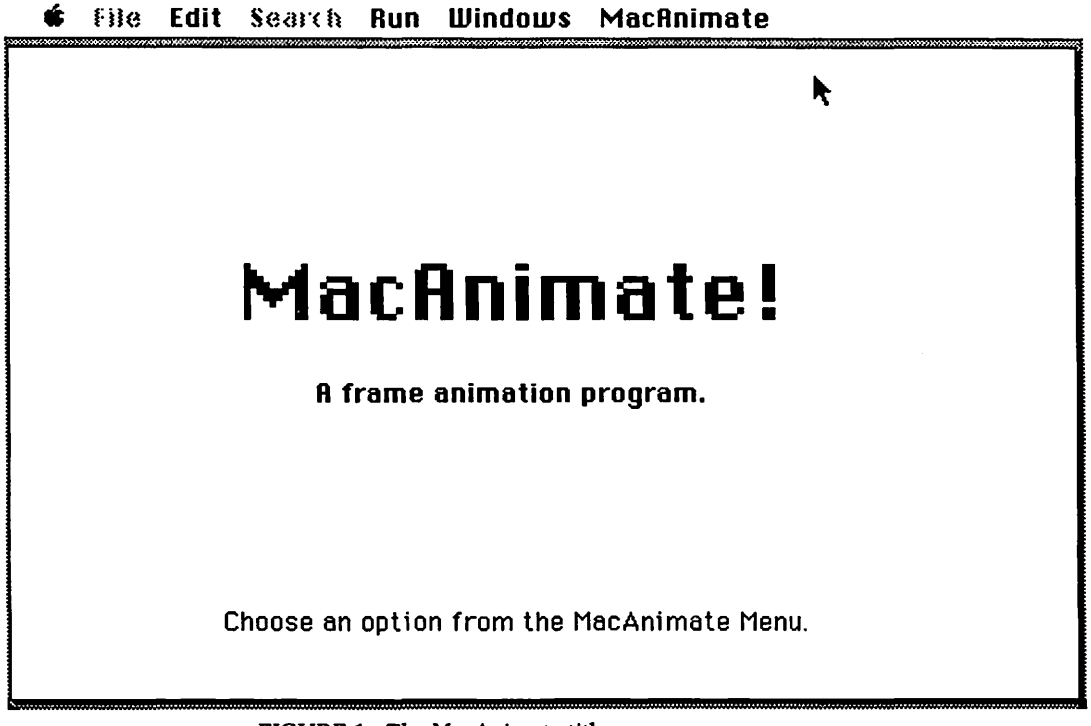


FIGURE 1. *The MacAnimate title screen*

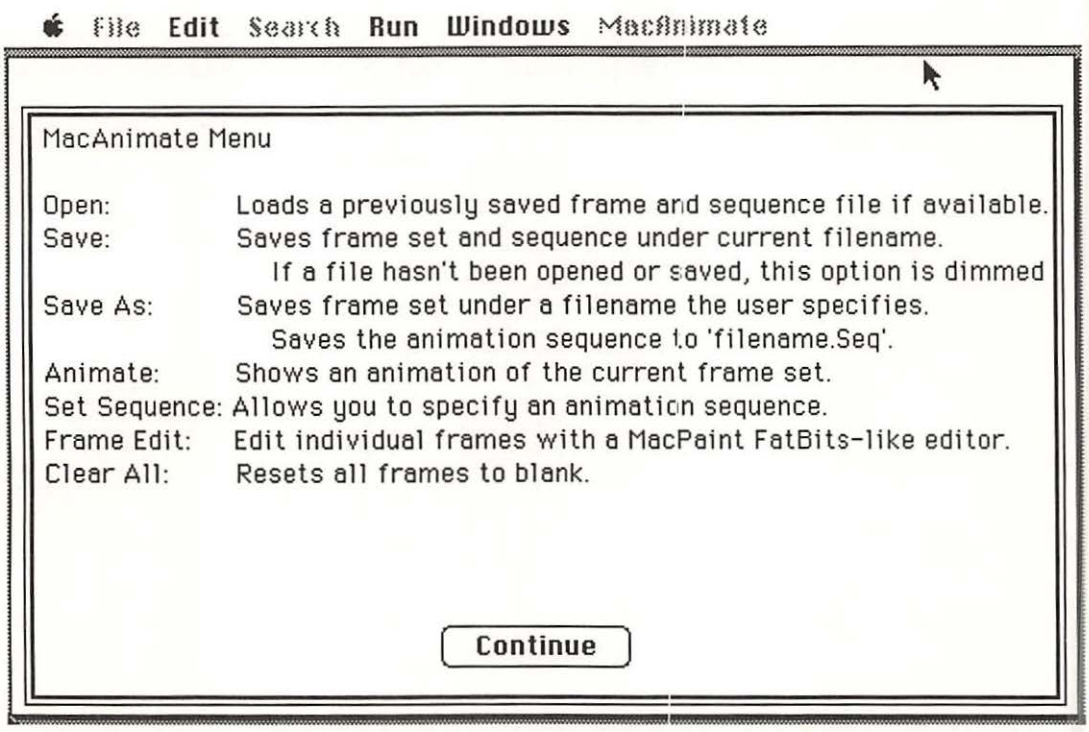


FIGURE 2. *The MacAnimate instruction window*

Editing the frames

The Frame Edit option is the first step in creating an animation. After choosing this option from the MacAnimate menu, you'll see a screen like that in Figure 3. As we mentioned, this screen uses the FatBits method for drawing pictures. The large rectangle at the left represents one "frame" of your animated sequence, and when you click the mouse pointer within the rectangle the "bit," or tiny square representing one screen pixel under the pointer, will be switched to its opposite state. This means that if the little square is white, it will turn black, while if it is black, it will be erased (turn white). The grid shown in Figure 3 is optional, and appears when the Grid button is clicked.

You use the Frame Editor to create each frame you need for your animation. How many frames you need (up to the maximum for your machine size) depends on how smooth you want the animation to be and what kind of motion you want to produce. For example, if you just wanted to create the image of a jet plane and move it around the screen, you might only need one frame because the animation routine includes the ability to "steer" the image around the screen. This would hardly be animation,

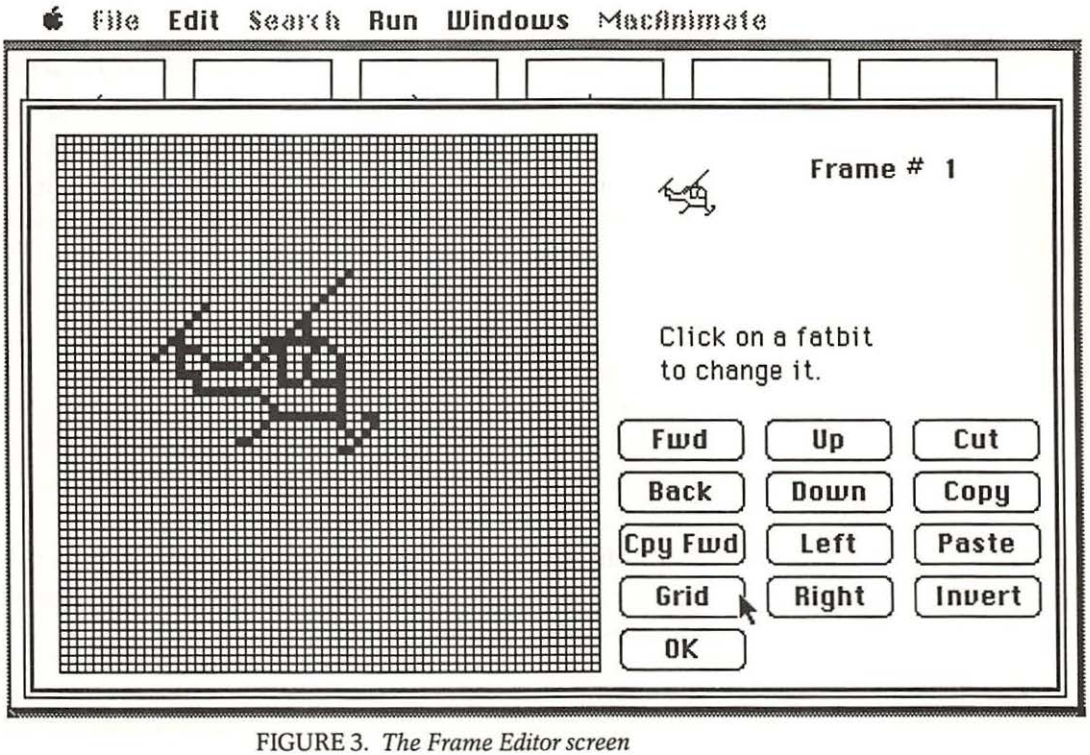


FIGURE 3. *The Frame Editor screen*

though, since there would be no movement or change *within* the object itself. In the case of our helicopter, we wanted to show the two propellers spinning, so we used four frames, one for each propeller position that could be shown. If we had had a larger, more elaborate propeller in mind, we would have needed more frames to show the various positions. If you wanted to do a realistic animation of a little man performing a tap dance, you might need to use all the available frames to show the small changes in position involved and produce a smooth animation.

Some other things to note about the Frame Editor screen are the frame number, which is displayed in the upper right corner of the screen, and the actual-size image of the contents of the current screen, which is shown just to the left of the frame number. Finally, in the bottom right corner of the screen is a whole flock of buttons. Let's look at what they do: We'll go down the columns of buttons starting on the left.

The Frame Editor buttons

Fwd moves to the next frame, which you can then edit. If you are currently on the last available frame (frame #12 or #18, depending on your machine memory size), it will "wrap around" to frame #1.

Back moves to the previous frame and enables you to edit it. If you are on frame #1, it will wrap around to the last frame (frame #12 or #18).

Cpy Fwd ("copy forward") copies the contents of the current frame to the next frame. Again, it will wrap around if necessary. Any existing contents of the frame being copied to will be replaced. Having made the copy, you can then edit it. This enables you to make small changes to an otherwise identical image, for instance, if only an arm is moving by small increments from frame to frame.

Grid superimposes the grid shown in Figure 3, which enables you to see exactly where the pixels are placed.

OK returns you to the "default screen" shown in Figure 4. This screen shows you the frames currently in use and the default file name (the last file you've opened or saved to, if any). You can then make another selection from the MacAnimate menu.

Up shifts the entire image up one pixel. Note that any pixel that moves beyond the top boundary of the editing area will be lost; you won't be able to get it back by clicking the Down button.

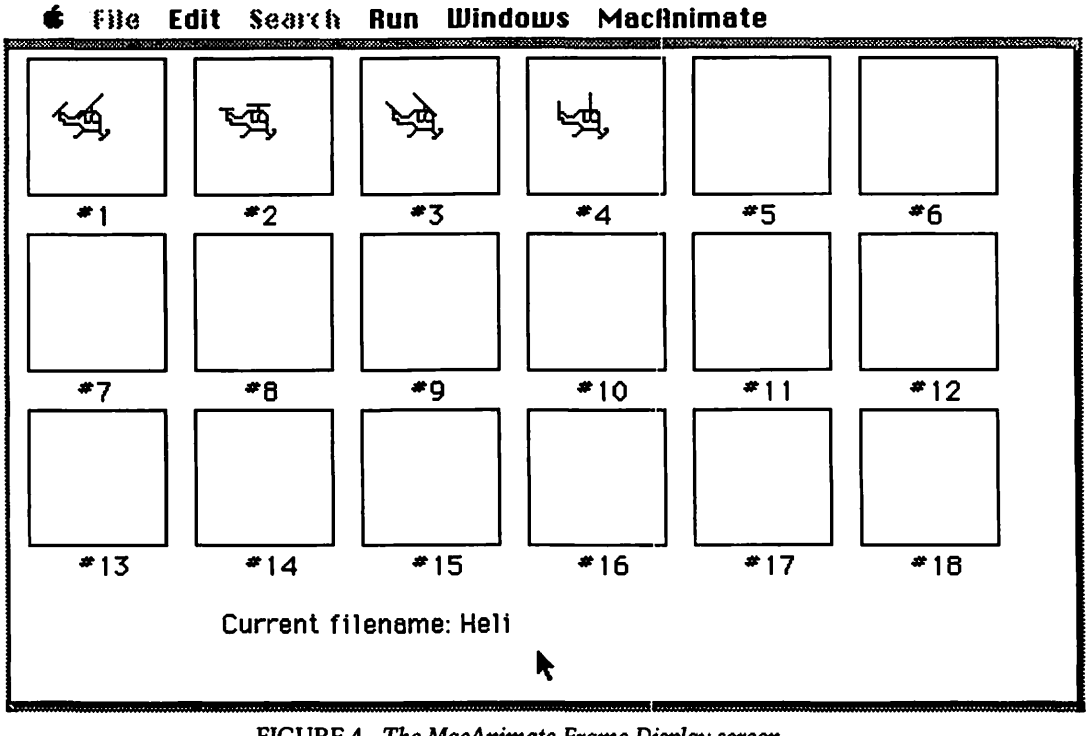


FIGURE 4. *The MacAnimate Frame Display screen*

Down works like Up except that it shifts the image one pixel down. Pixels that move below the bottom boundary of the editing area are lost.

Left shifts the image left one pixel. Pixels that move to the left of the left boundary are lost.

Right shifts the image right one pixel. Pixels that move to the right of the right boundary are lost.

Cut erases the image in the current frame and copies it to a pseudo-clipboard.

Copy copies the image in the current frame to the simulated clipboard but does not erase the image.

Paste copies an image stored on the "clipboard" to the current frame, replacing the frame's contents.

Invert inverts (reverses) all the pixels in the edit area. White pixels become black, and black ones become white.

Some editing tips

If you haven't done much FatBits-style drawing, you'll find it takes a bit of practice to get the image you want. You *can* draw a straight line by dragging the mouse, but it requires a steady hand. You may find it easier, though more time-consuming, to click on the pixels one at a time. The Grid option is useful for making precise and regular changes from frame to frame so you can animate a part of the figure—our propellers are a good example of this technique.

You can use the shift options (Up, Down, Left, and Right) to shift frames progressively in a specified direction. You can then combine this frame-to-frame motion with the motion controls in the Animation procedure to get interesting effects, such as a planet that appears to revolve in a circle (through shifting), rotate (through changing the surface features from frame to frame), and travel through space (through motion commands in the Animation procedure)...all at once!

Once you've edited a sequence of frames and animated them (we'll describe the animation procedure a bit later), you'll probably find that you want to go back and edit the frames some more. If you're editing a set of frames from a disk file and make a mistake (such as shifting the image part of the way out of the editing area), don't worry. If you've already saved the sequence as a disk file, the contents of your disk file aren't changed until you tell MacAnimate to again save your current frames to disk. Only saving to the current file name will change the contents of the file you last loaded.

Saving and reading sets of frames from disk

It can take a lot of work to create a series of frames for animation, so once you've completed one it's a good idea to save it to a disk file. You do this by choosing Save As from the MacAnimate menu. (If you're in the Frame Editor window, exit it first by clicking on the OK button.) After you've selected Save As, a standard file-save dialog box appears, and you can then specify the file name under which the animated sequence is to be saved.

A set of frames is read into memory by choosing Open from the MacAnimate menu. A standard file-opening dialog box appears, and you simply click on the name of the file to be opened (it must be a file created by MacAnimate). The file will be read into memory, and the full set of frames will be shown on the Frame Display screen. The file name selected is remembered; if you later choose the Save option, the frames in memory will automatically be saved to this file name. If a sequence file (discussed below) exists for the opened file, it will be read in also.

Setting an animation sequence

Animation requires more than a collection of images or frames. You also need to specify the order in which the frames will be shown. To do this, you must first have either created or read in from disk a set of frames. To set the sequence, choose Set Sequence from the MacAnimate menu. You will then see the screen shown in Figure 5.

The set of frames in use is shown at the top of the screen. At the bottom of the screen are 50 little boxes. Each box represents one frame, and the number that you place in the box represents the number of the frame you want to be shown at that point in the animation sequence. For example, we wanted our propeller animation to show the propellers revolving once each time frames #1 through #4 were displayed in order. If you look at the frames at the top of the screen, you can visualize this movement. We designed our frames so that the propellers move 45 degrees in each frame: Since both ends of a propeller move simultaneously, 180 degrees of motion of one blade gives the effect of the whole propeller moving 360 degrees. Because of the number of pixels used for the propellers and their relationship to the helicopter body, the propellers are most easily moved in steps of 45 degrees.

For our sequence we simply specified frames #1 through #4 to be shown in order. We didn't have to specify frame #1 being shown again after frame #4, since the defined sequence is automatically and endlessly

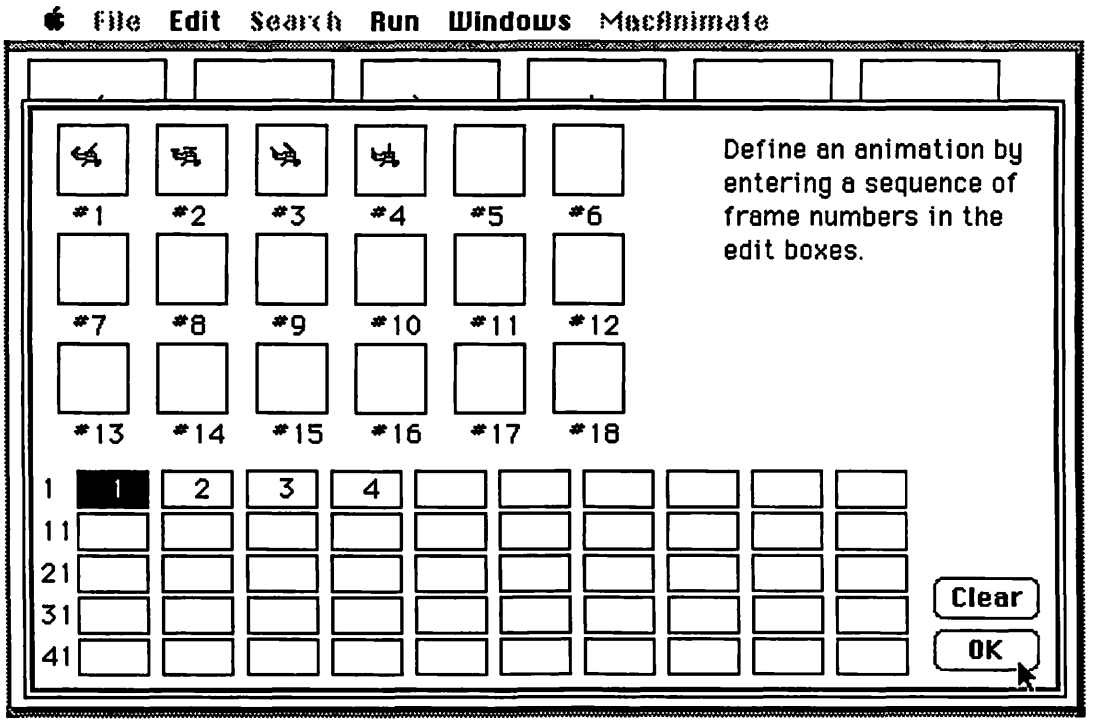


FIGURE 5. *The Set Sequence screen*

repeated during animation; you have to specify only one complete sequence. The order, of course, depends on how you want the image to appear to move, so it is important when defining sequences to make sure there is a smooth transition from the end of the sequence to its beginning.

The Sequence Editor uses standard Macintosh edit field functions (similar to those you would use to change the name of an icon, for example). The first box is shown in inverse (black on white), indicating that it is the frame position currently being edited. Clicking the mouse pointer in a box makes the box current, and a cursor appears in it. Numbers can be entered, cut, pasted, and so on using the usual Macintosh editing commands. If you want to clear out an existing sequence and start over again, click on the Clear button. Click on the OK button when you have finished entering the sequence.

The currently specified sequence will be saved to disk with the current collection of frames whenever you do a Save or Save As operation. The file name for the sequence will be the file name used in the Save operation, with the extension *.Seq*. When a file is opened, any existing sequence file is automatically loaded along with the frame file.

Running the animation

Once you have both a set of frames and a sequence, you're ready to see the animation in action. Choose Animate from the MacAnimate menu, and the screen in Figure 6 appears. You will then see your animation running near the center of the screen.

Note the instructions at the top of the screen. As they indicate, the F and S ("fast" and "slow") keys control the speed of the animation. The delay is initialized to 500 (rather slow), but it can be reduced as low as 1 by pressing the F key repeatedly. By using the S key, on the other hand, you can *increase* the delay to a large number so that you can see the animation in very slow motion and observe the movement closely from one frame to the next.

Note that the I, J, K, and M keys form a diamond on the keyboard. You can think of them as a kind of joystick that controls the speed and direction of the image. The I key moves the image toward the top of the screen; hitting the key repeatedly makes it move faster. The M key moves the image toward the bottom of the screen. If the image is already moving up the screen, hitting the M key first slows down its upward movement and

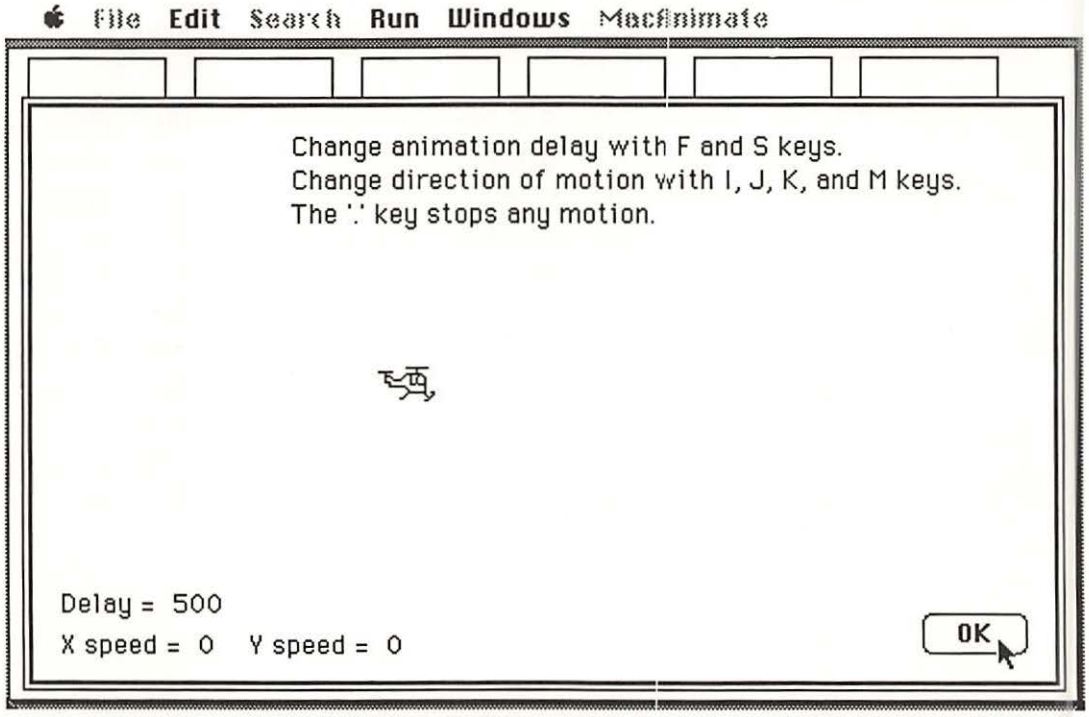


FIGURE 6. *The Animate screen*

then begins an increasing downward movement. The J and K keys work the same way to move the image left or right on the screen, respectively.

The X and Y speeds are shown in the bottom left corner of the screen. A negative Y speed is up; positive is down. A negative X speed is toward the left, and positive is toward the right. Since up/down and left/right speeds are independent of each other, you can be moving both up and to the right at different speeds, for example. The period key stops all directional motion of the image, but animation of the image itself continues.

Directional movement wraps around the screen: Going above the top of the screen resets the image to the bottom, and so on. When you're through running the animation, click the OK button in the lower right corner of the screen.

Now that you know all the steps involved, we encourage you (if encouragement is needed!) to create some frames and sequences and play with them. We suggest starting with simple images and sequences. Don't forget to save your work to disk if you want to keep it. When you want to exit MacAnimate (perhaps for food or sleep), you can select our usual Quit to BASIC or Quit to Desktop option from the MacAnimate menu.

How MacAnimate works

The program outline for MacAnimate is shown in Figure 7 on the next page. As you can see from it, and from the program listing itself at the end of the chapter, this is a very long program (although it really isn't too much more complicated than most of the others in the book). Consequently, our explanation of the program in the following sections will necessarily be a bit less thorough than those for the other programs in the book. But we've made sure to cover the most interesting and important aspects of the program. We also sometimes refer to other chapters where some of the techniques used in MacAnimate are discussed in depth.

This chapter also introduces a new aspect of BASIC programs, called *overlays,* which required that we somewhat modify our labeling scheme for the program outline and listing. The sections of the main MacAnimate program are labeled as usual, beginning with [Init 1], but you will discover that each of the four overlay sections of the program has a special sequence of keyed labels, prefixed with the overlay number. Thus, Overlay 0 is labeled from [OVR0-1] through [OVR0-4]; Overlay 1 is labeled from [OVR1-1] through [OVR1-15]; and so on.

Initialization	
each time program is run, find number of current overlay	**Init**
if Overlay 0 not present, merge and run it (**BringIn**)	SR 6
Main Program	
run endless loop, interrupted by menu events	**Main**
Menu Events	
MenuEvent: branch to appropriate subroutine	**ME 0**
after menu subroutine processed, redraw frames (**AftrMenu**)	SR 1
FIO: load or save file	**ME 1**
if Overlay 2 not present, merge and run it (**BringIn**)	SR 6
Animate: run animation	**ME 2**
open second window (**OpenWindow**)	SR 5
show instruction text	
create OK button in corner	
if no sequence loaded, display error message	
initialize animation variables	
display animation settings (**ShowSettings**)	SR 2
WHILE not quitting (OK button clicked)	
find current location and frame number of image	
if image not moving, draw with PSET	
if image is moving, draw with XOR	
if animation delay or direction keys pressed, change delay or direction variable	
pause for length of delay before redrawing	
change location of image	
modify location if window boundary crossed	
increment sequence number	
draw next image at new location	
WEND	
close second window	
Sequence: set animation sequence	**ME 3**
open second window (**OpenWindow**)	SR 5
create sequence edit fields (**EditFields**)	SR 3
display instruction text	
show frame set at reduced size (**ShowFrames**)	SR 4
create OK and Clear buttons	
WHILE not quitting (OK button clicked)	
if Clear button clicked, clear all edit fields (**EditFields**)	SR 3
if tab key pressed, move to next edit field	
WEND	
save contents of edit fields in sequence array	
close second window	
EdFrame: edit individual frame	**ME 4**
if Overlay 1 not present, merge and run it (**BringIn**)	SR 6

(continued)

FIGURE 7. *Program outline*

```
    ClearAll: clear all frames                                    ME 5
      clear screen
      reset current filename
      save blank image into each element of frame array

    Inst: display instructions                                    ME 6
      if Overlay 3 not present, merge and run it (BringIn)        SR 6

    BQuit: quit to BASIC                                          ME 7

    DQuit: quit to Mac Desktop                                    ME 8

Subroutines
  AftrMenu:                                                       SR 1
    show all current frames (ShowFrames)                          SR 4
    enable menu selection

  ShowSettings: print animation settings                          SR 2

  EditFields: display grid of edit fields                         SR 3

  ShowFrames: display grid of frame collection                    SR 4

  OpenWindow: open second window for frame operations             SR 5

  BringIn: merge and run specified overlay                        SR 6

Overlays
  Overlay 0: Initialize program (MacAnimate.Ovr0)
    determine whether running on Slim or Fat Mac                  Ovr0-2
    dimension arrays for frame bitmaps, frame sequence
    initialize arrays, cursor pattern and grid pattern
    define constants for window size, animation delay, etc.
    set main output window                                        Ovr0-3
    display title screen
    install and enable MacAnimate menu

  Overlay 1: edit frames (MacAnimate.Ovr1)
    open second window (OpenWindow)                               SR 5
    set constants and dimensions of edit area
    define function to determine if mouse pointer in edit area
    create buttons for editing
    display instruction text
  WHILE not quitting (OK button clicked)
    show current frame number and contents
    draw background grid if selected
    WHILE not a new frame and not quitting
      get mouse pointer location
      if pointer in edit area, change to pencil cursor
      if mouse button is down while pointer in edit area
        calculate corresponding bitmap pixel
        reverse color of pixel
                                                                  (continued)
```

Figure 7. Program outline (continued)

```
        WHILE button still down (AffectBits)                    OVR1-15
          get cursor location
          keep drawing in same color
        WEND
        save new state of frame in frame array
      if mouse button is down while pointer not in edit area
        check if editing button clicked
        branch to appropriate subroutine (see below)
    WEND
  WEND

Overlay 1: Subroutines
  Fwd: increment frame number                                   OVR1-3
  Shift: shift image up, down, right or left                    OVR1-4
  Cut: cut image to "clipboard" array (ToClip)                  OVR1-5
  Back: decrement frame number                                  OVR1-6
  Copy: copy image to "clipboard" array (ToClip)                OVR1-7
  CopyFwd: copy image forward to next frame (Fwd)               OVR1-8
  Paste: copy image from "clipboard" array (FromClip)           OVR1-9
  Grid: set backgound grid for edit area if selected            OVR1-10
  Invert: reverse all bits in edit area, resave image to array  OVR1-11
  OKBtn: set flag to leave WHILE...WEND loop                    OVR1-12

  ToClip: copy image to "clipboard" array                       OVR1-13
  FromClip: copy image from "clipboard" array                   OVR1-14
  AffectBits: change bits in image while button still down      OVR1-15

Overlay 2: file input/output (MacAnimate.Ovr2)
  on menu event, branch to appropriate subroutine:              OVR2-1

    OpenFileOvr: get frame and sequence files from disk         OVR2-2
      get filename from user
      if file not found, return
      load frame file into bitmap array
      if sequence file not found, return (FileError)            OVR2-5
      load sequence file into array

    SaveFileOvr: save frame and sequence arrays to disk         OVR2-3
      use current filename
      save frame set array
      save sequence array

    SaveAsOvr: save as: save frame and sequence arrays to disk  OVR2-4
      get filename from user
      if no name entered, return
      save files (SaveFileOvr)                                  OVR2-3

Overlay 3: display instructions (MacAnimate.Ovr3)
  open second window                                            OVR3-2
  display instruction text
  create OK button for quitting overlay
  wait for button click to end instructions
```

Figure 7. Program outline (continued)

Program overview

The key to the structure of MacAnimate is its use of *overlays.* When the program is first run, the code listed under Main Program is loaded into memory. This code includes (among other things) the usual "endless" main program loop that waits for menu selections, the main menu event-handler, a secondary handler for file I/O (input/output) routines, and finally the subroutines that run the actual animation.

The MacAnimate program has to handle many operations, including initialization, disk-file operations, frame editing, and showing instructions. If all this code had to be kept in memory all the time, there wouldn't be much memory left for the array of bit maps that holds the frames to be animated. In fact, when writing this program we ran into a real problem trying to provide all of MacAnimate's nifty features and still leave memory for enough frames for animation: The problem is especially acute on a 128K Slim Mac.

The solution was to break the code into blocks of logically related operations and then load in only the segment needed for the operation being performed. Thus, when frame editing (for example) is called for, the subroutines involved in frame editing are loaded and added to the program in memory. If the user then decides to perform disk operations, the code for frame editing is replaced or "overlaid" with the code for disk I/O.

This process is actually implemented by ending the main program (the part that always remains in memory) with the labels 5000 and 5999 [SR 6]. These labels define the overlay area—the "slot" into which overlays are inserted. When the program is first run, Overlay 0, containing the initialization subroutines, is brought in. Later, when the user makes a menu selection, the appropriate subroutine checks to see whether the overlay containing the subroutines needed to perform the requested function is currently in memory. The variable *overlay* contains the number of the overlay currently in use (there are four overlays, named *MacAnimate.OvrN,* where *N* is the overlay number from 0 through 3). Each overlay contains a DATA statement with the overlay's identifying number, so the program can READ it in order to determine which overlay is in memory when the program is run. (This is necessary because the program may have been stopped and then run again from BASIC, for example.)

Overlays are "brought in" (loaded and added to the main program) by BringIn [SR 6]. The variable *newOvr* specifies the number of the overlay to be brought in, and the current overlay number in *overlay* is also set to this overlay's number. The CHAIN statement actually brings the overlay into the program.

The reserved word CHAIN indicates that a program will be brought in from disk. MERGE specifies that the program being brought in will merge with, rather than replace, the existing program (MacAnimate itself). The variable *ovr$* contains the name of the overlay program, and 5000 is the line number to which control will be transferred (the Microsoft BASIC manual emphasizes that you have to use a number, not an alphanumeric label, for this purpose). All overlays in MacAnimate begin with 5000 and end with 5999: Between them, regular alphanumeric labels can be used (and are in MacAnimate).

The ALL specifies that all variables in the main program (except variables local to subprograms, if any) will be available to the overlay as well. The *DELETE 5000-5999* tells BASIC to delete any existing code between the numbers 5000 and 5999 before bringing in the overlay (that is, to delete the current overlay before bringing in the new one). The CHAIN statement can be used with other options: for example, to transfer control to another program without overlaying.

Initialization

The FileName$ function, defined at the start of [Init], finds the colon that separates the volume (disk) name from the name of the file itself, then extracts the latter. This avoids having to display very long file names when the volume part is unnecessary.

We've already given a general description of the way overlays work. The initialization overlay, known by the file name *MacAnimate.Ovr0* [OVR0-1], is brought in by BringIn [SR 6]. When the program is run, the number of the overlay currently loaded into memory is determined. This is done by using READ to get the number specified in the DATA statement at the beginning of the current overlay starting at the label OverlayData.

We have used a "dummy" overlay number at the end of the main program to force the program to merge the first, initialization overlay. The way you should enter these programs is to type in the main program and save it under the name *MacAnimate*. Then type the overlays in separately, saving each under the name *MacAnimate.OvrN*, where *N* is the number of the overlay. By entering the program in this way, it will be easy to edit and debug each module independently, without affecting any of the others.

At the beginning of [OVR0-1] is a sequence of code common to all the overlays. The code sequence begins with a GOSUB to whatever subroutine is needed to continue appropriate processing. Here, it's Initialize

[OVR0-2] (in other overlays, control may be switched to subroutines to process other program functions, such as the current menu selection). After the subroutines in the overlay are processed and control returns to the start of the overlay, the ON MENU GOSUB and MENU ON statements must be repeated. This is due to the fact that the CHAIN MERGE statement used to bring in overlays disables all event trapping; so we have to make sure that event trapping is turned on before jumping back (via a GOTO) to the endless loop in the main program.

In those overlays that are called in response to menu events (that is, all but the initialization overlay), AftrMenu [SR 1] is called just before the program returns to the main loop. This subroutine clears the screen and shows the "default screen" using ShowFrames [SR 4] (Figure 4), which is always shown when a menu event has been processed. If a default file isn't present (*file$* = ""), the user is reminded to choose an option from the MacAnimate menu. If a file is present, its name is shown (using the FileName$ function to remove the unnecessary volume designation). At the end of AftrMenu, the MacAnimate menu is re-enabled.

If an overlay is already in memory when it is needed, an ordinary GOSUB in that menu-event subroutine in the main program is used to jump to the appropriate subroutine in the overlay. There is no need in this case to execute the statements at the beginning of the overlay, since event trapping and the menu don't have to be re-enabled. Upon return from that subroutine, control will return to the endless main loop in the normal way from the menu-event subroutine without a GOTO being necessary.

Now let's look at what the initialization overlay does, beginning with [OVR0-2]. The number of sequence positions *maxSeq*, and the parameters for displaying each frame are given first. Next, the memory capacity of the machine running the program is determined. The BASIC function FRE(0) returns the number of free (unused) bytes in BASIC's memory space. A number larger than 30000 could be used, but we know that BASIC will never have as many as 30,000 free bytes on a 128K Mac (there are less than 21,000 free bytes even when no program is loaded). You might find this technique useful if you write a program that can offer additional features or capacity on larger machines but that will also run as a "bare bones" version on Slim Macs. Here, *maxFrames*, the number of frames that can be used in an animation set, is set to 18 if the Mac is fat and 12 if it is not.

Now the three main arrays are dimensioned. Each element of the *frame* array is a bit-mapped image. The size of one element in bytes is determined using a simplified form of the formula given in the Microsoft

BASIC documentation under the GET statement. The number of integer elements (remember, an integer is two bytes or 16 bits) in one frame works out to 327, or 654 bytes. (You can see why we must use whatever tricks we can find to maximize the amount of memory available for frames.) The *frame* array thus has *maxFrames* elements of *arraySize* integers.

Clip, the array that holds one frame copied from the Frame Editor, has one element of *arraySize.* The array *seq* has *maxSeq* integer elements, each holding one sequence position number. A little further on, *seq* is initialized by a FOR...NEXT loop to all negative 1s. This is done so we can abort an animation if there is no current sequence (*sequence(1)* = −*1*), and also so the Sequence Editor will show all the edit fields as blank.

The pencil cursor is next read into an array called *pencil.* The cursor was created with MacCursor, another utility found in this book, using data statements generated by MacCursor and transferred via the Clipboard. The DATA statements appear in [OVR0-4]. If you want a different cursor (a quill pen, perhaps?), you can easily create it with MacCursor and substitute its data statements for ours. The grid pattern (*gridPat*), used as an option with the Frame Editor, is then initialized.

Next, various constants used by the program are set. The patterns *patBic* and *patOr* stand for the "black is changed" and "OR" modes. These will be used in the Frame Editor to draw a grid as selected. The boundaries of the secondary window (which is used for Frame Edit, Sequence Edit, and Animate), as well as the size of a FatBit in pixels are specified, as are the current frame number (1) and delay (500).

ClearAll [ME 5] is called to initialize the bit maps for the frames in the *frame* array to empty. The screen is cleared, and the current frame file name is set to null (that is, there is no current frame file). This is done with a FOR...NEXT loop in ClearAll that simply GETs the image in the upper right corner of the screen corresponding in dimensions to the frame edit area. Since the screen is blank, the image stored in the bit map in the array is also blank. When the loop is finished, all of the *frame* array elements represent blank frames.

Next, in [OVR0-3] the primary window is set up and the title screen is drawn. Its operation is very straightforward.

The last step of the overall initialization sequence is creating the MacAnimate menu. Note that when the menu is first created, the Save option is dimmed, since there can be no current file to save when the program first starts up. When the Save As option is used, thus establishing a current frame file, the Save option will be enabled.

Control now returns to the beginning of Overlay 0, where Initialize was called so very long ago. Then, as mentioned before, menu event-trapping is enabled, and a GOTO sends us to the endless loop in the main program [Main] to wait for a menu selection.

We'll now describe the operations involved in handling the menu items, taking them in order. Some of the options are simple enough that you can easily figure out how they work with the aid of the program outline. We'll reserve detailed explanations for the more complex ones.

File I/O operations

If MenuEvent [ME 0] determines that one of the three file I/O operations (Open, Save, Save As) was selected, control goes to the file-handler subroutine FIO [ME 1]. This subroutine calls BringIn [SR 6] to bring in Overlay 2 (*MacAnimate.Ovr2*) if it's not already loaded. The options are then processed [OVR2-2] using Overlay 2's subroutines.

If Open is chosen, a new frame file is opened by the subroutine OpenFileOvr [OVR2-2]. The BASIC FILES$ function is used to get a file name from the user: The file must be a TEXT type, so only files of that type are shown. If FILES$ returns a null file name, then no file was selected (the Cancel button was pushed instead), and OpenFileOvr returns. Otherwise, the variable *pict*, which counts the number of frames read in, is set to 0.

A WHILE...WEND loop reads in the frames. In addition to testing for EOF, it tests for more than *maxFrames* being read in. If *maxFrames* is exceeded, any further images in the file aren't read in—to do so would cause the index to the *frame* array to go out of bounds. If *maxFrames* isn't exceeded, the frame read with INPUT$ is displayed on the screen by a PICTURE statement, and the image is then stored from the screen into the current element of the *frame* array. Finally, the current file name is set to the name just used, and the Save menu option, which is now relevant, is enabled as mentioned earlier.

The sequence file is then read in. The extension *.Seq* is added to the file name, and the program attempts to open this file. If an error occurs (probably due to the file not being present on the disk), FileError [OVR2-5] is called. This subroutine halts the program completely (with *GOTO 0*) if the file error is something other than "File not Found"—perhaps an unresolved program bug. Otherwise, it simply sets the flag *fileHere* to *false* and OpenFileOvr RETURNs; otherwise the sequence file is read in.

The Save option is handled by SaveFileOvr [OVR2-3]. First, a FOR...NEXT loop clears the screen, then saves each frame by turning

on picture recording (PICTURE ON), displaying the corresponding element of the *frame* array, getting the graphics in string form from PICTURE$, and printing the length of the string in bytes and then the string itself to the file. You can check the OpenFileOvr subroutine again to verify that pictures are read back as a byte count (that is, string length) followed by the picture string itself. The file name for the sequence file is then created by adding the extension *.Seq*, and a second FOR...NEXT loop is used to save the sequence file.

Save As works the same way and also uses SaveFileOvr. However, since a file name is needed, it is first obtained from the user by a call to the SaveAsOvr [OVR2-4], which uses the FILES$ function to get a file name. Since Save As, like Open, establishes a current file name, the Save menu option is enabled.

Animation

The Animate subroutine [ME 2] handles the animation and sequence of a frame set. A secondary window is first opened by a call to OpenWindow [SR 5]. Animation doesn't require an overlay, so all necessary routines are in the main program.

First, the starting (x,y) coordinates for the instruction text are set, and the instructions telling the user which keys to use are displayed. The OK button is set up relative to the lower right corner of the screen. Then the first element of the *seq* array is checked; if it's a -1, there is no current animation sequence. The user is then told to define an animation sequence before using this option, and the subroutine returns.

If there is an animation sequence, the current frame number is set to 1, and the working (x,y) coordinates for the animation in (*aX,aY*) are initialized. The speeds *xSpd* and *ySpd* are set to 0. ShowSettings [SR 2] is called to show the current value of the delay factor, and the current x and y speeds of the sequence.

A WHILE...WEND loop beginning with *WHILE NOT aQuit* is used to do the animation until the user clicks OK to quit (setting the flag *aQuit* to *true*). In the next line, the variables *x* and *y* are set to the working values (*aX,aY*), and the variable *c* is set to the current frame number (*crnt*).

To understand the next three statements, you must note that at the end of the loop a new set of coordinates for the image is calculated based on its x and y speeds. The result is, in effect, a "new" image: the next one in the sequence (this is true every time except the first time the loop is executed, of course). If both the x and y speeds are zero (*IF NOT moving*), the image hasn't moved since the last time it was checked. So the current

frame (that is, the one in the sequence after the last one drawn) is drawn with a PUT statement using the PSET option. There is no need to worry about the background, since the image hasn't moved, and the new image simply replaces the old. If either the x or y speed isn't zero (*IF moving*), the image has moved since last time through the loop. We therefore want to preserve the background we are moving over, so we draw the image by PUTting it with the XOR option.

DIALOG(0) is then checked to see if the user wants to quit. If so, the *aQuit* flag is set to *true* so the loop will exit at the end of this pass. We next check for a key press, first converting any key in the INKEY$ buffer to uppercase so the user doesn't have to worry about case. The keys can be considered in two groups: speed keys and direction keys.

For the F and S speed keys, the delay is decreased and increased respectively and then the new delay is shown. For the F (faster means less delay) option, by multiplying the current delay by a reduction factor, we create an adjustment that starts out with large increments but becomes finer and finer until it only changes the delay by 1. On the other hand, the delay can *increase* indefinitely via the S-key option and will do so in larger and larger increments. (Eventually, of course, you'll overflow the integer variable, but unless you're doing something like an animated study of real-time fungus growth, there is little point in having really large delays. If you just want to closely study individual frames, the Frame Editor works much better.) For both the F and S keys, the new delay value is shown by calling ShowSettings at the end of the section.

The direction keys (J, K, I, M) simply increase or decrease the appropriate speed by one pixel per key press. The period key stops directional movement by setting both speeds to zero. The new x and y speeds are shown via a call to ShowSettings in all cases.

The *WHILE INKEY* <> "" : *WEND* loop following the key processing is a useful trick to remember. Impatient users have been known to hit a key a dozen times or so before they're satisfied with what is happening, but this loop clears out the keyboard buffer so only one key is processed at a time. The user gets a chance to see what happened—and only then can press another key with effect.

A delay loop next pauses for the length of the specified delay. The x and y speeds are then added to the working variables *aX* and *aY*, and we check to see if the new coordinates would place the image outside a window boundary. If you visualize the coordinates in terms of the window width and height, you'll see that if a boundary is exceeded, the image's coordinates are changed to put it just one frame width inside the *opposite*

boundary. Next, the number of the frame to be shown is incremented. The MOD function is used to wrap the frame after *maxSeq* to frame 1. If there are less than *maxSeq* sequence numbers, the number following the last valid one will have been left as −1 by the Sequence Editor. Therefore, if a −1 is encountered, the current sequence number is reset to 1.

Finally, if either or both of the x and y speeds are not 0, the image is drifting across the screen. The effect is created by erasing the current image by PUTting it at its location with the XOR option, then returning to the top of the loop to draw the new image at the new position.

When the user clicks the OK button, control drops through the bottom of the WHILE...WEND loop, the secondary window is closed, and control returns to the main program loop.

The Sequence Editor

The Set Sequence menu option is handled in [ME 3]. The secondary window is first set by calling OpenWindow. Then the top and left boundaries of the edit field area are set. EditFields [SR 3] is called to open the sequence edit fields. In this subroutine, the flag *seqEnd* is set to *false,* and the number of columns is set to *INT (maxSeq / 5).* Note that the extra effort expended here and throughout the routine to make the layout more flexible means that the routine can be used to set up a smaller or larger number of edit fields if desired.

The FOR...NEXT loop in EditFields first finds the left and top coordinates for each edit-field box. The left coordinate is the left boundary of the edit area (*leftEd*) plus the column number times the width of one edit field (40). As is usual with offset-oriented operations, the column number must start with 0 for this to work, so we subtract 1 from the value of the loop index which is the same as the number of the edit field. Using MOD with the index gives us a column number that wraps around to 0 each time the number of columns (*col*) is exceeded.

The top of the edit-field box is determined in a similar fashion, except that we use INT to find the integer result of *dividing* by the column number. This means that we add the height of one row each time we use up one set of columns, thus putting each edit field in the correct row. The final coordinate is obtained by multiplying by 20, the height of an edit field.

Since we want to print a guide number to the left of each row of edit fields, *(n − 1) MOD col* is again checked to see if we are at the start of a new column. If we are, the loop index is printed as a guide number. The value of the element in the *seq* array corresponding to the current edit

field is then checked, and the flag *seqEnd* is set to *true* if a −1 is found. The string to be printed in the edit field is null (nothing will be printed) when the value is −1; otherwise, the value is converted to a string for printing.

The EDIT FIELD statement opens each edit field. The edit field is given the loop index *n* as an identifier, the string converted from the *seq* array value as the string to be shown and edited, a rectangle defined from the coordinates (*l,t*) we just calculated, and options indicating that a return or tab key will move the user to the next field and that text will be center justified. The current edit field is set to 1. (A more detailed discussion of edit fields can be found in the chapter on MacGraph.)

After the edit fields have been established, control returns to Sequence [ME 3]. The coordinates for the start of the instruction area are set, and the instruction lines are printed relative to them. ShowFrames [SR 4] is then called to display the current set of frames at the top of the Sequence Editor screen. This subroutine is general purpose: It is also used to show the frames on the "default" (waiting for menu events) screen. The variable *reduction* controls the size of the frame images: The width and height in pixels are both divided by the value of the reduction. After this calculation is done and the width and height of the frame are reduced accordingly, the left (*showL*) and top (*showT*) boundaries of the area in which the frames will be shown are set.

The FOR...NEXT loop in ShowFrames displays the total of *maxFrames* frames. The width plus 15 (to allow for the space between frames) is multiplied by the current column position. The height plus 20 is multiplied by the current row. (We need a larger gap between rows so the frame numbers can be printed there.) The column and row numbers are calculated using the same method that was used for spacing the edit fields, except that the total number of columns here is in the constant *fPerLine*. A LINE statement with the "box" option is used to draw each empty frame, and then the corresponding image in the *frame* array is PUT into the box. The pen is then positioned below the frame, and the number is printed as a string, right-justified by the use of the RIGHT$ and LEN functions.

After the frames have been shown and control has returned to Sequence, the OK and Clear buttons are established. OK is set to *false*, and a *WHILE NOT OK...WEND* loop is used to actually edit the fields. The value of DIALOG(0), assigned to *diag*, is checked first to see whether a button was pushed. If it was, DIALOG(1) is checked to see which button was pushed. If DIALOG(1) = 1, the OK button was pushed, so the value of OK is set to *true*. If DIALOG(1) = 2, the Clear button was pushed, so the first

element of *seq* is set to −1 and EditFields is called. We've already seen that under these conditions, EditFields will show all the edit fields and their contents as empty.

If *diag* = 2, the mouse has been moved into a new edit field and clicked, and the identifier of the new field is returned by DIALOG(2)—it is defined this way by the BASIC field-editing routines. In this case, the current edit field is set to the new edit field. The values 6 and 7 in DIALOG(2) indicate that the Return (6) or Tab (7) key was used to move to the next edit field. If so, the current edit field is incremented by one (or wrapped around to 1 if necessary).

Once the user's editing is finished (the OK button is clicked), a FOR...NEXT loop gets up to *maxSeq* values from the edit fields (the values are accessed by the special function EDIT$, defined by BASIC). If the value is negative or greater than *maxFrames,* it is set to −1 and the sequence ends at that point. These values are then stored in the corresponding elements of the *seg* array. Closing the secondary window completes the Set Sequence option.

The Frame Editor

The EdFrame subroutine found in [ME 4] first calls in Overlay 1 (*MacAnimate.OVR1*) if it's not in memory. The EditOvr subroutine [OVR1-2], which has the dubious distinction of being one of the longest to be found in our programs, starts by opening the secondary window via a call to OpenWindow. The standard rectangular coordinates for the frame edit (FatBits) area are defined. (The 2 has to be subtracted in each equation in order to align the results of the InBits function with the actual pattern of FatBits in the edit area.

The coordinates for the borderless frame that will display the actual-size image are offset from the upper right corner of the edit area. The function InBits at [OVR1-2a] is then defined to check whether a given pair of coordinates is within the edit area. A FOR...NEXT loop reads in the names of the 13 buttons from DATA statements and sets them up. The instruction text is then displayed.

We now set OK to *false* as usual, then initialize *gridMode* to the BIC (black is changed to white) mode. This background is in effect invisible against the white screen, except that the crisscross lines change the black in the image to white and thus show the black pixels outlined in white. You can see the effect of this when using any of the image-shifting buttons: All the pixels are momentarily bigger, then shrink as the white

grid is written over them. The pattern is toggled back and forth between this one and OR mode (*patOr*), which draws the black-lined grid, by clicking the Grid button.

The *WHILE NOT OK...WEND* loop at [OVR1-2b] edits frames until the user clicks the OK button. First, the current frame number is printed in the upper right corner of the screen. Then the image in the current element of the *frame* array is PUT in the edit area. The pen mode is set to the current value of *gridMode,* and the grid pattern is set. The PAINTRECT statement fills the edit area with the current pattern, after which the pen is set back to normal. We will now let the user edit this frame until he or she either quits or activates a new frame for editing.

The *WHILE NOT (newFrame OR OK)...WEND* loop at [OVR1-2c] first checks the mouse status and location. If the InBits function indicates that the mouse isn't in the "bits" (edit) area, the cursor is set back to normal and a button press is checked for and processed if found.

If the mouse pointer is in the edit area, it is then checked to see whether the button is being held down. If it is, the grid coordinates of the FatBit the mouse is on are calculated. Next, the image currently being displayed to the upper right of the edit box is checked: The pixel in that image corresponding to the FatBit being clicked in the edit area is found by offsetting the FatBit coordinates from the edge of the "invisible" frame around the image, whose upper left corner is (*sX1,sY1*). This is a clever trick that lets us use the BASIC POINT function to obtain the color of this pixel so we can change it to its opposite. (The approach to this problem used in MacCursor is to keep a separate bit map and check the coordinates against it. Our approach here is equally arcane but has the advantage of not requiring the memory for *maxFrames* additional bit maps, which we don't have to spare!)

Once we've set the first pixel, AffectBits [OVR1-15] is called to change the color of this and all other pixels encountered as long as the mouse button is down in the edit area. The WHILE...WEND loop in AffectBits gets the screen coordinates of the mouse location and uses a PSET statement to offset into the real-size image and turn on the corresponding bit. The coordinates of the FatBit are then calculated, and it is drawn with a LINE statement with a box-fill in the required color. When editing on each frame is completed, the new frame is saved to the *frame* array. When the mouse button is no longer down, the new mouse status and location are obtained and the subroutine returns to EditOvr [OVR1-2].

The program outline gives a thorough description of how button options [OVR1-3] through [OVR1-14] are processed, so we'll leave it to you to compare the outline and the actual code and figure them out. Note that some buttons can affect the frame currently being edited. If this happens, control goes back up to the main WHILE...WEND loop in EditOvr and the new frame is set up. When editing is completed, the overlay concludes as described previously for other overlays.

Remaining menu options

The Clear All option calls ClearAll [ME 5], which we've already discussed as part of the program initialization. The Instructions [ME 6], Quit to BASIC [ME 7], and Quit to Desktop [ME 8] options are all standard for our programs, except that the instructions are in Overlay 3. This overlay is handled in the same way as the others, with the actual instructions appearing via InstOvr [OVR3-2].

Suggestions for MacAnimate

If you've followed us through this chapter, you'll no doubt agree that some of it was rough going, and there was certainly a lot of material presented. When you understand this program, you can definitely consider yourself a Macintosh applications expert!

When you feel you've gained a thorough understanding of how this program works there are a number of improvements that you might want to make. Before doing so, remember that adding significantly more code will either reduce the number of frames the program can handle, or will require the addition of new overlays and code to manage them.

You can create frame-editing tools other than a pencil (perhaps a brush?) using the MacCursor program found in this book. After creating the cursor, paste the DATA statements generated by MacCursor in place of [OVR0-4], or include both and provide buttons so the user can choose which of several different tools are to be used.

As in the case of our helicopter, many images you might work with will be considerably smaller than the grid size of 64 x 64 that we've used in MacAnimate. You could try changing the grid size to 16 x 16, which would allow many more frames to be used (though not sixteen

times as many, due to overhead). Alternatively, you can create your images only in the upper left quarter of the grid, and have programs read in only that much of the encoded "picture string."

A simple but helpful little change is to have MacAnimate create all of its files with the *GRPH* file type (simply by using this as an extension on the file name in a NAME...AS statement). This will mean that only those files will appear in the file dialog boxes, making it easier to find and use these files on your disk.

Two other options to consider are using animated sequences created in MacAnimate in other BASIC programs, and creating images in MacPaint and loading them into MacAnimate via MacInterface, another program in this book. Let's look at each of these procedures individually.

Using MacAnimate sequences with other BASIC programs

The general procedure for using a set of MacAnimate frames in a BASIC program is to dimension an array to hold them, read them in from the MacAnimate file, and show them in the desired sequence. The following is a more detailed step-by-step description.

1. Dimension your image array as *(arraySize, maxFrames)*. Calculate *arraySize* from the image grid dimensions using the formula given in [OVR0-2]. *maxFrames* is the total number of frames your program will use. Dimension an array to hold the sequence file if it will be used. You could also insert an option into MacAnimate itself to calculate and display the dimensions needed for a given number of frames.
2. The code in [OVR2-2] can be used with little modification as a stand-alone subroutine to read in a frame and a sequence file. Change the variable names to conform to your own, and remove references to subroutines you will not be using.
3. The code in the MacAnimate routines (starting with [ME 2]) should give you the basic ideas on how to animate by drawing, erasing, and moving objects. (A number of other programs in this book—nearly all the games, for example—contain other examples of animation.) If you want to use the sequence file to control the animation, simply read it into an array and step the array index through the array to set each frame number in succession. You can use a counter with MOD (as we do in [ME 2] near the end of the main loop) to automatically restart the sequence when the last frame is reached.

Using MacAnimate with MacInterface

If you have read the chapter on MacInterface, you know how that program uses the Clipboard to move images back and forth between MacPaint (and other applications) and disk files accessible to BASIC programs. Since MacInterface reads images from and copies them to the Clipboard, you can, for example, create an image using MacPaint, copy it to the Clipboard, exit MacPaint, run MacInterface to read the Clipboard and create a disk file from the image or images, and then run MacAnimate and load the file for editing and animation.

MacAnimate program listing

```
'*************************************************************
'                          MacAnimate
'            A frame animation program with overlays.
'*************************************************************

                                    'returns filename from 'Volume:Filename' string
  DEF FN FileName$(f$) = RIGHT$(f$, LEN(f$) - INSTR(f$, ":"))

  RESTORE OverlayData
  READ overlay                              'find number of current overlay
  IF overlay = 0 THEN GOSUB Initialize
  IF overlay <> 0 THEN newOvr = 0 : GOTO BringIn      'if not init, reset overlay

  ON MENU GOSUB MenuEvent : MENU ON

'************************************************ MAIN PROGRAM
MainLoop:
  WHILE true : WEND                         'loop until menu event

'************************************************ MENU EVENTS
MenuEvent:                                  'all menu events come through here
  MENU 6, 0, 0                                        'disable menu
  item = MENU(1)
  ON item GOSUB FIO,FIO,FIO,Animate,Sequence,EdFrame,ClearAll,Inst,,BQuit,DQuit
  GOSUB AftrMenu
  RETURN

FIO:            '_____________________________________ all file I/O comes here
  IF overlay = 2 THEN ON item GOSUB OpenFileOvr, SaveFileOvr, SaveAsOvr
  IF overlay <> 2 THEN newOvr = 2 : GOTO BringIn
  RETURN

Animate:        '_____________________________________ animate frames
  GOSUB OpenWindow
  x = 120 : y = 20
  CALL MOVETO(x,y) : y = y + 16
  PRINT "Change animation delay with F and S keys."
  CALL MOVETO(x,y) : y = y + 16
  PRINT "Change direction of motion with I, J, K, and M keys."
  CALL MOVETO(x,y) : y = y + 16
  PRINT "The '.' key stops any motion."
  BUTTON 1, 1, "OK", (wind2W - 60, wind2H - 30) - (wind2W - 10, wind2H - 10)
  aQuit = (seq(1) = -1)

  IF NOT aQuit THEN NotAQuit
  CALL MOVETO(x - 15, y + 32) : TEXTFONT(0)
```

INIT

MAIN

ME 0

ME 1

ME 2

```
    PRINT "You must define an animation sequence first!"
    CALL TEXTFONT(1)
    WHILE DIALOG(0) <> 1 : WEND
NotAQuit:
    crnt = 1: aX = 150: aY = 100
    xSpd = 0: ySpd = 0
    GOSUB ShowSettings

    WHILE NOT aQuit
      x = aX : y = aY : c = crnt
      moving = (xSpd <> 0 OR ySpd <> 0)
      IF moving THEN PUT (x,y), frame(1,seq(c)), XOR
      IF NOT moving THEN PUT (x,y), frame(1,seq(c)), PSET

      IF DIALOG(0) = 1 THEN aQuit = true
      key$ = UCASE$(INKEY$)
      IF key$ = "" THEN NoKey
      IF key$ = "F" THEN delay = INT(.9 * delay)
      IF key$ = "S" THEN delay = 1.1 * delay + 1
      IF key$ = "J" THEN xSpd = xSpd - 1
      IF key$ = "K" THEN xSpd = xSpd + 1
      IF key$ = "I" THEN ySpd = ySpd - 1
      IF key$ = "M" THEN ySpd = ySpd + 1
      IF key$ = "." THEN ySpd = 0 : xSpd = 0
      GOSUB ShowSettings
      WHILE INKEY$ <> "" : WEND                          'empty keyboard buffer
NoKey:
      FOR t = 0 TO delay : NEXT
      aX = aX + xSpd : aY = aY + ySpd
      IF aX < 0 THEN aX = wind2W - bitsW
      IF aX > wind2W - bitsW THEN aX = 0
      IF aY < 0 THEN aY = wind2H - bitsH
      IF aY > wind2H - bitsH THEN aY = 0
      crnt = (crnt MOD maxSeq) + 1 : IF seq(crnt) < 1 THEN crnt = 1
      IF xSpd <> 0 OR ySpd <> 0 THEN PUT (x,y), frame(1,seq(c)), XOR
    WEND
    WINDOW CLOSE 2
    RETURN

ME 3
Sequence:          '_____ set animation sequence
    GOSUB OpenWindow
    topEd = 170 : leftEd = 20
    GOSUB EditFields
    x = 325 : y = 20
    CALL MOVETO(x,y) : y = y + 16 :  PRINT "Define an animation by"
    CALL MOVETO(x,y) : y = y + 16 :  PRINT "entering a sequence of"
    CALL MOVETO(x,y) : y = y + 16 :  PRINT "frame numbers in the"
    CALL MOVETO(x,y) : y = y + 16 :  PRINT "edit boxes."
    reduction = 2
    GOSUB ShowFrames
    BUTTON 1, 1, "OK", (wind2W - 55, wind2H - 25) - (wind2W - 5, wind2H - 5)
    BUTTON 2, 1, "Clear", (wind2W - 55, wind2H - 50) - (wind2W - 5, wind2H - 30)
```

```
    OK = false
    WHILE NOT OK
      diag = DIALOG(0)
      IF diag <> 1 THEN NotSBtn
      OK = (DIALOG(1) = 1)
      IF DIALOG(1) = 2 THEN seq(1) = -1 : GOSUB EditFields
NotSBtn:
      IF diag = 2 THEN eField = DIALOG(2)
      IF diag <> 7 AND diag <> 6 THEN NotTab
      eField = eField MOD maxSeq + 1
      EDIT FIELD eField
NotTab:
    WEND

    FOR n = 1 TO maxSeq                                    'save new sequences
      j = VAL(EDIT$(n))
      IF j < 1 OR j > maxFrames OR INT(VAL(EDIT$(n))) <> j THEN j = -1
      seq(n) = j
    NEXT n
    WINDOW CLOSE 2
    RETURN

EdFrame:          '_____________________________________ edit frames
    IF overlay = 1 THEN GOSUB EditOvr
    IF overlay <> 1 THEN newOvr = 1 : GOTO BringIn
    RETURN

ClearAll:         '_____________________________________ clear all frames
    CLS : file$ = ""
    IF overlay <> 0 THEN MENU 6, 2, 0
    FOR n = 1 TO maxFrames
      GET (0,0) - (bitsW - 1, bitsH - 1), frame(1,n)
    NEXT n
    RETURN

Inst:             '_____________________________________ show instructions
    IF overlay = 3 THEN GOSUB InstOvr
    IF overlay <> 3 THEN newOvr = 3 : GOTO BringIn
    RETURN

BQuit:            '_____________________________________ quit to BASIC
    MENU RESET
    END

DQuit:            '_____________________________________ return to Mac Desktop
    MENU RESET
    SYSTEM
```

ME 4

ME 5

ME 6

ME 7

ME 8

```
'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
SR 1  AftrMenu:          '_____ after any menu event; also called by overlays
        CLS
        reduction = 1
        GOSUB ShowFrames
        CALL MOVETO(100,280)
        IF file$ = "" THEN PRINT "Choose an option from the MacAnimate Menu.";
        IF file$ <> "" THEN PRINT "Current filename: "; FN FileName$(file$);
        MENU 6, 0, 1                                                    'restore menu
        RETURN

SR 2  ShowSettings:      '_____ during animation, show delay and x,y speeds
        CALL MOVETO(10, wind2H - 30) : PRINT "Delay ="; delay
        CALL MOVETO(10, wind2H - 10) : PRINT "X speed =" xSpd "  Y speed =" ySpd
        RETURN

SR 3  EditFields:        '_____ open sequence edit fields
        seqEnd = false : col = INT(maxSeq / 5)
        FOR n = 1 TO maxSeq
          l = leftEd + ((n - 1) MOD col) * 40 : t = topEd + INT((n - 1) / col) * 20
          IF ((n - 1) MOD col) = 0 THEN CALL MOVETO(l - 28, t +12)  : PRINT n;
          IF seq(n) = -1 THEN seqEnd = true
          IF seqEnd THEN n$ = "" ELSE n$ = STR$(seq(n))
          EDIT FIELD n, n$, (l,t) - (l + 30, t + 15), , 2
        NEXT n
        EDIT FIELD 1 :  eField = 1
        RETURN

SR 4  ShowFrames:        '_____ show all frames
        bw = bitsW / reduction : bh = bitsH / reduction                 'use reduction ratio
        showL = 10 : showT = 5
        FOR n = 1 TO maxFrames
          x = showL + ((n - 1) MOD fPerLine) * (bw + 15)
          y = showT + INT((n - 1) / fPerLine) * (bh + 20)
          LINE (x - 1, y - 1) - (x + bw, y + bh), , b
          PUT (x,y) - (x + bw - 1, y + bh - 1), frame(1, n)
          CALL MOVETO(x + ((bw - 20) / 2), y + bh + 15)
          PRINT "#"; RIGHT$(STR$(n), LEN(STR$(n)) - 1)
        NEXT n
        RETURN

SR 5  OpenWindow:        '_____ open second window
        WINDOW 2, , (wind2L,wind2T) - (wind2L + wind2W, wind2T + wind2H), 2
        RETURN

SR 6  BringIn:           '_____ bring in overlay number newOvr
        ovr$ = "MacAnimate.Ovr" + MID$(STR$(newOvr), 2, 1)
        overlay = newOvr
        CHAIN MERGE ovr$, 5000, ALL, DELETE 5000-5999
```

```
5000 '********************************************* DUMMY "OVERLAY"

OverlayData:                                  'a dummy overlay number is used here
  DATA 9 :                                    'to force the program to merge the first overlay

5999 '******************************************* END OF DUMMY OVERLAY
```

OVR0-1

```
5000 '********************************** OVERLAY 0: INITIALIZATION
  GOSUB Initialize
  ON MENU GOSUB MenuEvent : MENU ON
  GOTO MainLoop

OverlayData:                                  'number for this overlay
  DATA 0
```

OVR0-2

```
Initialize:
  DEFINT A - Z
  OPTION BASE 1
  maxSeq = 50                                 'number of animation sequences
  bitsW = 64 : bitsH = 64                     'width & height of a frame

  fatMac = (FRE(0) > 30000)
  IF fatMac THEN maxFrames = 18 ELSE maxFrames = 12
  arraySize = INT(1 + bitsW / 16) * (bitsH + 1) + 2
  DIM frame(arraySize,maxFrames)              'holds frame bitmaps
  DIM clip(arraySize)                         'temporary holding area for frames
  DIM seq(maxSeq)                             'sequence order
  DIM pencil(34)
  DIM gridPat(4), btRect(4)

  FOR n = 1 TO maxSeq : seq(n) = -1 : NEXT    'init sequence array
  RESTORE PencilData                          'initialize pencil cursor
  FOR n = 1 TO 34 : READ pencil(n) : NEXT
  gridPat(1) = &H44FF : gridPat(2) = &H4444   'initialize grid pattern
  gridPat(3) = &H44FF : gridPat(4) = &H4444

  false = 0 : true = NOT false
  white = 30 : black = 33                     'colors used for screen drawing
  patBic = 11 : patOr = 9
  wind2L = 16 : wind2T = 55
  wind2W = 479 : wind2H = 270
  fatSize = 4                                 'size of fatbit in pixels
  fPerLine = 6                                'frames per line when displayed
  crntS = 1 : delay = 500                     'set startup current frame and animation delay
  GOSUB ClearAll                              'init frame array by GETting white
```

OVR0-3

```
WINDOW 1, "", (2,24) - (508,337), 4
CLS : CALL TEXTFONT(0) : CALL TEXTSIZE(36)                    'show title screen
CALL MOVETO(108,130) : PRINT "MacAnimate!"
CALL TEXTSIZE(12)
CALL MOVETO(144,170) : PRINT "A frame animation program."
CALL TEXTFONT(1)
CALL MOVETO(100,280)
PRINT "Choose an option from the MacAnimate Menu.";

MENU 6, 0, 1, "MacAnimate"                                    'install MacAnimate Menu
MENU 6, 1, 1, "Open"
MENU 6, 2, 0, "Save"
MENU 6, 3, 1, "Save As"
MENU 6, 4, 1, "Animate"
MENU 6, 5, 1, "Set Sequence"
MENU 6, 6, 1, "Frame Edit"
MENU 6, 7, 1, "Clear All"
MENU 6, 8, 1, "Instructions"
MENU 6, 9, 0, "-"
MENU 6, 10, 1, "Quit to BASIC"
MENU 6, 11, 1, "Quit to Desktop"
RETURN
```

OVR0-4

```
PencilData:                                                   'cursor data from MacCursor
  DATA  1920, 1088, 2112, 3200, 4992
  DATA  4352, 8448, 8704, 16896, 17408
  DATA -31744, -30720 , -4096 , -8192, -16384
  DATA -32768, 1920, 1984, 4032, 3968
  DATA  8064, 7936, 16128, 15872, 32256
  DATA  31744, -1024, -2048, -4096, 0
  DATA  0, 0, 15, 0

5999 '*********************************************** END OF OVERLAY 0
```

OVR1-1

```
5000 '************************************ OVERLAY 1: EDIT FRAMES
  GOSUB EditOvr
  ON MENU GOSUB MenuEvent : MENU ON
  GOSUB AftrMenu
  GOTO MainLoop

OverlayData:                                                  'number of this overlay
  DATA 1
```

OVR1-2

```
EditOvr:                '_____ edit frames
   GOSUB OpenWindow
   btX1 = 10 : btY1 = 10                              'coordinates for bit box
   btX2 = btX1 + fatSize * bitsW - 2
   btY2 = btY1 + fatSize * bitsH - 2
   btRect(1) = btY1 : btRect(2) = btX1
   btRect(3) = btY2 + 1 : btRect(4) = btX2 + 1
   sX1 = btX2 + 20 : sY1 = btY1
   sX2 = sX1 + bitsW-1 : sY2 = sY1 + bitsH - 1
```

OVR1-2a

```
                                    'FN InBits returns true if (X,Y) is in bit area
   DEF FN InBits(fX,fY) = (fX >= btX1 AND fX <= btX2 AND fY >= btY1 AND fY <= btY2)

   btnX = 275 : btnY = 145
   RESTORE BtnData
   FOR n = 0 TO 12
      READ btn$
      bc = btnX + (n MOD 3) * 70
      br = btnY + INT(n / 3) * 25
      BUTTON n + 1, 1, btn$, (bc, br) - (bc + 60, br + 20)
   NEXT n
BtnData:
   DATA "Fwd", "Up", "Cut", "Back", "Down", "Copy"
   DATA "Cpy Fwd", "Left", "Paste", "Grid", "Right", "Invert"
   DATA "OK"

   CALL MOVETO(btnX + 20, btY1 + 100) : PRINT "Click on a fatbit"
   CALL MOVETO(btnX + 20, btY1 + 116) : PRINT "to change it."
   OK = false : gridMode = patBic
```

OVR1-2b

```
   WHILE NOT OK
      CALL MOVETO(sX2 + 20, sY1 + 20) : CALL TEXTFONT(0)
      PRINT "Frame #"; crntS
      CALL TEXTFONT(1)
      PUT (sX1,sY1), frame(1,crntS), PSET
      LINE (btX1 - 1, btY1 - 1) - (btX2 + 1, btY2 + 1), , b
      PUT (btX1,btY1) - (btX2,btY2), frame(1,crntS), PSET
      CALL PENMODE(gridMode) : CALL PENPAT(VARPTR(gridPat(1)))
      CALL PAINTRECT(VARPTR(btRect(1)))
      CALL PENNORMAL
```

OVR1-2c

```
      newFrame = false
      WHILE NOT (newFrame OR OK)
         status = MOUSE(0) : x = MOUSE(1) : y = MOUSE(2)
         IF NOT FN InBits(x,y) THEN CALL INITCURSOR : GOTO NotDown
         IF FN InBits(x,y) THEN CALL SETCURSOR(VARPTR(pencil(1)))

         IF  status <> -1 THEN NotDown
         cX = INT((x - btX1) / fatSize)                  'cursor is down in fatbit area
         cY = INT((y - btY1) / fatSize)                  'calculate which bit cursor is on
                                                         'reverse color of current bit
         IF  POINT(sX1 + cX, sY1 + cY) = black THEN clr = white ELSE clr = black
         GOSUB AffectBits
```

```
NotDown:
        IF DIALOG(0) <> 1 THEN NoButton
        btn = DIALOG(1)
        ON btn GOSUB Fwd,Shift,Cut,Back,Shift,Copy,CopyFwd,Shift,Paste,Grid,Shift,Invert,OKBtn
NoButton:
    WEND                                                    'while not newFrame
  WEND                                                      'while not OK
  CALL INITCURSOR
  WINDOW CLOSE 2
  RETURN

OVR1-3  Fwd:
  newFrame = true : crntS = (crntS MOD maxFrames) + 1
  RETURN

OVR1-4  Shift:
  b = INT((btn - 2) / 3)
  x = (1 - (b = 2) * - 2) * (b > 1)
  y = (1 - (b = 0) * -2) * (b < 2)
  GET (sX1 + x, sY1 + y) - (sX2 + x, sY2 + y), frame(1,crntS)
  newFrame = true
  RETURN

OVR1-5  Cut:
  GOSUB ToClip
  LINE (sX1,sY1) - (sX2,sY2), white, bf                     'clear image
  GET (sX1,sY1) - (sX2,sY2), frame(1,crntS)                 'clear frame
  newFrame = true
  RETURN

OVR1-6  Back:
  newFrame = true
  crntS = crntS - 1 : IF crntS = 0 THEN crntS = maxFrames
  RETURN

OVR1-7  Copy:
  GOSUB ToClip
  RETURN

OVR1-8  CopyFwd:
  GOSUB Fwd : GET (sX1,sY1) - (sX2,sY2), frame(1,crntS)
  RETURN

OVR1-9  Paste:
  GOSUB FromClip : newFrame = true
  RETURN

OVR1-10 Grid:
  newFrame = true
  IF gridMode = patBic THEN gridMode = patOr ELSE gridMode = patBic
  RETURN
```

OVR1-11

```
Invert:
   LINE (sX1,sY1) - (sX2,sY2), black, bf
   PUT (sX1,sY1), frame(1,crntS), XOR
   GET (sX1,sY1) - (sX2,sY2), frame(1,crntS)
   newFrame = true
   RETURN
```

OVR1-12

```
OKBtn:
   OK = true
   RETURN
```

OVR1-13

```
ToClip:              '_____ transfer image to clip array
   GET (sX1,sY1) - (sX2,sY2), clip
   RETURN
```

OVR1-14

```
FromClip:            '_____ move image from clip array to frame array
   PUT (sX1,sY1), clip, PSET
   GET (sX1,sY1) - (sX2,sY2), frame(1,crntS)          'put into frame
   RETURN
```

OVR1-15

```
AffectBits:          '_____ affect bits until button is released
   WHILE status < 0                                   'while button is still held down
      IF NOT FN InBits(x,y) THEN OutSide
      cX = INT((x - btX1) / fatSize)                  'button down in fatbit area at (cX,cY)
      cY = INT((y - btY1) / fatSize)
      PSET (sX1 + cX, sY1 + cY), clr
      x = btX1 + cX * fatSize : y =  btY1 + cY * fatSize
      LINE (x,y) - (x + fatSize - 2, y + fatSize - 2), clr, bf
OutSide:
      status = MOUSE(0) : x = MOUSE(1) : y = MOUSE(2)
   WEND
   GET (sX1,sY1) - (sX2,sY2), frame(1,crntS)          'save new frame
   RETURN

5999 '* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * END OF OVERLAY 1
```

OVR2-1

```
5000 '* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * OVERLAY 2: File I/O
   ON item GOSUB OpenFileOvr, SaveFileOvr, SaveAsOvr
   ON MENU GOSUB MenuEvent : MENU ON
   GOSUB AftrMenu
   GOTO MainLoop

OverlayData:                                          'number of this overlay
   DATA 2
```

OVR2-2

```
OpenFileOvr:                    '_____ read frame file and sequence file
   f$ = FILES$(1,"TEXT")
   IF f$ = "" THEN NoLoad
   IF UCASE$(RIGHT$(f$,4)) = ".SEQ" THEN f$ = LEFT$(f$, LEN(f$) - 4)
   GOSUB ClearAll

   OPEN f$ FOR INPUT AS #1                    'open & read frame file first
   pict = 0
   WHILE NOT EOF(1)                           'loop for each image in file
      INPUT #1, bytes
      pict = pict + 1
      pict$ = INPUT$(bytes,1)
      IF pict > maxFrames THEN NoMore
      CLS : PICTURE (0,0), pict$
      GET (0,0) - (bitsW - 1, bitsH - 1), frame(1,pict)
NoMore:
      pict$ = INPUT$(1,1)
   WEND
   CLOSE #1

   file$ = f$
   MENU 6, 2, 1
   f$ = f$ + ".Seq"
   fileHere = true                            'check to see if sequence file exists
   ON ERROR GOTO FileError                    'enable error trapping
   OPEN f$ FOR INPUT AS #1
   ON ERROR GOTO 0                            'disable error trapping
   IF NOT fileHere THEN NoSeqLoad             'not here, don't get sequence
   j = 0
   WHILE NOT EOF(1)
      j = j + 1 : INPUT#1, seq(j)
   WEND
   CLOSE#1
NoSeqLoad:
NoLoad:
   RETURN
```

OVR2-3

```
SaveFileOvr:                    '_____ save frames and sequence to file$
   OPEN file$ FOR OUTPUT AS #1                'first save frames
   FOR n = 1 TO maxFrames
      CLS
      PICTURE ON : PUT (0,0), frame(1,n) : PICTURE OFF
      pict$ = PICTURE$
      PRINT #1, LEN(pict$)
      PRINT #1, pict$
      pict$ = ""
   NEXT n
   CLOSE #1
   f$ = file$ + ".Seq"                        'now save sequence
   OPEN f$ FOR OUTPUT AS #1
   FOR n = 1 TO maxSeq : PRINT#1, seq(n) : NEXT
   CLOSE#1
   RETURN
```

OVR2-4

```
SaveAsOvr:              '_____________________________ save to new file name
   f$ = FILES$(0, "Save as what file?")
   IF f$ = "" THEN RETURN
   file$ = f$ : MENU 6, 2, 1
   GOSUB SaveFileOvr
   RETURN
```

OVR2-5

```
FileError:              '_____________________ fileHere = false, if error is "File not Found"
   IF ERR <> 53 THEN ON ERROR GOTO 0                    'unknown error, print and halt
   fileHere = false
   RESUME NEXT

5999  '* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * END OF OVERLAY 2
```

OVR3-1

```
5000  '* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * OVERLAY 3: INSTRUCTIONS
   GOSUB InstOvr
   ON MENU GOSUB MenuEvent : MENU ON
   GOSUB AftrMenu
   GOTO MainLoop

OverlayData:                                            'number of this overlay
   DATA 3
```

OVR3-2

```
InstOvr:                '_____________________________ show instruction screen
   WINDOW 2, , (16,55) -(495,325),  2
   PRINT "MacAnimate Menu"
   PRINT
   PRINT "Open:          Loads a previously saved frame and sequence file if available."
   PRINT "Save:          Saves frame set and sequence under current filename."
   PRINT "                 If a file hasn't been opened or saved, this option is dimmed."
   PRINT "Save As:       Saves frame set under a filename the user specifies."
   PRINT "                 Saves the animation sequence to 'filename.Seq'."
   PRINT "Animate:       Shows an animation of the current frame set."
   PRINT "Set Sequence: Allows you to specify an animation sequence."
   PRINT "Frame Edit:    Edit individual frames with a MacPaint FatBits-like editor."
   PRINT "Clear All:     Resets all frames to blank.";
   CALL INITCURSOR
   BUTTON 1, 1, "Continue", (190,240) - (280,260)
   WHILE DIALOG(0) <> 1 : WEND
   BUTTON CLOSE 1 : WINDOW CLOSE 2
   RETURN

5999  '* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * END OF OVERLAY 3
```

II. GAMES

- MacDart
- MacBandit
- MacMouse
- MacBall
- MacGurkha
- MacSpace

MacDart

You're having a relaxing evening with your friends, standing around with mugs of your favorite brew, your darts, and your...Macintosh? Well, why not? Thanks to the Mac's wizardry, the local pub's time-honored dart game can now be played in the comfort of your computer screen. And no one will end the fun with the closing-time call of "Time, gentlemen, please!"

How to play MacDart

When you first start MacDart, the title screen shown in Figure 1 appears. It shows a big dart on the right and a fat, happy balloon on the left. You then hear a brief sweep of sound. A moment later, the initial playing screen appears as shown in Figure 2. It shows a little balloon sitting in the lower left corner. Along the bottom of the screen you'll see your current score and the speed that the current dart will have once it is thrown (more about that later). On the right is a stack of nine darts and one that is ready to be thrown. Your goal in MacDart is to pop the balloon before it reaches the top of the screen. The MacDart menu contains these options:

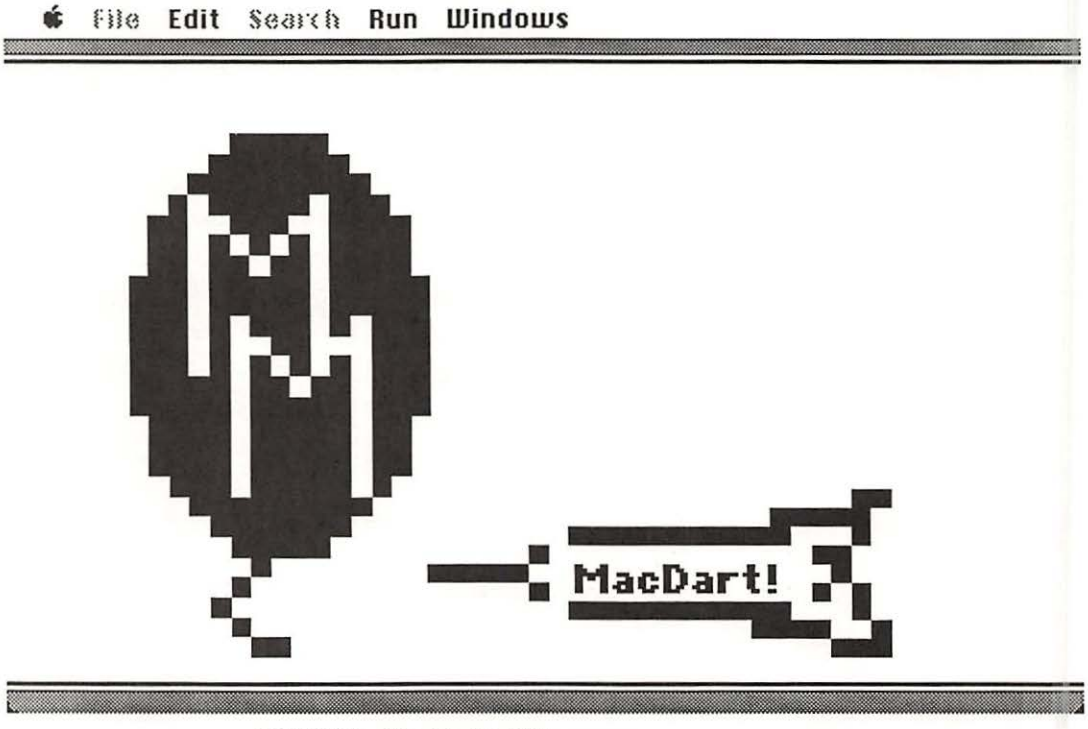


FIGURE 1. *The MacDart title screen*

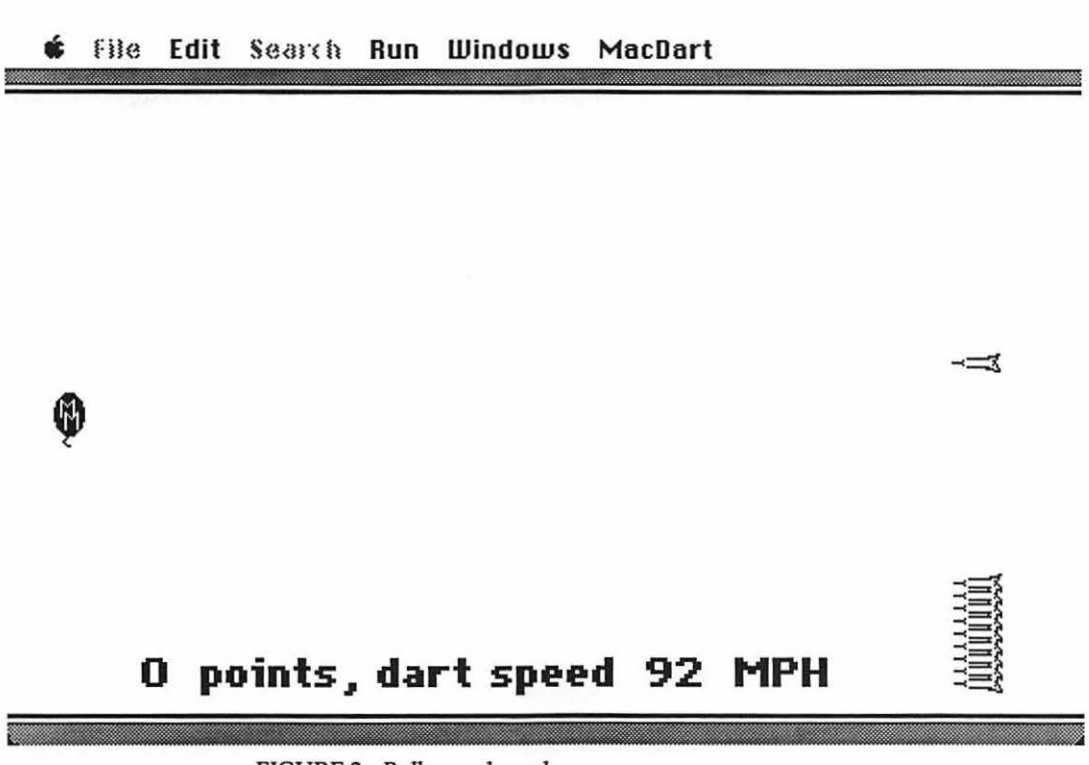


FIGURE 2. *Balloon released*

If you move the mouse a bit, you'll discover that the top dart moves up and down but not sideways. Think of yourself standing on the throwing line, jiggling the dart to get a feel for its weight. You can do this as long as you like; nothing else will happen until you double-click the mouse button. When you do, the balloon starts to rise toward the top of the screen, as shown in Figure 2. When the balloon rises, sometimes it will float up very slowly, and sometimes it will rocket toward the top of the screen. Fast or slow, the balloon always rises straight up.

After launching the balloon, you can throw the dart at it by single-clicking the mouse button. You will notice that the dart does not move in a straight line. Just like in your favorite pub, MacDart's darts drop with the effect of gravity. To get really good at the game, you must learn to estimate how far above the balloon to aim in order to break it. With practice, you'll learn how the trajectory, or path, the dart takes toward the target is related to the dart speed shown at the bottom of the screen.

If the dart misses the balloon, or if the balloon rises past the top of the screen, you score no points for that dart. When you do manage to find

your range and your dart hits the balloon (or its string), you'll hear a sound and see the balloon disintegrate in a pattern of lines. One to six points will be added to your score, depending on how fast the balloon was moving: The faster it was going, the more points you get. If the dart misses the balloon and there is still time to throw another dart, just aim and press the mouse button again—the next dart will shoot off.

Let's consider what's happening as the dart moves toward the target. Faster darts (speeds of about 80 up to the maximum of 100 mph) fly in almost a straight line, dropping only a little as they go across the screen. Slower darts (from the minimum of 50 to about 70 mph) tend to fall in an arc and drop much farther before they reach the left side of the screen. Indeed, if the dart is slow enough and wasn't released from a high enough altitude, it will fall through the bottom of the screen before it even reaches the area of the target!

If you think about the difference between lobbing a baseball with a nice, slow underhand motion and coming over the top with a blazing fast ball, the behavior of the dart should begin to make sense. The MacDart program includes simulated "gravity," so the darts will fall (move down the y axis) as they move left along the x axis. As with real gravity, the longer the dart falls, the faster its rate of falling will be and the farther it will fall in a given unit of time.

Do slow darts fall faster than fast ones? If you have a stopwatch around the house, you can experiment for yourself, releasing darts of different speeds from the same height and measuring how far each has fallen after a few tenths of a second. In fact, as you may remember if you've had high school physics, the horizontal speed of an object has no effect on how fast or far the object falls. The only thing that matters (discounting friction and air resistance, of which there's none on the Mac screen unless you add it to your simulation) is *how long* the object has been falling. While falling the same distance, the fast dart moves farther at every moment across the screen, so it gets to the target before it's had much time to fall very far.

How does this physics lesson help with the job of balloon-busting? You can see that you have to "lead" the target (that is, position the dart higher than the balloon) much more for slow darts than for fast ones. You also have to judge the balloon speed so as to pick a rendezvous point where both the dart and the balloon will arrive at the same time. Not only that, for very slow darts you have to pick an intersection point low enough to accommodate the fact that the slow dart will have dropped quite a ways by the time it reaches the left border of the screen. If you've got a real slow

dart and a real fast balloon, things can get very sticky! It might be comforting for you to know that this aiming and "leading" the target is the same problem fighter pilots face shooting in dogfights, multiplied by three dimensions instead of just two!

How MacDart works

MacDart shows several interesting programming ideas. At the beginning, the random-number generator is reseeded with a value from the timer, certain constants are set, and the window is sized. The dart and the balloon images are formed, the MacDart menu is created, and then the initial title screen and instructions are displayed on the screen. The main program loop, which makes use of nested WHILE...WEND loops, is called next. Following the main program loop is the section that handles menu events, and then a section that contains various subroutines for moving the balloon, the dart, and both at the same time, as well as checking to see if the balloon has popped. The structure of the program is shown in outline form in Figure 3.

```
Initialization
  initialize variables                                              Init 1
  create output window
  make dart and balloon shapes                                      Init 2
  draw title screen                                                 Init 3
  install MacDart menu and enable menu event-trapping               Init 4
  show instructions (Instructions)                                  ME 2

Main Program
  WHILE true  (endless loop until interrupt by menu event)          Main 1
    WHILE there are darts left                                      Main 2
      redraw initial screen (InitScreen)                            SR 1
      until double-click (balloon release),                         Main 3
        move dart along yaxis only (UpdateDart)                     SR 6
      WHILE balloon not at top of screen, popped, or no more darts  Main 4
        move balloon (MoveBal)                                      SR 2
        if balloon reaches screen top, go to next dart (SubDart)    SR 4
        if dart is released (single-click), move both objects (MoveBoth)  SR 3
      WEND
    WEND

    game over:                                                      Main 5
      update score (GiveScore)                                      SR 5
      display 'game over' message
      idle loop until another menu choice, to play again or quit
  WEND
```

(continued)

FIGURE 3. *Program outline*

Menu Events	
MenuEvent: deactivate menu and branch to appropriate subroutine	**ME 0**
PlayMenu: reset game if user wants to play	**ME 1**
Instructions: show instructions	**ME 2**
BasQuit: quit to BASIC	**ME 3**
DeskQuit: quit to Mac Desktop	**ME 4**
Subroutines	
InitScreen: initialize screen to launch new balloon	**SR 1**
MoveBal: move only balloon until double-click	**SR 2**
MoveBoth: move both objects until either balloon reaches top, dart reaches left side, or balloon is popped	**SR 3**
SubDart: subtract one dart from total left and redisplay remaining	**SR 4**
GiveScore: print points and dart speed	**SR 5**
UpdateDart: update dart position just return if no movement show cursor if dart above window	**SR 6**
UpdateBal: update balloon position	**SR 7**
PopTest: test for dart and balloon in same place; pop balloon if hit	**SR 8**

Figure 3. Program outline (continued)

Initialization and drawing objects

This program starts by reseeding the random-number generator with a number from the timer, dimensioning arrays for the dart (*dart%*) and balloon (*bal%*) images [Init 1], and setting a somewhat arbitrary constant representing our simulated gravity. Next comes the sizing of the window in which the game will be played. In [Init 2] the dart shape is drawn and then a GET statement stores it in the array *dart%*. We then get rid of the shape on the screen with a PUT statement. (Remember that a PUT statement, unless otherwise specified, does an XOR with the shape existing at the specified location; this has the effect of erasing the previously drawn shape if the same shape is PUT on top of itself.)

The same procedure is followed in creating the balloon shape. Note how the two Ms that are part of the balloon shape are drawn using built-in QuickDraw routines. The TEXTMODE is set to 3. Mode 3 is the

BIC or "black is changed" mode, which means that when the two Ms are printed, they appear white against the black balloon (this is another example of how text and graphics can be made to interact in interesting ways on the Macintosh).

Title screen, instructions, and MacDart menu

Next the program displays the title screen and instructions for playing the game. The title screen procedure [Init 3] starts out by drawing a big balloon and the word *MacDart!* with the big dart superimposed on it, and a "sound sweep" caused by the FOR...NEXT loop produces a series of very brief sounds with regularly rising pitch.

The Instructions subroutine [ME 2] shows the player a screen with text that describes how to play the game. It also sets up a button labeled Continue to allow the player a chance to read the instructions before continuing on with the game.

The MacDart menu [Init 4] is installed next. It is set to include the title, MacDart, and the options Play Again, Instructions, Quit to BASIC, and Quit to DeskTop.

The main program

The set of WHILE...WEND loops, [Main 1] through [Main 5], handles the playing of the game until the player decides to quit (by moving to the menu and choosing Quit to BASIC). The game starts at [Main 1] where the value for the number of darts available is set to 10 at the beginning of each game round. The key to understanding this program is realizing that each "turn" (dart throw) breaks down into three states or conditions. Each state contains a loop that includes a test to see if the event triggering the next state has occurred. These three states are:

1. Player may be moving dart up and down; neither balloon nor dart has been released.
2. Player has released balloon; may still be moving dart up and down; dart not yet released.
3. Both balloon and dart have been released; player has no more input until next dart.

Keep these states in mind, and refer to the program outline while you read the following explanation of how MacDart works.

Initialize balloon and dart positions and speeds

First, the initial positions of the balloon and dart are set by a call at [Main 2] to InitScreen [SR 1]. These initial values are always set the same. The balloon position is (*xBal,yBal*), and the active dart will start at (*xDart,yDart*). Corresponding variables that will hold the "old" balloon and dart coordinates are assigned the same starting values: These will be used to erase the old images in animating the balloon and dart. The dart speed along the x axis (*xDartStep*) is set to a random integer between 25 and 50. The balloon speed is set to a random integer between 1 and 6. We use the statement RANDOMIZE TIMER to ensure that the program will generate a new series of random numbers each time. Appropriately for a *Midnight Madness* program, this statement uses the number of seconds that have elapsed since midnight as the random "seed."

A call to GiveScore [SR 5], while still within InitScreen, updates the display of the game situation. GiveScore prints the current number of points and the speed of the current dart times 2 as "MPH," just to make it sound a bit more impressive.

A FOR...NEXT loop draws the darts the player has left, other than the one "in hand." The dart in play is then drawn (with a PUT) at (*xDart,yDart*), and the balloon is drawn at (*xBal,yBal*).

State 1: Waiting for balloon release

The WHILE...WEND segment at [Main 3] is a loop that checks to see that the mouse has not been double-clicked (*MOUSE(0)* <> 2), then assigns the result of the MOUSE(2) function to *yDart*. This value is the value of the mouse y coordinate the last time MOUSE(0) was called. A call is then made to UpdateDart [SR 6], which first checks to see if either the x or the y coordinate of the mouse pointer has changed since last time (that is, differs from *xDartOld* or *yDartOld*, respectively). If neither coordinate has changed, UpdateDart simply returns. If either has changed, the y position is checked to see if it is above the window. If it is, the cursor appears. If it isn't, the dart hasn't been released and only the y position is changed. The dart in hand is updated by drawing it in a new y position and erasing the old dart. The current x and y values are then saved in *xDartOld* and *yDartOld* for future comparison.

This is a good place to take a short trip back to the WINDOW statement in [Init 1], where we define the window to be a little wider than the screen. Why? The operation of windows in BASIC does not allow clicking in an area outside the current output window; if this is done, the Mac will beep and do nothing. Since the pointer is hidden to prevent confusion

with the dart we've created, we can't see exactly where the pointer is and it is possible to click the button with the invisible pointer outside the window. If that were to occur, all that would happen for the player would be a beep and nothing else.

We've taken care of the motion of the mouse pointer in the vertical direction by testing to see whether the arrow pointer should be displayed instead of the dart. We prevent the pointer from being outside the window in the horizontal direction by making the window a little wider than the screen.

After returning from UpdateDart, the program is still in the WHILE...WEND loop which means the MOUSE(0) function is checked again. This accomplishes two things. First, if MOUSE(0) = 2, a double-click has taken place, and the program will go to State 2 (balloon released). The call to MOUSE(0) also updates the value that will be read the next time MOUSE(2) is used. If there was no double-click, the program repeats the loop section by calling UpdateDart.

One important insight for writing event-driven routines is knowing when you need an interrupt like ON MOUSE GOSUB. Here, the WHILE...WEND construct is used since there are no calculations or other activities that the player might want to interrupt.

State 2: Balloon released

The code segment in [Main 4] handles the state in which the player has released the balloon but has not yet single-clicked to release the dart. This, too, is handled by a WHILE...WEND loop. First, a check is made to see that the value of *yBal* is greater than zero (the balloon hasn't yet reached the top of the window), that the balloon hasn't been popped, and that there are darts left for the player to throw. Then a call is made to MoveBal [SR 2]. MoveBal consists of a WHILE...WEND loop that checks that the balloon still hasn't reached the top, and that the mouse has not been clicked once (*MOUSE(0)* <> *−1*) to release the dart. The *yDart* position is set to MOUSE(2), and UpdateDart is called to draw the new position of the dart if necessary. After the dart is redrawn, a call is made to UpdateBal [SR 7], which works much like UpdateDart. The new balloon position is calculated by subtracting *yBalStep* from the balloon's y coordinate in *yBal* (the y coordinate decreases as you move toward the top of the screen), the new balloon is drawn, the old is erased, and the new coordinates are saved in *xBalOld* and *yBalOld* for future reference. Remember that only the y position of the balloon actually changes, because the balloon rises straight up.

After updating the balloon's position, the WHILE...WEND loop in MoveBal continues to check whether the balloon has reached the top, and whether the mouse button has been pressed. If the button hasn't been pressed, the loop continues and moves the balloon. If the player doesn't click the mouse to release the dart soon enough, the balloon will eventually reach the top of the window. If the player does press the mouse button, control will move to the IF statement at the next line in [Main 4] (more on what happens there later). If the player doesn't press the button and the balloon does reach the top (*yBal* <= *0*), control will pass to the line that reads *xDart* = *450* : *yDart* = *MOUSE(2)*, which simply means that the dart position is somewhere along the right edge of the window.

The program continues in the [Main 2] WHILE...WEND loop while there are darts left. When there are no more darts, the program goes to the series of commands at [Main 5] (these will be discussed later). For now, we'll show you what happens after the player throws the dart.

State 3: Dart thrown

In the middle of the program loop at [Main 4] there is a call to MoveBal [SR 2]. In this subroutine, the balloon is moved until there is a single-click to signal the launch of a dart. When this single-click occurs, control passes to the IF statement in the next line in [Main 4] that checks to see that the balloon hasn't hit the top of the window. If it hasn't, the program calls SubDart [SR 4]. SubDart subtracts one dart from the total left, and if there are any darts left, blanks one of the darts in the stack at the right edge of the screen by using a PUT statement in XOR mode.

Control then moves back to the main program which next calls MoveBoth [SR 3]. The idea behind this subroutine is to move both the balloon and the dart until the balloon reaches the top, the dart reaches the left side of the screen, or the balloon is popped.

Initially in this subroutine, the value of *dartTime* is set to zero. This is used in the simulation of gravity, which we'll get to in a moment. A WHILE...WEND loop is set up to operate while the balloon is still below the top, and the dart hasn't reached the left, and *popped* is false. The value of *dartTime* is increased by one, and *xDartStep* is subtracted from the current *xDart* position to get the new dart's x position (since the dart is moving from right to left, the x coordinate is decreasing).

The change in the dart's y position is more complicated, since it represents the effect of gravity. The y value will be increasing as the dart falls toward the bottom of the screen, but by how much? From high school

physics (or from Newton's run-in with the apple—a McIntosh apple no doubt!), you might remember the equation for the effect of gravity on a falling body:

$y = gt^2$

The distance, y, traveled by a falling body in a period of time, t, is equal to the rate, g, at which it is falling times the *square* of the time that it falls. In this case, the value of *dartTime* (representing the length of time the dart has been falling) is substituted for t, and is multiplied by itself. Then this value is multiplied by the constant variable *gravity* (.08). This means, for example, that at *dartTime* = 2 the dart will fall (0.8 * 2 * 2) or 3.2 pixels (or 3, since the drawing routines convert these values to integers), at *dartTime* = 4 it will fall (0.8 * 4 * 4) or 12 pixels, and so on. (You might try changing the value of *gravity* in [Init 1] to see the effect of different gravitational constants.) In this subroutine, the distance that the dart has dropped is added to the current *yDart* value, which gives a new value to *yDart*. Having calculated the new dart position, the program first calls UpdateDart [SR 6] to draw the dart in its new position; next, the program calls UpdateBal [SR 7] to make the balloon rise another step. Finally, the dart's x position is checked to see if it's less than the balloon's x position plus 20. If it is, the dart may have reached the balloon, and PopTest [SR 8] is called to find out. Otherwise, the routine goes back to the top of the WHILE...WEND loop to keep moving the dart and the balloon until either the balloon gets to the top of the window, or the dart hits the left side of the screen and disappears.

PopTest [SR 8] checks to see whether the dart's y position is within the boundaries of the balloon's body (including the string—if that's hit, the balloon presumably dies of fright!). If a hit has been made, the value *popped* is set to true, and the SOUND statement makes the sound of the expiring balloon. The outer FOR...NEXT loop then causes the inner loop (the explosion effect) to be executed twice, once with black lines and once with white. The inner FOR...NEXT loop draws pairs of lines that converge upon the center of the balloon, decreasing constantly, representing the exploding, punctured balloon. After the first set of lines is drawn, the color is changed to white and the outer loop executes the line-drawing loop once more. Finally, PopTest adds the speed of the erstwhile balloon to the player's total score as a measure of the difficulty of hitting it.

When PopTest returns to MoveBoth [SR 3], the value of *popped* is true, and control then returns to the main program at [Main 4] where the

dart is set back to the right side of the screen. Control then goes back up to [Main 2], where everything is ready for the next balloon launch.

When the tenth dart has been played, control goes to [Main 5], where GiveScore [SR 5] is called one more time to give the final score. Next, it's time to find out whether the player wants to play again.

After printing the message *Game Over* in the middle of the playing screen, the program returns the cursor to its normal shape with a CALL INITCURSOR. That way, the poor player isn't trying to make menu selections with an invisible pointer. Forgetting to take care of details like this produces results embarrassing to the programmer and irritating to the user. For example, someone might be asked to make choices about exiting a "bouncing vegetables" game by trying to figure out how to push a button with a tomato! This exemplifies the essential programming philosophy of always making sure that a user who leaves your program (or is about to) is returned to the normal Macintosh environment.

Suggestions for MacDart

You could make the game harder by having an obstacle (say a net to snag darts) moving up the middle of the screen. If a dart gets close enough, it is caught in the net and you miss! The net would begin moving as the balloon is released, and it would have a random speed perhaps 2 or 3 times that of the balloon (experiment with different values). To draw the net, base your routine on the dart- and balloon-drawing routines. To move the net, use steps similar to the balloon steps and a routine similar to UpdateBal [SR 7]. To check for a dart being caught in the net, check for the dart x coordinate being close enough to the net x coordinate. If it is, go to a routine called CaughtTest, similar to PopTest [SR 8]. (You can also embellish things with an appropriate sound if you wish.) A caught dart would, like other kinds of misses, take control back to the top of the main dart loop.

You might experiment with different shapes and sizes of nets by using MacPaint to draw them, and then using MacInterface to incorporate them into your program.

Another thing you could do is assess the player a penalty for caught darts, perhaps reducing the current score by the amount that would have been awarded for a hit on the current balloon. Have fun . . . and if you go crazy adding paddle wheels, flippers, black holes, flying-dart teleporter boxes, and so on, don't blame your friendly authors. We warned you that tinkering with games is addictive!

MacDart program listing

```
'*****************************************************************
'                          MacDart
'          Throw the dart and see if you can pop the balloon!
'*****************************************************************

'************************************************** INITIALIZE
RANDOMIZE TIMER
DIM dart%(20), bal%(70)
gravity = .08
false = 0 : true = NOT false

WINDOW 1, "", (0,34) - (512,324), 2

                                        'make dart and balloon shapes
CIRCLE (20,10), 8, , , , .3             'dart body
LINE (22,8) - (30,6) : LINE (30,6) - (28,10)   'top fin
LINE (22,12) - (30,14) : LINE (30,14) - (28,10)  'bottom fin
LINE (12,10) - (8,10)                   'point of dart
GET (8,6) - (30,14), dart% : PUT (8,6), dart%   'get array & erase shape

FOR size = 0 TO 10                      'balloon body
  CIRCLE (20,20), size, , , , 1.5
NEXT size
LINE (20,30) - (17,33) : LINE (17,33) - (20,35)   'string at bottom
CALL TEXTMODE(3)                        'print double-M's on balloon
CALL MOVETO(15,22) : PRINT "M"
CALL MOVETO(17,28) : PRINT "M"
GET (10,10) - (30,35), bal% : PUT (10,10), bal%   'get array & erase shape

                                        'draw title screen
PUT (30,30) - (230,280), bal%           'draw big balloon
CALL TEXTFACE(1) : CALL TEXTMODE(1)     'set text for title
CALL TEXTSIZE(18)
CALL MOVETO(270,250) : PRINT "MacDart!"
PUT (200,200) - (420,280), dart%        'draw big dart
FOR n = 20 TO 80 STEP 3                 'sound sweep
  SOUND n, 2
NEXT
FOR t = 1 TO 3000 : NEXT                'wait a bit

MENU 6,0,1,"MacDart"                    'install MacDart menu
MENU 6,1,0,"Play Again"
MENU 6,2,0,"Instructions"
MENU 6,3,0,"-"
MENU 6,4,1,"Quit to BASIC
MENU 6,5,1,"Quit to DeskTop"
ON MENU GOSUB MenuEvent : MENU ON

GOSUB Instructions
```

INIT 1

INIT 2

INIT 3

INIT 4

```
'* * * *
```

ME 2

```
Instructions:                                              'show instructions
   WINDOW 2, , (16,55) - (495,325), 2
   PRINT
   PRINT "                        Instructions for MacDart"
   PRINT
   PRINT "          See if you can pop the balloon with the dart."
   PRINT "       Double-click the mouse button to release the balloon."
   PRINT "          Then single-click the button to throw the dart."
   PRINT "       If the dart hits the balloon, the balloon will explode."
   CALL INITCURSOR

   BUTTON 1, 1, "Continue", (190,240) - (280,260)              'create button
   WHILE DIALOG(0) <> 1 : WEND                            'and wait for button click
   BUTTON CLOSE 1 : WINDOW CLOSE 2
   CLS
   RETURN
```

ME 3

```
BasQuit:                                                   'quit to BASIC
   FOR n = 1 TO 2 : WINDOW CLOSE n : NEXT
   MENU RESET
   END
```

ME 4

```
DeskQuit:                                                  'quit to Mac Desktop
   MENU RESET
   SYSTEM
```

SR 1

```
'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
InitScreen:                                'initialize screen to launch new balloon
   xBal = 20 : xBalOld = xBal                                      'initial positions
   yBal = 260 : yBalOld = yBal                                     'for balloon and dart
   xDart = 450 : xDartOld = xDart
   yDart = 100 : yDartOld = yDart
   xDartStep = INT(25 * RND(1) + 25)                                    'dart speed
   yBalStep = INT(6 * RND(1)) + 1                                     'balloon speed
   CLS
   popped = false
   GOSUB GiveScore
   FOR d = 1 TO dart - 1                                       'display remaining darts
      PUT(450, 280 - 6 * d), dart%                              'in lower right corner
   NEXT
   PUT(xDart,yDart), dart% : PUT(xBal,yBal), bal%                          'draw objects
   RETURN
```

SR 2

```
MoveBal:                                   'move only balloon until double-click
   WHILE yBal > 0 AND MOUSE(0) <> -1
      yDart = MOUSE(2) : GOSUB updateDart
      GOSUB updateBal
   WEND
   RETURN
```

SR 3

```
MoveBoth:          '_____ move both until either balloon reaches top,
                   'dart reaches left side, or balloon is popped
  dartTime = 0
  WHILE yBal > 0 AND xDart > -20 AND popped = false
    dartTime = dartTime + 1
    xDart = xDart - xDartStep                          'new dart position
    yDart = yDart + (gravity * dartTime * dartTime)
    GOSUB updateDart
    GOSUB updateBal
    IF xDart <= xBal + 20 THEN GOSUB PopTest
  WEND
  RETURN
```

SR 4

```
SubDart:           '_____ subtract one dart from total left
  dart = dart - 1
  IF dart > 0 THEN PUT(450, 280 - 6 * dart), dart%
  RETURN
```

SR 5

```
GiveScore:         '_____print points and speed
  LINE (50,250) - (430,330), 30, bf
  CALL MOVETO(50,280)
  PRINT points; "points, dart speed"; xDartStep * 2; "MPH";
  RETURN
```

SR 6

```
updateDart:        '_____ update dart position; show cursor if dart above window
                   'just return if no movement
  IF xDart = xDartOld AND yDart = yDartOld THEN RETURN

  IF (yDart < -5) = cursFlag THEN CursorOK
  IF cursFlag THEN CALL HIDECURSOR ELSE CALL SHOWCURSOR
  cursFlag = NOT cursFlag
CursorOK:
  PUT(xDart,yDart), dart%                              'draw new dart
  PUT(xDartOld,yDartOld), dart%                        'erase old using XOR
  xDartOld = xDart : yDartOld = yDart                  'make new image old
  RETURN
```

SR 7

```
updateBal:         '_____ update balloon position
  yBal = yBal - yBalStep
  PUT(xBal,yBal), bal%                                 'draw new balloon
  PUT(xBalOld,yBalOld), bal%                           'erase old using XOR
  xBalOld = xBal : yBalOld = yBal                      'make new image old
  RETURN
```

SR 8

```
PopTest:           '_____ test for dart and balloon in same place, pop balloon if hit
  IF NOT (yDart < yBal + 20 AND yDart > yBal - 5) OR xDart < 5 THEN RETURN
  popped = true
  FOR z = 0 TO 5                                       'sound if popped
    SOUND 120, 3, 255 - (50 * z)
  NEXT z
```

```
xExp = xBal + 10 : yExp = yBal + 10                    'display explosion
color = 33
FOR n = 0 TO 1
   FOR r = n TO 25 STEP 3
      rfac = r/2 + 12
      LINE(xExp - rfac, yExp + r) - (xExp + rfac, yExp - r), color
      LINE(xExp - rfac, yExp - r) - (xExp + rfac, yExp + r), color
   NEXT
   color = 30
NEXT
points = points + yBalStep
RETURN
```

MacBandit

Have you ever won it big (or even little) at Las Vegas? No? Well, try your luck on the world's most sophisticated and user-friendly slot machine: your Mac plus MacBandit! We offer a penny slot (try and find that *in Vegas these days!), and scrupulously fair odds (ditto!). You can see and hear the symbols roll in the windows, and hear a cheery jingle when you win.*

Sorry, we can't offer a real payoff! You'll still have to go to Nevada for the bountiful buffets and the floor shows, too. Still, we think you'll find MacBandit a lot of fun. Next time you have a party, leave this game up on your Mac and we bet you'll soon find half your guests clustered around it.

How to play MacBandit

Playing MacBandit is simplicity itself. When the program starts running, the slot machine is drawn on the left side of the screen, and on the right side you'll see four piles of five coins each, as shown in Figure 1. Below the coins are given the totals of coins won in the current play (0 to start) and the coins in your possession (20 to start). As the instructions above the slot machine explain, simply grab any coin with the mouse pointer, drag it over to the machine's deposit slot, and release it to start the machine.

After you "deposit" your coin, the word *MAC* briefly appears in the first of the machine's three windows. Then the windows seem to flicker as the various images (Mac, cherry, bell, lemon, orange, plum) appear, accompanied by a clicking sound from the Bandit's "mechanism."

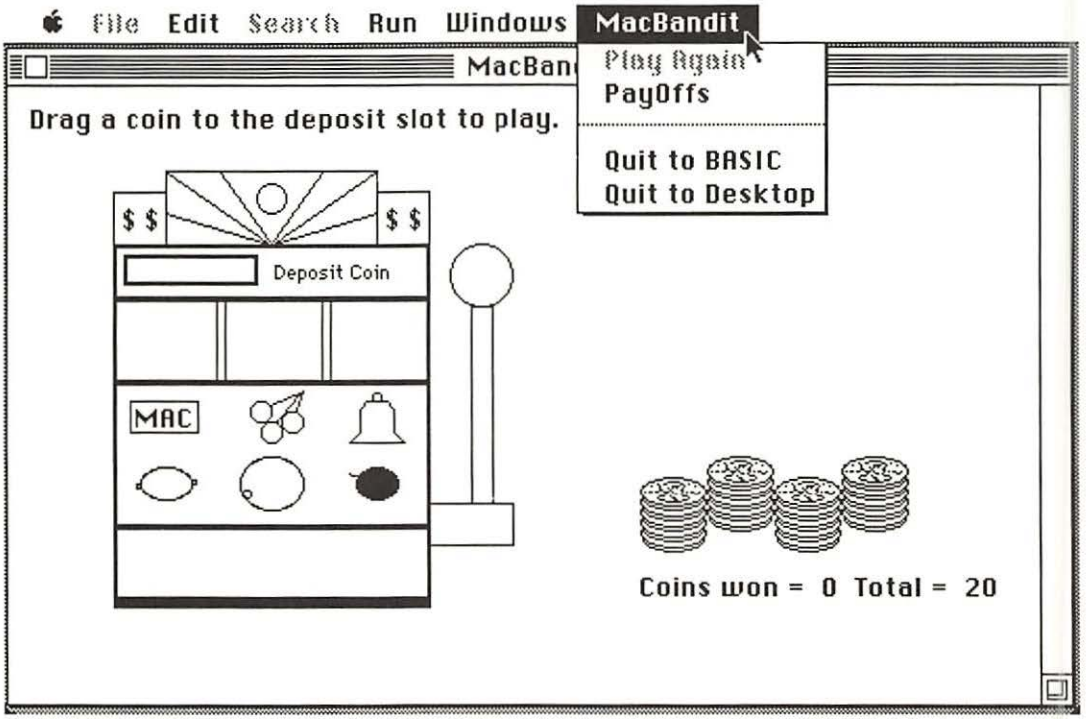


FIGURE 1. *The MacBandit playing screen and menu*

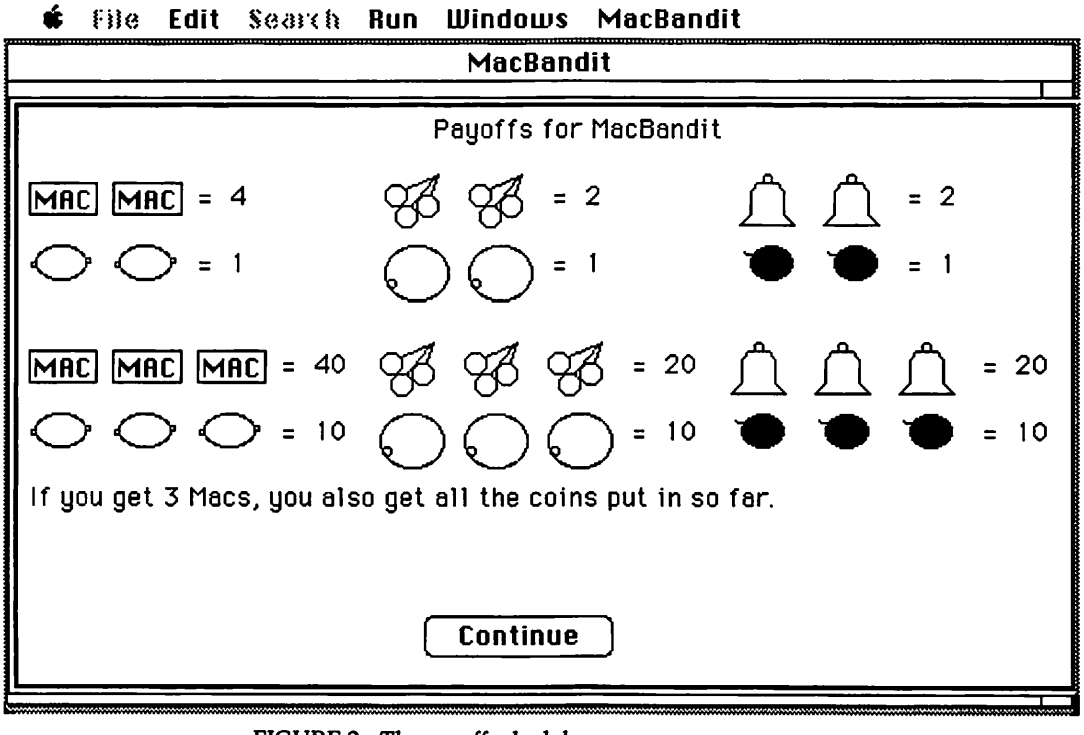


FIGURE 2. *The payoff schedule*

What happens next depends on how lucky you were. The payoff depends on whether two or three symbols matched, and which symbols they were. To see these payoff amounts (while the machine isn't in play), pull down the MacBandit menu and choose the PayOffs item: The display in Figure 2 appears with the symbol combinations and their payoffs. Note that matching three symbols pays more than matching two, and that the Mac symbol pays the most in both cases. If you match three Macs you win the "Macpot," and you not only get the 40-coin payoff, you also get all coins deposited since the last Macpot (or the beginning of the game, if there is no previous Macpot).

When you get a jackpot, the machine appears to disgorge a pile of coins comprising your winnings, and a musical selection plays. A two-match win plays "Pop Goes the Weasel," while a three-match win calls more of the Mac's musical resources into play for a rendition of "Happy Days Are Here Again."

Unfortunately, you can't take your winnings down to the local computer store and get that second disk drive you've always wanted for your Mac: All you can do is use the extra coins to play some more. (Come to think of it, that's even better *house* odds than in Nevada, because no

matter what it gives you, sneaky MacBandit *always* gets all its money back!) After the jackpot has spilled out of the machine, MacBandit picks it up and carefully stacks it with your other coins, and updates the total for that jackpot and your total coins.

How to beat MacBandit? You're kidding: You could easily rig the machine by altering the program code, but it would be like cheating at solitaire. We don't recommend jiggling the Mac either; although no bouncer will escort you to the door, it may not be good for your computer's innards. Some things in life just have to be played where they lie.

How MacBandit works

As you can see in the program outline in Figure 3, the program's first task is to initialize a number of constants and arrays. The arrays contain pictures of the fruit, the results for each window, the payoff rates for the fruit, two views of the coins, the coin-slot rectangle, the coin-stacks rectangle, and the values for the pile size for the payout coins. Subroutines called in the early stage of the program form the image arrays for the coins and the fruit. The MacBandit menu is set up with the four options: Play Again, PayOffs, Quit to BASIC, and Quit to Desktop.

Initialization	
define size of graphics arrays and constants	**Init 1**
define "point in rectangle function"	**Init 2**
create playing window	**Init 3**
get coin image arrays (**FormCoins**)	**Init 4** (SR 19)
display playing screen (**DrawScreen**)	SR 12
save fruit symbols (**SaveItems**)	SR 16
install MacBandit menu, enable menu event-trapping	
Main Program	
WHILE true (endless loop interrupted by menu events)	**Main 1**
set up initial stack of coins (**ShowStack**)	SR 13
WHILE coins left	**Main 2**
wait for player to deposit a coin (**DepositCoin**)	SR 1a
erase machine windows	
'spin' the fruit by showing symbol sequences (**SpinFruit**)	**Main 3** (SR 2a)
put random final fruit in each window	
check for matches	
branch to appropriate subroutine (**MatchTwo, MatchThree**)	SR 5, 6
update player's score (**UpdateCount**)	SR 9
WEND	
wait for menu event to restart game	**Main 4**
WEND	

(continued)

FIGURE 3. *Program outline*

Menu Events

MenuEvent: branch to appropriate subroutine	**ME 0**
PlayAgain: set flag to play another game	**ME 1**
PayOffMenu: set flag to show payoffs while waiting to deposit coin	**ME 2**
BasQuit: quit to BASIC	**ME 3**
DeskQuit: quit to Mac Desktop	**ME 4**

Subroutines

DepositCoin: wait for player to deposit coin	**SR 1**
WHILE coin not deposited	
WHILE waiting for button press	
if payoff flag set, display payoffs (**Payoffs**)	SR 3
WEND	
if pointer is in stack area:	
hide pointer	
subtract coin (**SubCoin**)	SR 11
animate dragging of coin	
show pointer	
if coin not dragged to slot, add coin back (**AddCoin**)	SR 10
WEND	
increment number of coins deposited	
SpinFruit: simulate spinning of fruit	**SR 2**
show random fruit in each window	
choose and show random final fruits	
Payoffs: show game payoffs	**SR 3**
open second window	
display two-match payoffs (**ShowFruit**)	SR 4
display three-match payoffs (**ShowFruit**)	SR 4
create Continue button, wait for button click	
close second window, redraw screen (**DrawScreen**)	SR 12
show stack of coins (**ShowStack**)	SR 13
ShowFruit: display specified fruit	**SR 4**
MatchTwo:	**SR 5**
determine payrate	
pile coins up at bottom of machine (**PileCoins**)	SR 7
play Pop Goes the Weasel (**Weasel**)	SR 18
transfer coins to stack (**UnpileCoins**)	SR 8
MatchThree:	**SR 6**
determine payrate	
pile coins up at bottom of machine (**PileCoins**)	SR 7
play Happy Days Are Here Again (**HappyDays**)	SR 17
transfer coins to stack (**UnpileCoins**)	SR 8
PileCoins: make pile of coins below machine	**SR 7**

(continued)

Figure 3. Program outline (continued)

UnPileCoins: transfer pile of coins to stack (**AddCoin**) **SR 8, 10**

UpdateCount: update coin count display **SR 9**

AddCoin: add coin to stack at correct position **SR 10**

SubCoin: subtract coin from stack **SR 11**

DrawScreen: set up initial screen **SR 12**

ShowStack: create stack of coins (**AddCoin**) **SR 13, 10**

DrawMachine: draw machine except for fruit **SR 14**

DrawItems: draw fruit items on screen **SR 15**

SaveItems: save fruit images to bitmap arrays **SR 16**

HappyDays: play Happy Days Are Here Again **SR 17**

Weasel: play Pop Goes the Weasel **SR 18**

FormCoins: get coin images **SR 19**
set up error trapping
look for MacBandit.graphics file on disk
if file present, read picture file
if file not present, read bit-map arrays from DATA statements (**ReadArray**) SP 1

Subprogram

ReadArray: read graphics array from DATA statements **SP 1**

Figure 3. Program outline (continued)

MacBandit uses a WHILE...WEND loop structure with calls to subroutines and a subprogram to perform most of the work of the game. The outer WHILE...WEND loop sets up the stack rectangle and continues with an inner WHILE...WEND loop that lasts as long as you have money and have not quit the game. This loop calls DepositCoin [SR 1a], which goes into a WHILE...WEND loop that waits for you to deposit your coin. Within this loop, your mouse movements are checked to see if you picked up a coin, where you moved it, and if you dropped it in the slot.

Once that happens, the program exits DepositCoin and returns to erase the windows in the slot machine in the main program. The main program then calls SpinFruit [SR 2a], which does just that: spins the fruit in their windows. After returning to the main program, the results are checked, and appropriate payoffs are made by calling MatchTwo [SR 5] or MatchThree [SR 6] and UpdateCount [SR 9]. This ends the inner loop. The Play Again menu item is enabled, and the program sits patiently waiting for your next move.

Initialization (and some programming tips)

There are a few things to notice about [Init 1]. Since this program uses a number of arrays to hold graphic objects (including two views of a coin), a CLEAR statement is used to reserve enough space in BASIC's data segment for the program text, arrays, and other variables. It's always a good idea to look at your program's data structures and reserve a generous amount of space for them. By reserving space this way, you won't get an Out of Memory error the first time you run the program—or worse, someone else won't get one due to some peculiar combination of inputs that you hadn't anticipated.

Also note the definitions of *false* and *true*. If you're used to programming in a language such as Pascal that has these values built in, be warned that you have to define them in Microsoft BASIC. Defining these logical values and using them in loop-control conditions makes your code more understandable.

There are several other touches here that make for programs that are easier to understand and run faster. You probably use many of them yourself, but it's worth reviewing them:

- When all your variables are going to be integers, say so with DEFINT. Integer variables take up less space than other variable types (such as SNG and DBL) and are calculated much faster.
- Name all the values you're going to use—even fixed constants—as variables.
- Use the variable names to dimension arrays involving the appropriate quantities. This makes the code easier to understand and therefore easier to maintain or modify. For example, even a beginning programmer who wants to start with 50 coins rather than 20 can change *startCoins* to 50 and expect reasonable results.

In [Init 2] we define the function PtinRect. This simply checks whether point (x,y) is within a rectangle with given side coordinates. We'll use it to see if the player has managed to get a coin into the deposit slot and also to check whether the player has started to drag the pointer in the coin-stack area. We also define the function Minimum, which is simply a crafty way of finding which of two numbers is smaller.

There are two good reasons for using functions like these. First, it obviously makes sense to have a complex condition defined as a function so a lengthy segment of code need appear only once in the program and the function can be called with any appropriate variables. However, in this program the function PtinRect will only be used twice, so is it really worth

it? It is, because the other reason to use a function is *clarity.* In this case, it allows us to read statements beginning with *IF PtinRect (...)* in the code and understand what they do without the details of their definition confusing us. It's something like writing a report that requires a lot of citations and supporting data: You use footnotes to make these details accessible while tucking them out of the way so the reader can concentrate on the thrust of your argument. In general, the more the main loop of a program and as many of the major subroutines as possible look like English (which is referred to as "self-documenting" code), the better the structure of your program and the easier it will be to modify and use.

In [Init 3], we make sure that the MacBandit window limits are set to the proper size. Next, the payoff values for each fruit are set. This is done by assigning a payoff to *payRate(n,1)* of 1 coin if two fruits match. This value is increased to 2 coins if the two fruits that match are from the first three items: Macpot, cherry, or bell. For three matches, the payoff of 10 coins is assigned, unless the items are among the first three, which have a payoff of 20 coins. One more value is set, for the case of matching Macpot items. For these, the payoff for two matching—*payRate(1,1)*—is 4 coins, and the payoff for three matching—*payRate(1,2)*—is 40 coins.

Initializing, displaying, and saving graphic objects

Next, [Init 4] calls FormCoins [SR 19a], which checks to see if the file *MacBandit.graphics* is on the disk. Since no disk volume is specified, this file must be on the same disk BASIC was started from, or it won't be found. If the file *is* found, FormCoins opens it and gets the count of bytes-per-image. A FOR...NEXT loop handles the two coin views. We input the graphics commands for each coin view as a string and use a PICTURE statement to both display the coin as an animated attention-getter, and enable us to capture the image and put it into our *coin* array with a GET statement for later use. Note that a two-dimensional array is used, since we want to store and access more than one related image. (By the way, this technique is described in detail in Chapter 17, "Animation," in another book of ours, *Macinations,* Microsoft Press, 1985.) We then erase the coin with PUT and go on. This technique of checking to see if a graphics file exists takes advantage of the MacInterface program (also in this book) to modify MacPaint files for incorporation into programs that use graphics, without the bother of keying in long strings of DATA statements. Once you've learned how to use MacInterface, you can then create your own coin symbols and generate appropriate DATA statements for drawing them, and incorporate the statements in MacBandit. (Perhaps you want a dollar slot machine?)

With the use of PUT and GET, we can produce animation effects when we have more than one view of a particular figure. Remember, when you PUT the same figure in the same location on the screen in the default XOR mode, you effectively erase it.

If the graphics file wasn't found, we go to the label ReadPictures [SR 19b], which first does a RESTORE to set the DATA pointer to the appropriate DATA statements for the ReadArray subprogram [SP 1] to first READ our two coin views, then draw them, and finally save them.

The program returns to [Init 4], and we are now ready to draw the remaining items that are needed to make this Bandit work: the slot machine and the fruit. The program first calls DrawScreen [SR 12], which in turn calls DrawMachine [SR 14].

Drawing the slot machine

DrawMachine draws all of the slot machine except for the fruit that will "spin" in the windows. This drawing is straightforward and is well commented in the listing, but we'd like to point out a handy technique used here: building proportions into the drawings by defining coordinates in terms of previously defined coordinates.

Consider the coin slot, for example. The bottom is defined in terms of the top (*slotR(1) + 15*), and the right side (*slotR(4)*) is defined as the coordinates of the left side (*slotR(2)*) plus twice the width of a coin (that is, *coinSep* × 2). This means that if you decide to move the slot down a bit, the bottom of the slot will remain the correct distance from the top. If you decide to make larger coins, the slot will expand to accommodate them! Things will still get out of kilter if you go too far, but building proportions into your graphics by defining relationships between variables makes the graphics much more flexible and intuitively understandable.

Drawing and saving the fruit

DrawItems [SR 15] is called next from DrawScreen [SR 12] and draws the Macpot jackpot bar and the fruit symbols—six items in all. Each is a simple figure, and for the lemon, orange, plum, and cherry, the built-in BASIC command, CIRCLE, makes the job easier. After returning to DrawScreen, the instruction: "Drag a coin to the deposit slot to play" is displayed on the screen.

After returning to [Init 4], SaveItems [SR 16] GETs the items into the *fruit* array. This is another example of making a bit of program code do double duty: First, the program draws the items to decorate the machine

and then gets them for use in the machine windows later. When designing games, it's a good idea to think of something useful to do with images that you draw, even if your main purpose is simply to GET them for future use.

Although we don't really save any space by using three separate subroutines to draw the machine and draw and get the symbols, the code *is* broken into three logical segments: draw fixed image (the machine); draw movable images (the fruit); and save movable images. This is an example of letting the logical structure of what you're doing determine how you segment your code.

Setting up the MacBandit menu

The next section of code [Init 4] sets up and enables the MacBandit menu. You will find that with most systems, creating a menu and checking for appropriate input is a tedious task that has to be repeated for each program or group of related functions within a program. As you can see in [Init 4], creating a menu on the Mac only takes one statement per menu item (plus one for the menu title). We create a pull-down menu at menu-bar position 6 with the title MacBandit, and include five items in the menu.

We enable the various items by putting a *1* as the last parameter in the MENU statement. This item will appear in black print when the menu is pulled down and will be "enabled"; that is, will be read as a valid user selection. Since Play Again isn't applicable when the player hasn't played at all yet, this item will appear as a "background" item (dimmed print) and won't be enabled the first time the game is played. In fact, the menu as a whole isn't quite ready to use yet: Menu event-trapping still needs to be activated. The next couple of lines of code do just that. An ON MENU GOSUB calls MenuEvent [ME 0] if the player makes selections from the MacBandit menu at any time.

The main program loop

This is a good time to glance back at our program outline to see what's on the agenda for the game (the outer WHILE...WEND loop, [Main 1]) and for the play of each coin (the inner WHILE...WEND loop, [Main 2]).

First, we set up (but don't display) a rectangle around the coin stack area so that we will have the reference points for placing our four coin stacks. A call to ShowStack [SR 13] sets the coin count to 0 and begins a FOR...NEXT loop that calls AddCoin [SR 10] to place each of the 20 coins that make up the player's starting supply. This subroutine uses the

MOD function to make sure that coins are distributed as evenly as possible among the stacks. Since the first and third stacks are closer to the bottom of the screen, we use another handy MOD to offset the second and fourth stacks by subtracting 10 from their y coordinates. (Because of the first MOD, think of the stacks as numbered 0, 1, 2, 3.) In all cases, coins are added by "erasing" the "top of coin" image with a PUT of the old image, and then a PUT of the new image, a coin-edge image stored in *coin(1,2)*.

As we add coins, we have to watch for the situation where all the stacks are filled evenly with coins and a new coin is going to start a new "layer" of coins. We can tell that this is going to happen when *coinCount* (not counting the coin being added) is divided evenly by the number of stacks. When this happens, we jump to the AddEmptyStack label, which accommodates the new layer of coins.

Back in ShowStack, we call UpdateCount [SR 9] to print the starting totals of coins won in the last play and total coins owned by the player. Since we haven't played yet, these totals are 0 and 20, respectively. Then control returns to the main program and the main playing loop, which handles the playing of the individual coins until the player either quits or runs out of money.

Main playing loop

After setting up a WHILE...WEND loop that makes sure the player hasn't lost all the coins (*WHILE coinCount <> 0*), we then call DepositCoin [SR 1a]. This starts out with the variable *deposited* set to *false,* then uses its own WHILE...WEND loop to wait for a successful coin deposit to be made by the player. Since this requires a mouse drag, a nested WHILE...WEND loop waits for the player to hold the mouse button down.

When MOUSE(0) is less than or equal to −1, we know the mouse is being dragged. If the menu-option PayOffs is chosen, *payOffFlag* is set to *true,* and PayOffs [SR 3a] is called. PayOffs sets *payOffFlag* to *false,* and then displays the fruit symbols [SR 3b], [SR 3c] (by calling ShowFruit [SR 4]) and their appropriate pay rates. Remember that at the beginning of this program we dimensioned the *payRate* array to hold the various pay rates. By setting up that array of values and then referencing it using the index, it's a simple matter to change the payoff schedule in [Init 3] without having to remember to change all of the occurrences of the values, which we'd have to do if each one had been given a specific value in different sections of the program.

The DIALOG expression enables the player to click a button to continue with the program after the payoff schedule has been read. This

technique makes the game much easier for users to play, since they can go at their own pace. It's easier for *you* as the programmer, too, because you don't have to code a timing loop based on your guess of the average player's speed-reading abilities. Instead, one set of instructions handles it all. After the user clicks the Continue button, the screen is redrawn with a call to DrawScreen [SR 12], which we discussed earlier.

If the PayOff menu selection was not made, the PtinRect function checks to see if the mouse activity is within the coin-stack area. If it is, we assume that the player wants to drag a coin to the slot machine (since it's the only game in town!). We then call SubCoin [SR 11], which manages the coin stacks much like AddCoin [SR 10], except that it takes a coin from the appropriate stack and reduces *coinCount* by 1.

Back in DepositCoin, we draw the coin over the (now hidden) arrow pointer. Another WHILE...WEND loop draws and redraws it while MOUSE(0) continues to be less than or equal to −1 (that is, while the player continues to drag it). Once the coin is "dropped"—the player has let go of the mouse button—we restore the pointer to normal and use our PtinRect function to see if the coin was released within the rectangle representing the deposit slot. If it wasn't, we call AddCoin [SR 10], which gives the effect of our Bandit indignantly snatching the coin away from the player and putting it back in the player coin stack. If the coin was properly deposited, the function sets the logical variable *deposited* to *true*, and we then fall through the bottom of DepositCoin's main WHILE...WEND loop, increase the value of *totalDeposit* by 1, and RETURN to the main playing loop.

The money is in the slot, so we're ready to give some action for the player's coin. After erasing the slot-machine windows [Main 2] (remember that a LINE statement with the *bf* parameter defines and fills a rectangle), we give the appearance of the wheels spinning within the windows (by flashing different images) with a call at [Main 3] to SpinFruit [SR 2a]. The heart of SpinFruit is a pair of nested FOR...NEXT loops. The outer loop gives us *spinCount* spins; the inner loop cycles through the list of six symbols in rapid succession, drawing and then erasing the next image in each of the three windows.

What we're doing here is somewhat different from the operation of a real slot machine. A real machine spins the windows separately and uses a mechanism to vary the point at which each wheel stops spinning,

thus providing random symbols in the windows. We spin all the windows *spinCount* times and *then* use another FOR...NEXT loop [SR 2b] to draw random symbols in the windows. (We also save the symbol numbers in the *result* array so we can check for winning combinations.) This process is a lot easier than trying to simulate the mechanical process of an actual slot machine, and it gives about the same effect for game purposes.

Next, the program returns to [Main 3] and checks to see if we've got a winner. There's a bit of clever coding here. The straightforward (and lengthy) way would be to use an IF...THEN test for each possible matching pair of symbols (does the result in window 1 equal the result in window 2; does window 2's result equal the result in window 3; and so on) as well as checking for a three-match (does the result in window 1 equal the result in window 2 and the result in window 3). We would then need additional IF...THEN statements to branch to the appropriate subroutines for handling a no-match, a two-match, and a three-match. Instead, we define a variable called *same* that can have three possible values: 0 if no match at all, 1 for a two-match, and 2 for a three-match. We check results in windows 1 and 2 and make *same* equal to 1 if they match. If windows 2 and 3 match, we add 1 to *same*. (If 1 and 2 matched, *same* is already 1, so it becomes 2, which makes sense, since if 1 and 2 match and 2 and 3 match, we have a three-match.) If nothing matched, *same* remains at 0, due to the *ELSE* clause in the first IF...THEN statement.

Now that we've got a numeric result, we use the ON...GOSUB structure to branch to the appropriate subroutine to handle the outcome found. If *same* was 0 (nothing matched), the ON...GOSUB doesn't get executed. We then call UpdateCount [SR 9], which prints the message that no coins were won that play and subtracts one coin from the stack. The program then returns to the top of the main playing loop at [Main 2] to play the next coin (if there is one).

If either two or three symbols matched, we have a winner. We then follow this general procedure: (1) Determine the number of coins won; (2) show a pile of coins representing the jackpot; (3) play some music; and (4) stack the coins in the player's pile. For a two-match we call MatchTwo [SR 5], which sets the value of *prize* equal to the *payRate* for the particular symbol. MatchTwo then calls PileCoins [SR 7], which draws a number of coins equal to the prize in random positions at the bottom of

the slot machine to simulate the coins pouring out. Next, Weasel [SR 18] is called to play "Pop Goes the Weasel," using a simple series of SOUND statements with appropriate values for the tune. Finally, UnPileCoins [SR 8] is called. This starts with a delay, so the player can gloat over the winnings for a moment, and then uses a FOR...NEXT loop to erase each coin (whose coordinates are in the *pile* array) and add it to the player's stack via a call to AddCoin [SR 10].

MatchThree [SR 6], which handles the big jackpots for three-matches, works the same way as MatchTwo. The prize is bigger, and if you are lucky enough to hit the "Macpot"—three Mac bars in a row—you also collect all of the coins deposited in the machine since the last Macpot (or the beginning of the game, if this is the first Macpot of the game). The other difference from MatchTwo is that the tune is played through a call to HappyDays [SR 17]. This produces a longer and louder tune (it uses the louder default volume of 127, while Weasel uses a volume of 20).

Having handled the jackpot, we call UpDateCount [SR 9] to summarize the good news in the player's totals, then we go back to the top of the main playing loop to play the next coin.

When the player runs out of coins, we fall into the bottom of the outermost (main game) loop [Main 4] and enable the Play Again menu item. We then loop until the player chooses Play Again (or Quit, which is already enabled). While we're here, let's look in a little more detail at the way menu events are handled.

Handling menu events

As mentioned earlier, we've enabled only the PayOffs, Quit to BASIC, and Quit to Desktop menu selections while coins are being played. If a menu selection is made, MenuEvent [ME 0] is automatically called, due to our use of the ON MENU GOSUB earlier. The MENU(1) function tells us which selection was made. The *ON mItem GOSUB* statement calls the appropriate subroutine according to which item is selected. PlayAgain [ME 1] sets the *pAgainFlag* to *true,* and deactivates the Play Again menu item (*MENU 6,1,0*) before it returns. The BasQuit [ME 3] and the DeskQuit [ME 4] subroutines each clean out the menu (MENU RESET) and then BasQuit ends the program, while DeskQuit exits to SYSTEM.

When at least one game (that is, one batch of player coins) has been played, the Play Again menu option is enabled. Selecting this option while we're in the loop following a game calls MenuEvent, which in turn calls PlayAgain because *mItem* is 1. PlayAgain sets *pAgainFlag* to *true* and

uses a MENU statement to disable Play Again. We do this because we want Play Again to be an active option only when a game has just been completed; trying to start a new game in the middle of an existing one would play havoc with the sequence of events and probably break the bank with a barrage of range errors. PlayAgain then returns to MenuEvent, which in turn returns to just after the post-game loop and thence to the top of the main game loop, where we set up the new game.

Suggestions for MacBandit

It would be easy for you to specify and check for your own winning combinations, determine their payoff, and choose a tune to serenade the winner. You could add a few more symbols to the symbol list (perhaps a nice McIntosh apple?). You can, of course, draw your own coins with MacPaint and use MacInterface to create the graphics file. You could animate the handle to simulate pulling it down. You could also rig the slot machine to be more like a Vegas slot (that is, give lower payoffs than the odds would justify)—but why be sadistic? After all, what could the Mac do with its accumulation of imaginary money?

MacBandit program listing

```
'*****************************************************************
'                          MacBandit
'                    A game of almost chance
'*****************************************************************

'********************************************************* INITIALIZE
INIT 1
IF FRE(0) < 22000 THEN CLEAR, 22000
DEFINT A-Z
OPTION BASE 1
false = 0 : true = NOT false
fruitCount = 6                          'number of different fruits
spinCount = 12                          'number of times to spin
windCount = 3                           'number of machine windows
windY = 108                             'y axis of Machine Windows
stackNum = 4                            'number of coin stacks
coinSep = 32                            'separation between coin stacks
stacksX = 300 : stacksY = 200           'bottom Left coords of coin stack
startCoins = 20                         'starting amount
maxPileSize = 50                        'maximum # of coins to pile up below the slot

DIM fruit(100,fruitCount)               'pictures of different fruits
DIM result(windCount)                   'results for each window
DIM payRate(fruitCount,2)               'rate at which fruit is paid off
DIM coin(95,2)                          'contains 2 views of coin
DIM slotR(4)                            'coin slot rectangle
DIM stR(4)                              'coin Stacks Rectangle
DIM pile(maxPileSize,2)                 'holds X and Y for payout coins
DIM penLoc(2)
RANDOMIZE TIMER

INIT 2
                                        'return true if (x,y) is in rectangle (t,l,b,r)
DEF FN PtinRect(x,y,t,l,b,r) = (x >= l AND x <= r AND y >= t AND y <= b)
                                        'return minimum of two numbers
DEF FN Minimum(x,y) = -(x < y) * x + -(x > y) * y

INIT 3
WINDOW 1, "MacBandit", (2,40) - (508,337), 1

FOR n = 1 TO fruitCount                 'set up payoff values for each fruit
   payRate(n,1) = 1                     'for two matches
   IF n < 4 THEN payRate(n,1) = 2
   payRate(n,2) = 10                    'for three matches
   IF n < 4 THEN payRate(n,2) = 20
NEXT
payRate(1,1) = 4 : payRate(1,2) = 40    'MacPot pays off highest

INIT 4
GOSUB FormCoins                         'form coin image arrays
GOSUB DrawScreen                        'draw initial screen
GOSUB SaveItems                         'get fruit pictures from screen
```

```
  MENU 6, 0, 1, "MacBandit"                          'install MacBandit menu
  MENU 6, 1, 0, "Play Again"
  MENU 6, 2, 1, "PayOffs"
  MENU 6, 3, 0, "-"
  MENU 6, 4, 1, "Quit to BASIC"
  MENU 6, 5, 1, "Quit to Desktop"
  ON MENU GOSUB MenuEvent : MENU ON

'********************************************** MAIN PROGRAM
  totalDeposit = 0                                   'user hasn't put in any coins yet
  WHILE true
    stR(1) = stacksY - 10 : stR(3) = stacksY + 25          'set up stack rectangle
    stR(2) = stacksX : stR(4) = stacksX + stackNum * coinSep
    stackSize = startCoins : GOSUB ShowStack

    WHILE coinCount <> 0                             'loop while player still has money
      GOSUB DepositCoin
                                                     'clean up machine; get ready for spin
      LINE(55,105) - (95,138), 30, bf                'erase machine windows before spin
      LINE(105,105) - (145,138), 30, bf
      LINE(155,105) - (195,138), 30, bf

      GOSUB SpinFruit                                          'spin windows

                                        'check for matches; either two right or three right
      IF result(1) = result(2) THEN same = 1 : type = result(1) ELSE same = 0
      IF result(2) = result(3) THEN same = same + 1 : type = result(2)
      IF same = 0 AND result(1) = result(3) THEN same = 1 : type = result(1)
                                'same now is 1 if two were same, or 2 if three were same
                               'type = type of fruit that matched (used to calculate payoff)
      ON same GOSUB MatchTwo, MatchThree
      GOSUB UpdateCount
    WEND
    MENU 6, 1, 1                                     'enable Play Again menu item
    pAgainFlag = false
    WHILE NOT pAgainFlag : WEND                      'loop until user chooses Play Again
  WEND
  END

'********************************************** MENU EVENTS
MenuEvent:
  MENU 6, 0, 0
  mItem = MENU(1)
  ON mItem GOSUB PlayAgain, PayOffMenu, , BasQuit, DeskQuit
  MENU 6,0,1
  RETURN

PlayAgain:              '_____________________ Play Again menu item selected
  pAgainFlag = true
  MENU 6, 1, 0
  RETURN
```

MAIN 1

MAIN 2

MAIN 3

MAIN 4

ME 0

ME 1

ME 2
```
PayOffMenu:                    '_____ user wants to see payoff
  payOffFlag = true
  RETURN
```

ME 3
```
BasQuit:                       '_____ quit to BASIC
  MENU RESET
  END
```

ME 4
```
DeskQuit:                      '_____ quit to Desktop
  MENU RESET
  SYSTEM

'********************************************** SUBROUTINES
```

SR 1a
```
DepositCoin:                   '_____ stay here until coin is deposited
  deposited = false
  WHILE NOT deposited                          'loop until coin is deposited
    WHILE MOUSE(0) > -1                        'wait until mouse button down
      IF payOffFlag THEN GOSUB PayOffs         'PayOffs menu item choosen
    WEND
    x = MOUSE(1) : y = MOUSE(2)                'is button down in stack rectangle?
    IF NOT FN PtinRect(x, y, stR(1), stR(2), stR(3), stR(4)) THEN NotPick

    CALL HIDECURSOR : GOSUB SubCoin            'yes, drag coin around
    PUT(x - 15, y - 15), coin(1,1)             'draw new view
```

SR 1b
```
    WHILE MOUSE(0) <= -1                       'loop until button is released
      IF MOUSE(1) = x AND MOUSE(2) = y THEN NotMoved
      PUT(x - 15, y - 15), coin(1,1)           'erase old view
      x = MOUSE(1) : y = MOUSE(2)
      PUT(x - 15, y - 15), coin(1,1)           'draw new view
NotMoved:
    WEND
    PUT(x - 15, y - 15), coin(1,1)             'erase old view
    CALL SHOWCURSOR                            'was coin dropped in the slot?
    deposited = FN PtinRect(x, y, slotR(1), slotR(2), slotR(3), slotR(4))
    IF NOT deposited THEN GOSUB AddCoin        'no, add back to stack
NotPick:
  WEND
  totalDeposit = totalDeposit + 1
  RETURN
```

SR 2a
```
SpinFruit:                     '_____ spin wheel
  FOR wind = 1 TO windCount : result(wind) = wind - 1 : NEXT
  FOR spin = 1 TO spinCount                    'spin wheel spinCount times
    FOR wind = 1 TO windCount                  'show something in each window
      result(wind) = (result(wind) MOD windCount) + 1
      x = 50 * wind + 10
      PUT(x,windY), fruit(1,result(wind))      'draw item
    NEXT wind
    SOUND 30, .7
    FOR wind = 1 TO windCount                  'erase what was shown in window
      x = 50 * wind + 10
      PUT(x,windY), fruit(1,result(wind))      'erase item
    NEXT
  NEXT spin
```

SR 2b

```
  FOR wind = 1 TO windCount                    'place random items in each window
    x = 50 * wind + 10
    item = INT(fruitCount * RND + 1)
    PUT(x,windY), fruit(1,item)
    result(wind) = item
  NEXT wind
  RETURN
```

SR 3a

```
PayOffs:                    '_____________________________________ show user payoffs
  payOffFlag = false
  WINDOW 2, , (10,55) - (505,325), 2
  PRINT SPACE$(48) + "Payoffs for MacBandit"
  PRINT
```

SR 3b

```
  FOR fruitNum = 1 TO 6
    FOR i = 1 TO 2 : GOSUB ShowFruit : NEXT i
    PRINT "="; payRate(fruitNum,1);
    CALL MOVE(58,0)
    IF fruitNum MOD 3 = 0 THEN PRINT : PRINT
  NEXT fruitNum
  PRINT
```

SR 3c

```
  FOR fruitNum = 1 TO 6
    FOR i = 1 TO 3 : GOSUB ShowFruit: NEXT i
    PRINT "="; payRate(fruitNum,2); "  ";
    IF fruitNum MOD 3 = 0 THEN PRINT : PRINT
  NEXT fruitNum
  PRINT "If you get 3 Macs, you also get all the coins put in so far."
  BUTTON 1, 1, "Continue", (190,240) - (280,260)
  WHILE DIALOG(0) <> 1 : WEND
  BUTTON CLOSE 1 : WINDOW CLOSE 2
  GOSUB DrawScreen
  stackSize = coinCount : GOSUB ShowStack
  RETURN
```

SR 4

```
ShowFruit:
  CALL GETPEN(VARPTR(penLoc(1)))
  PUT (penLoc(2),penLoc(1) - 15), fruit(1,fruitNum)
  CALL MOVE(40,0)
  RETURN
```

SR 5

```
MatchTwo:                   '_____________________________ two items matched on spin
  prize = payRate(type,1)                      'type is type of item that matched
  GOSUB PileCoins
  GOSUB Weasel
  GOSUB UnPileCoins
  RETURN
```

SR 6

```
MatchThree:                 '_____________________________ three items matched on spin
  prize = payRate(type,2)                      'type is type of item that matched
  'if you get three Macs, then you get back all coins put in so far
  IF type = 1 THEN prize = prize + totalDeposit : totalDeposit = 0
  GOSUB PileCoins
  GOSUB HappyDays
  GOSUB UnPileCoins
  RETURN
```

SR 7
```
PileCoins:              '_____ make pile of coins below machine
  FOR n = 1 TO FN Minimum(prize,maxPileSize)          'prize is pile showing
    pile(n,1) = INT(140 * RND + 51)
    pile(n,2) = INT(40 * RND + 212)
    PUT(pile(n,1), pile(n,2)), coin(1,1)
  NEXT
  RETURN
```

SR 8
```
UnPileCoins:            '_____ clean up pile of coins and add to stack
  FOR delay = 1 TO 5000 : NEXT delay
  FOR n = 1 TO FN Minimum(prize,maxPileSize)
    FOR delay = 1 TO 1000 : NEXT delay
    PUT(pile(n,1),pile(n,2)),coin(1,1)
    GOSUB AddCoin
  NEXT
  IF prize <= maxPileSize THEN UnPile1                'add rest of coins that
  FOR n = 1 TO (prize - maxPileSize)                  'weren't shown in pile
    GOSUB AddCoin
  NEXT
UnPile1:
  RETURN
```

SR 9
```
UpdateCount:            '_____ update coinCount display
  CALL MOVETO (stR(2), stR(3) + 20)                   'update coin num display
  PRINT "Coins won ="; prize; "Total ="; coinCount; SPACE$(14)
  prize = 0
  RETURN
```

SR 10
```
AddCoin:                '_____ add one coin to stack
  stackX = (coinCount MOD stackNum)
  stackY = stacksY - 5 * INT(coinCount / stackNum)
  IF stackX MOD 2 = 1 THEN stackY = stackY - 10
  IF INT(coinCount / stackNum) = 0 THEN AddEmptyStack
  PUT(stackX * coinSep + stacksX, stackY + 5), coin(1,1)      'erase old top coin
  PUT(stackX * coinSep + stacksX, stackY + 5), coin(1,2)      'add one coin edge
AddEmptyStack:
  PUT(stackX * coinSep + stacksX,stackY), coin(1,1)           'draw new top of stack
  coinCount = coinCount + 1
  IF stackX = 0 THEN stR(1) = stR(1) - 5
  RETURN
```

SR 11
```
SubCoin:                '_____ subtract one coin from stack
  coinCount = coinCount - 1
  stackX = (coinCount MOD stackNum)
  stackY = stacksY - (5 * INT(coinCount / stackNum))
  IF stackX MOD 2 = 1 THEN stackY = stackY - 10
  PUT(stackX * coinSep + stacksX,stackY), coin(1,1)           'erase old top of stack
  IF INT(coinCount / stackNum) = 0 THEN SubEmptyStack
  PUT(stackX * coinSep + stacksX, stackY + 5), coin(1,2)      'erase one coin edge
  PUT(stackX * coinSep + stacksX, stackY + 5), coin(1,1)      'draw new top coin
SubEmptyStack:
  IF stackX = 0 THEN stR(1) = stR(1) + 5
  RETURN
```

SR 12

```
DrawScreen:          '_____ set up initial screen
  CLS : GOSUB DrawMachine : GOSUB DrawItems
  CALL TEXTFONT(0)
  CALL MOVETO(10,20) : PRINT "Drag a coin to the deposit slot to play."
  RETURN
```

SR 13

```
ShowStack:           '_____ show stackSize number of coins
  coinCount = 0
  FOR n = 1 TO stackSize : GOSUB AddCoin : NEXT
  GOSUB UpdateCount
  RETURN
```

SR 14

```
DrawMachine:         '_____ draw machine except for fruit
  slotR(1) = 80 : slotR(2) = 55
  slotR(3) = slotR(1) + 15 : slotR(4) = slotR(2) + coinSep * 2
  CALL TEXTSIZE(9) : CALL TEXTFONT(1)
  CALL MOVETO(slotR(4) + 8,slotR(1) + 12) : PRINT "Deposit Coin"
  CALL TEXTSIZE(12) : CALL TEXTFONT(0)
  CALL MOVETO(54,68) : PRINT"$ $"
  CALL MOVETO(179,68) : PRINT"$ $"
  LINE(50,75) - (200,250), , b                          'main box
  LINE(51,76) - (199,249), , b                          'make it thicker
  CALL PENSIZE(2,2)
  CALL FRAMERECT(VARPTR(slotR(1)))
  CALL PENNORMAL

  LINE(75,40) - (175,75), , b : CIRCLE(125,53), 7       'box with rays, sun
  LINE(125,75) - (75,40) : LINE(125,75) - (75,60)
  LINE(125,75) - (175,40) : LINE(125,75) - (175,60)
  LINE(125,75) - (100,40) : LINE(125,75) - (150,40)

  LINE(50,50) - (75,75), , b : LINE(175,50) - (200,75), , b   'left, right $$ box

  LINE(50,100) - (200,102), , bf : LINE(99,100) - (103,140), , b   't,l window
  LINE(149,100) - (153,140), , b : LINE(50,140) - (200,142), , bf  'r,b window

  LINE(220,105) - (230,200), , b : LINE(200,200) - (240,220), , b  'arm
  CIRCLE(225,90), 15                                    'handle
  LINE(50,210) - (200,212), , bf : LINE(50,245) - (200,250), , bf  't,b of tray
  RETURN
```

SR 15

```
DrawItems:           '_____ draw items on machine
  CIRCLE(75,190), 12, , , , .7 : CIRCLE(62,191), 1 : CIRCLE(88,189), 1   'lemon
  CIRCLE(125,190), 15, , , , .85 : CIRCLE(113,195), 2                    'orange

  FOR n = 0 TO 10 :  CIRCLE(175,190), n, , , , .8 : NEXT                 ' plum
  LINE(162,185) - (175,190)
  CALL MOVETO(60,163) : PRINT"MAC"
  CALL TEXTFONT(1)
```

```
    LINE(58,150) - (90,165), , b                                    'jackpot bar
    CIRCLE(120,155), 5 : CIRCLE(125,165), 5 : CIRCLE(135,160), 5    'cherry
    LINE(124,152)-(140,145) : LINE(128,160)-(140,145)
    LINE(137,155)-(140,145)

    CIRCLE(175,148),2                                               'bell
    LINE(170,150)-(180,150) : LINE(170,150)-(167,155)
    LINE(180,150)-(183,155) : LINE(183,155)-(183,165)
    LINE(167,155)-(167,165) : LINE(183,165)-(188,170)
    LINE(167,165)-(162,170) : LINE(162,170)-(188,170 )
    RETURN
```

SR 16

```
SaveItems:          '_____ save images from screen
    GET(58,146) - (90,165), fruit(1,1)                              'Macpot
    GET(115,145) - (140,170), fruit(1,2)                            'cherry
    GET(162,146) - (190,170), fruit(1,3)                            'bell
    GET(60,180) - (90,200), fruit(1,4)                              'lemon
    GET(110,175) - (140,205), fruit(1,5)                            'orange
    GET(160,180) - (185,200), fruit(1,6)                            'plum
    RETURN
```

SR 17

```
HappyDays:          '_____ play 'Happy Days Are Here Again'
    SOUND 262,6 : SOUND 330,3 : SOUND 330,9 : SOUND 392,6           'c e e g
    SOUND 392,6 : SOUND 523,3 : SOUND 523,9 : SOUND 659,6           'g c c e
    SOUND 659,6 : SOUND 523,6 : SOUND 523,6 : SOUND 392,6           'e c c g
    SOUND 392,6 : SOUND 330,3 : SOUND 330,6                         'g e e
    RETURN
```

SR 18

```
Weasel:             '_____ play 'Pop Goes the Weasel'
    SOUND 523,4,20 : SOUND 523,2,20 : SOUND 587,4,20                'c c d
    SOUND 587,2,20 : SOUND 659,2,20 : SOUND 784,2,20                'd e g
    SOUND 659,2,20 : SOUND 523,4,20                                 'e c
    RETURN
```

SR 19a

```
FormCoins:          '_____ get coin images
                    'if file MacBandit.graphics exists, then read it, else read from DATA
    fileHere = true             'ON ERROR will change this to false if file isn't here
    ON ERROR GOTO FileError                                         'set up error trapping
    OPEN "MacBandit.graphics" FOR INPUT AS #1                       'is file present?
    ON ERROR GOTO 0                                                 'disable error trapping
    IF NOT fileHere THEN ReadPictures                               'no, read from DATA

    FOR n = 1 TO 2                                                  'get 2 coin images from file
      INPUT #1, bytes                                               'get byte count for image
      image$ = INPUT$(bytes,1)                                      'input it into string
      noUse$ = INPUT$(1,1)                                          'read past end of line marker
      PICTURE (0,0), image$                                         'display image
      GET (0,0) - (32,30), coin(1,n)                                'transfer bit image into array
      PUT (0,0), coin(1,n)                                          'erase it from window
    NEXT
    CLS
    CLOSE 1
    GOTO FormPictEnd
```

SR 19b

```
ReadPictures:                    'MacBandit.Graphics isn't on disk; read from DATA
   RESTORE SlantHeadData : CALL ReadArray(coin(),1)
   RESTORE EdgeData : CALL ReadArray(coin(),2)
FormPictEnd:
   RETURN
```

SR 19c

```
FileError:                       '_____ return fileHere = false if file not found
   IF ERR <> 53 THEN ON ERROR GOTO 0          'unknown error, print and halt
   fileHere = false
   RESUME NEXT
```

SP 1

```
SUB ReadArray(array(2),index) STATIC          '_____ read given array from DATA
   READ size
   FOR n = LBOUND(array) TO LBOUND(array) + size -1
      READ num : array(n,index) = num
   NEXT
   END SUB
```

```
SlantHeadData:                   '_____ data for picture of slanted coin
DATA 95
DATA 33 , 31

DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 15, -1024, 0, 240, 960, 0, 1795, -4040, 0
DATA 2124, 3204, 0, 12832, -3565, 0, 8226, -23551, 0, 16433
DATA 3072, -32768, 22222, -31388, -32768, 16388, 26648, -32768, 8249, 1793
DATA 0, 12352, -16253, 0, 10296, 26373, 0, 5895, -1990, 0
DATA 2288, 964, 0, 1807, -968, 0, 240, 960, 0, 15
DATA -1024, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0

EdgeData:                        '_____ data for picture of edge of coin
DATA 95
DATA 33 , 31

DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 16384
DATA 0, -32768, 16384, 0, -32768, 16384, 0, -32768, 8192, 1
DATA 0, 12288, 3, 0, 10240, 5, 0, 5888, 58, 0
DATA 2288, 964, 0, 1807, -968, 0, 240, 960, 0, 15
DATA -1024, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0
```

MacMouse

MacMouse is an ideal program for introducing young children to the Mac. When you think about it, many of the things that appeal to us about the Mac—its easy-to-use menus, buttons, and windows, the visual richness of its graphics capabilities, and the gratifyingly tactile response of the mouse—are all things that reach the child in us. Children want to see, touch,

manipulate, and explore the world around them, whether they're hiking in the woods or sitting in front of a computer. They have even less patience with unfriendly machines than we do. With the Mac and Macintosh BASIC, we can write programs that let kids play directly with the images on the screen. As kids play with MacMouse, they'll learn how to use the mouse to start an exciting mouse race. As the mice race neck and neck down the track, kids can cheer "their" mouse on, then watch a photo finish. We'll also suggest some ways that you can modify this program to make it interesting and useful to older kids.

How to play MacMouse

When MacMouse starts running, the screen shown in Figure 1 appears. A "banner" across the top of the screen tells you that you've arrived at the MAC & TOSH RACEWAY. Instructions just below tell how to start the race. On the left side of the screen, behind the starting gate, are two mice. The black one is Mac, and his opponent, the white one, is called (surprise!) Tosh. The finish line is on the right side of the screen. Each mouse's total wins are tallied in the big box or "scoreboard" at the top of the screen. Right now, of course, the score is tied at 0-0.

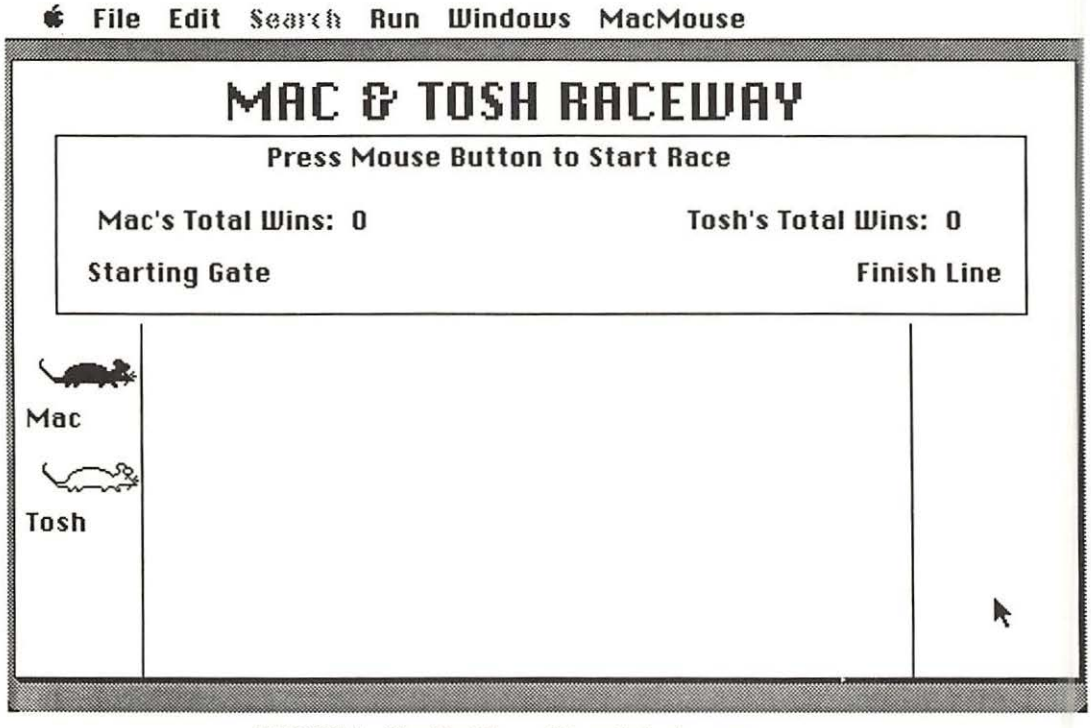


FIGURE 1. *The MacMouse title and playing screen*

To start the race, simply click the mouse button (it doesn't matter where the mouse pointer is, as long as it's on the screen). You'll hear a familiar bugle call (you can yell "They're off!" if you wish). The mice will appear to run across the screen, their little legs pumping away. Most of the time they will run "neck and neck," with one seldom getting more than a head in front of the other. When a mouse reaches the finish line, the message "[Mouse's name] wins!" appears in the center of the scoreboard. You'll hear a triumphant refrain: Each mouse has its own victory tune, a snippet of notes from "Pop goes the weasel." The finish will usually be a close one, since random numbers are used to determine how far each mouse moves with each "stride," and random numbers tend to average out over time. Occasionally, the race will be a tie, and a message to that effect will appear on the scoreboard.

After each race, 1 is added to the winning mouse's score on the scoreboard. MacMouse will then set up the racetrack again, with the mice back at the starting gate, and wait for you to click the mouse button to start a new race. To stop MacMouse and return to BASIC, pull down the MacMouse menu and choose Quit to BASIC or Quit to DeskTop.

There aren't any options or strategies for playing MacMouse, but after you've read our discussion of the code and tinkered with the program a bit, you'll probably think of a number of things that could be added to make the game more interesting. We'll suggest some fairly elaborate projects using MacMouse at the end of the chapter.

How the program works

The program outline in Figure 2 shows the main events that take place in MacMouse and the way they are structured. The main program consists of two WHILE...WEND loops: an outer one to set up each new race and start it when the mouse is clicked, and an inner one to move the mice until one mouse crosses the finish line. When that happens, the outer loop takes over again to proclaim the winner and update the score.

Initialization

dimension arrays for images	**Init 1**
set constants for mouse size and mouse paths	
set window size	**Init 2**
install MacMouse menu	
draw and store mouse pictures (**MakeMice**)	SR 5

(continued)

FIGURE 2. *Program outline*

```
Main Program
  WHILE true
    set mouse starting positions                                  Main 1
    draw raceway banner (DrawBanner)                              SR 1
    draw start and finish lines
    draw two mice in starting positions
    wait for mouse button to be clicked
    start race: make bugle sound and erase starting line (StartSound)   Main 2 (SR 2)

    WHILE neither mouse has reached or passed finish line:        Main 3
      calculate how far each mouse will go this time
      erase old mice
      draw mice in new positions
      switch to alternate view for animation
    WEND (repeat until a mouse reaches finish line)

    test for winner                                               Main 4
      if x positions of mice are equal, race is tie: print message
      if not, play appropriate victory tune, update score, display message
  WEND

Menu Events
  MenuEvent: transfer control to appropriate subroutine           ME 0

    BasQuit: quit to BASIC                                        ME 1

    DeskQuit: quit to Mac desktop                                 ME 2

Subroutines
  DrawBanner: draw raceway banner                                 SR 1

  StartSound: bugle call to start race                            SR 2

  MacWinSound: Mac's victory tune                                 SR 3

  ToshWinSound: Tosh's victory tune                               SR 4

  MakeMice:                                                       SR 5
    enable error trap if file not found
    open graphic file
    if file not found
      read images from DATA statements (ReadPictures)             SR 5c
    if file found
      get both views of Mac and save to array                     SR 5a, b

  PicToClip:                                                      SR 6
  convert image array to DATA statements
    put DATA statements into Clipboard for pasting at end of program

Subprogram
  ReadMArray: read image array from DATA statements               SP 1
```

Figure 2. Program outline (continued)

Dimension arrays and set up constants

In [Init 1], the random-number generator is "seeded" with a random number from the timer so that a new series of numbers will be obtained when RND is called. Only simple arithmetic with integers will be needed for this game, so we DEFINT A-Z. The arrays *mac* and *tosh* will each hold two views of their respective mice; the two images will be alternated on the screen to produce a rudimentary animation that makes the legs of the mice appear to move as they run.

The constant variables are defined next: *false* is given the value zero, and *true* is defined as *NOT false*. These are set this way because Microsoft BASIC lets any *nonzero* value—positive or negative—be interpreted as "true" in any conditional statement. Two other constants to note are *macY* and *toshY*, which specify the y coordinates of our two mice. The y coordinates can be specified as constants because the mice race in a straight line across the screen, each on its own "track," so only their x coordinates change during the course of the race. The constant *finish* will be used both in drawing the finish line and in testing to see if either mouse has won the race.

The line of code at [Init 2] ensures that the MacMouse window is the right size. Next, we install the MacMouse menu. This menu has only two options, Quit to BASIC, and Quit to DeskTop. The menu handler is coded at [ME 0] and will be called automatically by menu events.

The call to MakeMice [SR 5] sets the stage for some interesting code. The object of MakeMice is to generate the mouse picture-arrays. It accomplishes this by reading the mouse pictures from the disk-file *MacMouse.graphics*. A FOR...NEXT loop is used for each mouse to INPUT, PICTURE, GET, and PUT (erase) the two pictures of that mouse [SR 5a, SR 5b]. If the disk file is not available, then control goes to the label ReadPictures [SR 5c] which calls the subprogram ReadMArray [SP 1] for each of the two views of the mice. ReadMArray makes use of the appropriate set of data statements that describe the mice images: Mac1Data [Data 1], Mac2Data [Data 2], Tosh1Data [Data 3], and Tosh2Data [Data 4]. MacMice then continues with the same processing after the [Init] section that it would have done had there been a *MacMouse.graphics* file.

Main program

The main program is an endless loop. Races will be run until the user decides to quit by pulling down the MacMouse menu and choosing Quit to

BASIC or Quit to DeskTop. To get ready for a new race, the first lines in the main loop [Main 1] set the x positions of the two mice (*macX and toshX*) to 10. (Remember that the y positions are constant and don't ever have to be changed.) [Main 1] calls DrawBanner [SR 1] to display all the text needed for the racecourse. This includes the banner message "MAC & TOSH RACEWAY," the instruction for starting the race by pressing the mouse button, and the total wins for Mac and Tosh. Next, the starting gate and finish line are also labeled, and the name of each mouse is placed beneath it at the starting line. Finally, a LINE statement with the box option is used to frame the scoreboard.

After control returns to the main program loop, the finish line is drawn, using the constant *finish* for the x coordinate. Next, the starting line is drawn at an x coordinate of *macX* + *mouseLen* + 2: The mouse starting position, plus the mouse length, plus 2. The extra two pixels make sure the mouse's nose is not quite touching the starting line (we wouldn't want any cheating, would we?). The same y coordinates are used for the finish and starting lines. Using *mouseLen* rather than a specific number for placing the starting line makes it easy to change the size of the mouse (or substitute another creature of different size) and still place the starting line correctly. You'll appreciate this when you write an elephant-race program (which would be very easy if you use MacInterface, another program in this book, to incorporate the elephants that you might draw in MacPaint).

The first of the two images for each mouse is drawn in its starting position just behind the starting line using PUT statements. Then a WHILE...WEND loop is used to wait for the mouse button to be pressed.

Once the button is pressed, it's time to start the race. StartSound [SR 2] is called at [Main 2] to play a traditional bugle call. The subroutine ends with a brief delay loop to add suspense.

Next, the starting line is erased so it won't be visible through the white mouse as the mouse is drawn over it. Note that the last parameter in the LINE statement, the color, is given as 0. Microsoft BASIC treats 33 as black and 30 as white, as noted in the manual, but it turns out that any even color number (including zero) comes out as white, while any odd number comes out as black. We've used 0 here to draw a white line over the black line to erase it. One thing to look out for if you run this progam with later versions of BASIC is whether the color numbers have been redefined.

Moving the mice

The WHILE...WEND loop at [Main 3] moves the mice until one crosses the finish line. Note that the actual condition is, "While the x coordinate of each mouse plus its length is less than the x coordinate of the finish line, keep moving the mice."

The first item inside this loop is a short delay loop. Next, the distance in pixels that Mac will move (*macInc*) and the distance for Tosh (*toshInc*) are determined. These increments are assigned a random number between 1 and 7. The mice are then erased from their old position with PUT statements specifying the "old" coordinates: that is, the x coordinates without the increments.

Next, the program draws the mice in their new positions, which have as their x coordinates *macX* + *macInc* for Mac, and *toshX* + *ToshInc* for Tosh. The y coordinates do not change. The new x coordinates are resaved in *macX* and *toshX*, respectively. These new x coordinates are used both as the starting point for the next move, and in the next move so the mice in these positions can then be erased.

The value of *view* must now be changed so that the next mouse drawn will use the alternate image. Since *view* should have a value of either or 1 or 2 (recall that there are two images for each mouse), a neat little trick can be used to do this: *view* is assigned the value of 3 minus its current value. If view is 1, this gives 3 – 1, or 2, while if view is 2, the result is 3 – 2, or 1. An alternative way to do this might be:

IF view = 1 **THEN** view = 2 **ELSE** view = 1

This might be easier for you to understand than the way we do it in MacMouse. The method in the program results in more compact code, but it does take a moment or two to figure out. Which do you prefer?

Control now goes back to the top of the mouse-moving loop, and the test for the end of the race is made again. When a mouse crosses the finish line, control falls through the bottom of the loop to [Main 4].

In the winner's circle

The first thing to check for is whether there really is a winner and not a tie. At this point, we know that at least one mouse (but possibly both) has reached or crossed the finish line. The first IF statement determines whether the x coordinates of the two mice are the same. Since both mice

move each time through the loop, it's possible, though not too likely, that they'll end up in a dead heat. Note that both mice can cross the finish line during the same "turn" but with one ahead of the other: This isn't a tie, but a win for the mouse with the greater x coordinate. If the x coordinates are not equal, control goes to NotTie [Main 5], where the winner will be determined. If they are equal, it's a tie, so a message to that effect is printed and control jumps past the various "win" routines to the label PastWin.

If the race is not a tie, the IF...THEN statement in [Main 5] determines the winner. If *macX* is less than *toshX*, then Tosh won and control is passed to ToshWins [Main 6]. Otherwise, Mac won and the code following the IF...THEN statement is executed. The blocks of code for Mac winning and for Tosh winning do exactly the same things: (1) add one to the winning mouse's score, (2) play the tune for the winning mouse (handled by MacWinSound [SR 3] or ToshWinSound [SR 4]), and (3) print the winning message with the mouse's name. The tunes and messages are different for the two mice, but the order of events is the same, and in either case control ends up at PastWin. If you use a structure like this in your own programs, don't forget the GOTO at the end of the first block of code (in [Main 4]). If you leave it out, both of the alternative paths will be taken.

After a moderately long delay, control returns to the top of the outer loop, which is, as previously noted, an infinite loop. The racetrack is redrawn, and the next race will start when the mouse button is pressed.

Suggestions for MacMouse

You can start tinkering with this program by adding small embellishments or "bells and whistles." These might include a flag that waves in the breeze and a "winner's circle," placed just past the finish line, for the winning mouse to enter.

A more elaborate (and perhaps adult) version of the game could be created by making it possible for several players to bet (in imaginary money) on the outcome of the race. An array could store the players' current money (they might all start with, say, $100 and bet $5 per race), and the money would be updated after the race. Alternatively, you could let players bet any amount they wish up to their total cash, and store the amounts bet in another array.

To make the race more realistic, you could change the odds of a given mouse winning from the present 50-50 by giving that mouse a larger or smaller range of random numbers for its increment. Bets could pay off

according to these odds, which would be posted before the race begins. If you go in that direction, consider adding some more mice (perhaps a total of four). You could use MacPaint to create four distinctive images (plus alternates) for the mice, then put them in a graphics file using the MacInterface program (see that chapter for details).

You might also use MacPaint and MacInterface to create more than two images for each mouse. Flickering back and forth between two images of the same object provides a *sense* of movement, but movement will be smoother and truer to life if more images are used.

Finally, you could take an entirely different tack and make the game an educational quiz for kids. To do that, you would need to either write a separate program or include in this one an option to have the parent type in questions and answers, which would be stored in a string array *quiz*. This array would be saved to disk as a file and opened when the child ran the game. During a race, one mouse (say Tosh) would move a random distance each "turn" as at present, but the child's mouse, Mac, would move only when a question was answered correctly. Since the child probably won't get all the answers right, the mouse should probably move up to twice as far as the average move of the computer mouse when a question is answered correctly.

MacMouse program listing

```
'*****************************************************************
'                          MacMouse
'                A mouserace featuring Mac and Tosh
'*****************************************************************

'************************************************** INITIALIZE
INIT 1
RANDOMIZE TIMER
OPTION BASE 1
DEFINT A-Z
DIM mac(100,2), tosh(100,2)                    'graphic images of mice

false = 0 : true = NOT false
mouseLen = 48                                  'length in pixels of mouse image
macY = 141 : toshY = 191                       'y coordinate of Mac and Tosh's paths
finish = 425                                   'x coordinate of finish line

INIT 2
WINDOW 1, "MacMouse", (4,30) - (508,325), 4

MENU 6, 0, 1, "MacMouse"                       'install MacMouse menu
MENU 6, 1, 1, "Quit to BASIC
MENU 6, 2, 1, "Quit to DeskTop"
ON MENU GOSUB MenuEvent : MENU ON

GOSUB MakeMice

'************************************************** MAIN PROGRAM
MAIN 1
WHILE true                                     'loop once per race, until quit by menu event
  macX = 10 : toshX = 10                       'starting positions

  GOSUB DrawBanner                             'draw raceway banner
  LINE (finish,125) - (finish,300)             'finish and starting lines
  LINE (macX + mouseLen + 2, 125) - (macX + mouseLen + 2, 300)
  view = 1
  PUT (macX,macY), mac(1,view)                 'show mice sitting and waiting
  PUT (toshX,toshY), tosh(1,view)
  WHILE MOUSE(0) > -1 : WEND                   'wait for button press

MAIN 2
  '_____________________________________ and they're off!
  GOSUB StartSound                             'erase start line
  LINE (macX + mouseLen + 2, 125) - (macX + mouseLen + 2, 300), 0

MAIN 3
  '_____________________ loop, moving mice until one crosses line
  WHILE macX + mouseLen < finish AND toshX + mouseLen < finish
    FOR t = 1 TO 50 : NEXT
    macInc = 7 * RND(1)                        'calculate how far they
    toshInc = 7 * RND(1)                       'will move this time
```

```
        PUT (macX,macY), mac(1,view)                    'erase old Mac
        PUT (toshX,toshY), tosh(1,view)                 'and Tosh images
        PUT (macX + macInc, macY), mac(1, 3 - view)     'draw new images
        PUT (toshX + toshInc, 191), tosh(1, 3 - view)
        macX = macX + macInc
        toshX = toshX + toshInc
        view = 3 - view                                 'flip view to other state
      WEND

      '_____ we have a winner!                                          MAIN 4
      CALL TEXTFONT(2) : CALL TEXTSIZE(24)
      CALL MOVETO(180, 110)
      IF macX <> toshX THEN NotTie
      PRINT "Tie Race!"                                 'tie game: nobody wins
      GOTO PastWin
NotTie:                                                                 MAIN 5
      IF macX < toshX THEN ToshWins
      macScore = macScore + 1                           'Mac wins
      GOSUB MacWinSound
      PRINT "Mac Wins!"
      GOTO PastWin
ToshWins:                                                               MAIN 6
       toshScore = toshScore + 1                        'Tosh wins
       GOSUB ToshWinSound
       PRINT "Tosh Wins!"
PastWin:
      FOR t = 1 TO  10000 : NEXT
    WEND                                                'loop back to race again

'********************************************************* MENU EVENTS
MenuEvent:                                                              ME 0
    MENU 6, 0, 0
    item = MENU(1)
    ON item GOSUB BasQuit, DeskQuit
    MENU 6, 0, 1
    RETURN

BasQuit:            '_____ quit to BASIC                                ME 1
    MENU RESET
    END

DeskQuit:           '_____ quit to Mac desktop                          ME 2
    MENU RESET
    SYSTEM

'********************************************************* SUBROUTINES
DrawBanner:         '_____ draw raceway banner                          SR 1
    CLS : CALL TEXTFONT(0)                              'Chicago font
    CALL TEXTSIZE(24)
    CALL MOVETO(100,28) : PRINT "MAC & TOSH RACEWAY"
```

```
    CALL TEXTSIZE(12)
    CALL MOVETO(120,50) : PRINT "Press Mouse Button to Start Race"
    CALL MOVETO(40,80) : PRINT "Mac's Total Wins:"; macScore
    CALL MOVETO(320,80) : PRINT "Tosh's Total Wins:"; toshScore
    CALL MOVETO(35,105) : PRINT "Starting Gate
    CALL MOVETO(400,105) : PRINT "Finish Line"
    CALL MOVETO(5,175) : PRINT "Mac"
    CALL MOVETO(5,225) : PRINT "Tosh"
    LINE (20,35) - (480,120), , b                          'frame scoreboard
    RETURN
SR 2
StartSound:                 '_____________________________ bugle call starts race
    SOUND 392,2 : SOUND 523,2 : SOUND 659,2
    SOUND 784,4 : SOUND 659,2 : SOUND 784,6
    FOR t = 1 TO 600 : NEXT                          'wait for bugle call to finish
    RETURN
SR 3
MacWinSound:                '_____________________________ play Mac's victory tune
    SOUND 523,2 : SOUND 587,2 : SOUND 659,2
    SOUND 587,4 : SOUND 659,2 : SOUND 523,2
    RETURN
SR 4
ToshWinSound:               '_____________________________ play Tosh's victory tune
    SOUND 523,2 : SOUND 0,2 : SOUND 523,2
    SOUND 587,2 : SOUND 0,2 : SOUND 587,2
    SOUND 659,2 : SOUND 784,2 : SOUND 659,2
    SOUND 523,2
    RETURN
SR 5
MakeMice:                   '_____________________________ make mouse picture arrays
                                        'if file MacMouse.Graphics exists, read images,
                                                'else read from data statements
    fileHere = true                  'ON ERROR will change it to false if not found
    ON ERROR GOTO FileError                          'set up error trapping
    OPEN "xMacMouse.graphics" FOR INPUT AS #1              'is file present?
    ON ERROR GOTO 0                                 'disable error trapping
    IF NOT fileHere THEN ReadPictures                   'no, read from data
SR 5a
    FOR view = 1 TO 2                                       'two views of Mac
      INPUT #1, bytes                                         'get byte count
      image$ = INPUT$(bytes,1)                              'input into string
      noUse$ = INPUT$(1,1)                             'read past end of line
      PICTURE (0,0), image$                                  'display image
      GET (0,0) - (mouseLen,19), mac(1,view)               'save Mac in array
      PUT (0,0) - (mouseLen,19), mac(1,view)                      'erase it
    NEXT
SR 5b
    FOR view = 1 TO 2                                      'two views of Tosh
      INPUT #1, bytes                                         'get byte count
      image$ = INPUT$(bytes,1)                              'input into string
      noUse$ = INPUT$(1,1)                             'read past end of line
      PICTURE (0,0), image$                                  'display image
```

```
    GET (0,0) - (mouseLen,19), tosh(1,view)                    'save Tosh in array
    PUT (0,0) - (mouseLen,19), tosh(1,view)                    'erase it
  NEXT view
  image$ = ""
  CLOSE 1
  RETURN

ReadPictures:                          'MacMouse.Graphics isn't on disk: read from data
  RESTORE Mac1Data : CALL ReadMArray(mac(),1)
  RESTORE Mac2Data : CALL ReadMArray(mac(),2)
  RESTORE Tosh1Data : CALL ReadMArray(tosh(),1)
  RESTORE Tosh2Data : CALL ReadMArray(tosh(),2)
  RETURN

FileError:                  '_____ returns fileHere = false, if error is "File not Found"
  IF ERR <> 53 THEN ON ERROR GOTO 0                    'unknown error, print and halt
  fileHere = false
  RESUME NEXT

PicToClip:                  '_____ generate DATA statements in Clipboard
  OPEN "Clip:Text" FOR OUTPUT AS #20
  na$ = "Tosh1"
  PRINT#20, na$; "Data: "; STRING$("_", 33); " data for picture "; na$
  low = LBOUND(tosh,1) : high = UBOUND(tosh,1)
  PRINT #20, "Data"; high - low + 1
  PRINT #20, "Data"; tosh(low,1); ","; tosh(low + 1, 1)
  FOR n = low + 2 TO high
    IF (n - (low + 2)) MOD 10 <> 0 THEN GOSUB NewLn ELSE PRINT #20, ", ";
    temp$ = STR$(tosh(n,1))
    IF LEFT$(temp$,1) = " " THEN temp$ = RIGHT$(temp$, LEN(temp$) - 1)
    PRINT#20, temp$;
  NEXT n
  PRINT #20, ""
  CLOSE 20
  STOP

NewLn:                      '_____ start new line, print DATA with indent
  PRINT #20, "" : PRINT #20, "   Data ";
  RETURN

'_____ read given array from DATA statements
SUB ReadMArray(array%(2), index%) STATIC
  READ size
  FOR n = LBOUND(array%,1) TO LBOUND(array%,1) + size - 1
    READ num : array%(n,index%) = num
  NEXT
  END SUB

Mac1Data:                   '_____ data for picture Mac1
  DATA 100
  DATA 49 , 20
  DATA 0, 0, 0, 0, 4096, 0, 896, 0, 8192, 0
```

SR 5c

SR 5d

SR 6

SR 7

SP 1

DATA 1

```
    DATA 1984, 0, 8192, 2040, 2032, 0, 8192, 16383, 1016, 0
    DATA 12288, -1, -15368, 0, 6145, -1, -12304, 0, 3075, -1
    DATA -30, 0, 1539, -1, -76, 0, 775, -1, -5, 0
    DATA 511, -1, -4, 0, 255, -1, -2, 0, 127, -1
    DATA -1008, 0, 3, -18429, -29152, 0, 3, 12291, 1536, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0
```

DATA 2

```
Mac2Data:               '_____ data for picture Mac2
    DATA 100
    DATA 49 , 20

    DATA 0, 0, 0, 0, 0, 0, 1792, 0, 0, 0
    DATA 3968, 0, 0, 60, 4064, 0, 0, 126, 2032, 0
    DATA 0, 511, -30736, 0, 0, 1023, -24608, 0, 0, 2047
    DATA -60, 0, 0, 2047, -152, 0, 24, 4095, -10, 0
    DATA 63, -1, -8, 0, 487, -1, -4, 0, 512, -1
    DATA -2016, 0, 0, 1911, 7232, 0, 0, 1638, 3072, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0
```

DATA 3

```
Tosh1Data:              '_____ data for picture Tosh1
    DATA 100
    DATA 49, 20
    DATA 0, 0, 0, 0, 2048, 0, 448, 0, 4096, 0
    DATA 544, 0, 4096, 1020, 568, 0, 4096, 7171, -32444, 0
    DATA 6144, 24576, 24900, 0, 3072, -32768, 5688, 0, 1537, 0
    DATA 2065, 0, 769, 0, 42, 0, 386, 0, 5, -32768
    DATA 252, 0, 2, 0, 64, 0, 511, 0, 62, 9214
    DATA 14856, 0, 1, 21505, 17680, 0, 1, -26623, -32000, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0
```

DATA 4

```
Tosh2Data:              '_____ data for picture Tosh2
    DATA 100
    DATA 49 , 20

    DATA 0, 0, 0, 0, 0, 0, 1792, 0, 0, 0
    DATA 2176, 0, 0, 14, 2272, 0, 0, 57, 1296, 0
    DATA 0, 193, -31472, 0, 0, 256, 22752, 0, 0, 512
    DATA 8260, 0, 0, 512, 168, 0, 2040, 1024, 22, 0
    DATA 1055, -2048, 8, 0, 7, -32768, 2044, 0, 1, -954
    DATA -6112, 0, 0, 681, 5184, 0, 0, 816, 3072, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
    DATA 0, 0, 0, 0, 0, 0, 0, 0
```

MacBall

Ball games of various sorts have probably been played since the very dawn of civilization. From the Mayas of Central America to bored pages in medieval castles to descendants of Abner Doubleday who glue themselves to the TV for the World Series, hitting something with a stick or racquet and getting it to go where you want it to has provided continuing fascination.

MacBall lets you bounce a video "ball" off a mouse-controlled "paddle" and guide it into a collection of video apples on the screen. It works much like the popular games Breakout and Pong.

While you may have bought your Mac for serious purposes like spreadsheeting and producing high-quality business charts, you will find that MacBall reveals some interesting programming techniques (as well as tests your hand-eye coordination!). Among the programming techniques you will discover are paddle-movement control, animation, and how to make an object appear to "bounce." So limber up your wrists, put a little English on your mouse moves, and play MacBall!

How to play MacBall

MacBall starts by giving you the title screen shown below in Figure 1. The next screen, the playing screen shown in Figure 2, presents you with the various elements of the game.

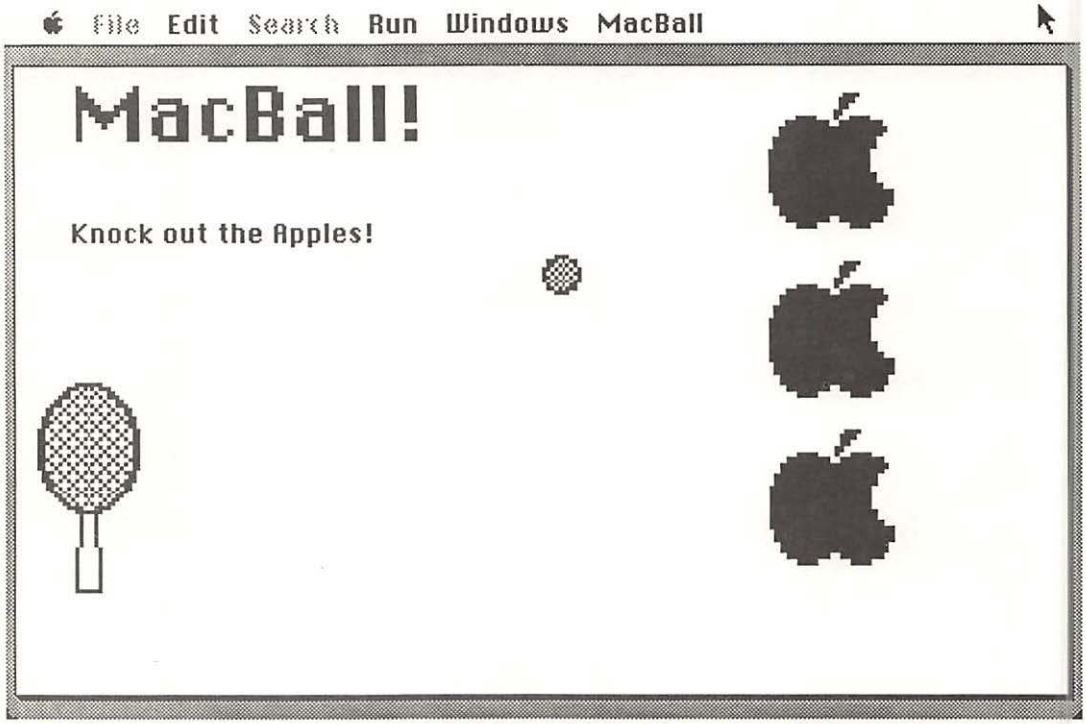


FIGURE 1. *The MacBall title screen*

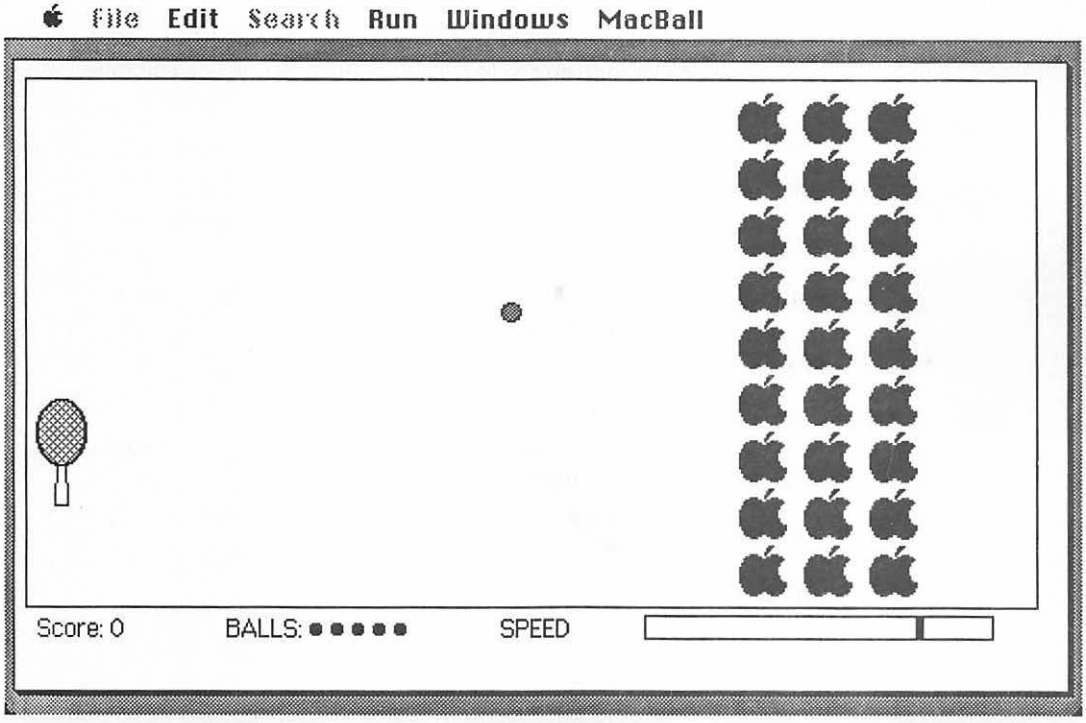


FIGURE 2. *The MacBall playing screen*

On the left side of the playing screen is your paddle (or racquet, if you prefer). On the right side are three columns of nine apples each (McIntoshes, we assume). When you start to play, a little ball whizzes out from in front of the apples. The object of the game is to keep batting the ball back across the screen with the paddle. When the ball hits an apple it bounces back, the apple disappears, and you score a point. The goal is to knock out all the apples with the ball while trying not to let the ball get past your paddle to the left and out of play. Your score (maximum possible is 32,767) is listed at the bottom of the screen, together with the number of balls remaining to be played (not counting the current one), and a ball-speed indicator/control, which we'll discuss shortly. The MacBall menu contains these choices:

The program contains a demonstration which you can run by choosing See Demo from the MacBall menu. When you select demo mode and then move the mouse forward and back, the paddle moves up and down along the left side of the screen. Next, a ball is served from the right side of the screen. When the ball comes, you can hit it by moving your paddle into its path. If you miss and the ball sails past your paddle and hits the left side of the screen, there's no harm done since this is a demo: The ball will simply bounce off the left wall and go its merry way, committing more mayhem in the apple orchard. (In a normal game, you'd lose one ball if you missed.) The demo game will run, all by itself, with no effort from you.

When you do hit the ball, it bounces off the paddle at an angle that depends on how squarely you hit it. Figure 3 illustrates the angles the ball will take after hitting the paddle at different points on its surface.

The real fun begins when you've cleared a path to the far-right column of apples. When a ball hits one of those apples, it's liable to bounce off, hit an apple in one of the front columns, bounce off to the back wall, then bounce back to another apple, then... well, you get the idea. If you

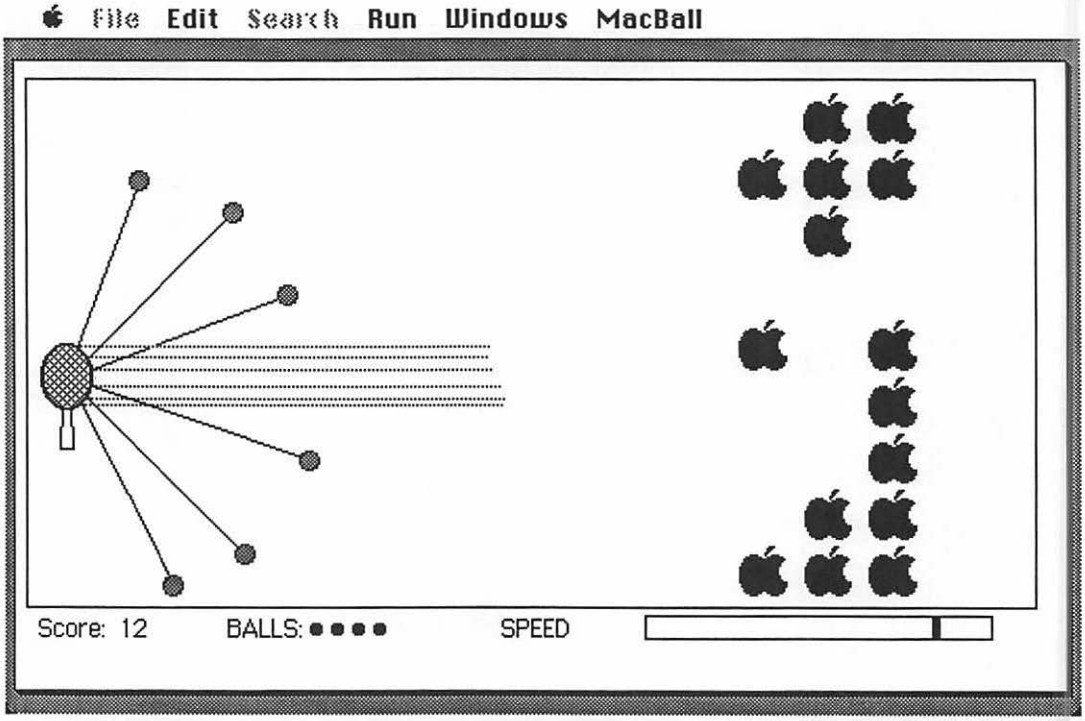


FIGURE 3. *Rebound angles from different points on the paddle*

have the skill (or the luck) to break through the apple barrier while there are lots of apples left, you can rack up an impressive score. At certain angles you can go through several apples before the ball can break free. When you've knocked out all the apples, a new supply of 27 is provided.

You can stop the demo game by choosing Quit to BASIC from the MacBall menu. To actually play a game, choose Start from the Run menu and then Play Game from the MacBall menu. When the title screen reappears, choose Play Game from the MacBall menu. Now when you play and miss a ball with the paddle, the ball goes out of play and one of the little balls in the supply shown below the playing screen disappears. Also, if you don't pick a speed to start with, the next ball served up by your Mac travels a little faster than the last. You'll find that each "serve" is lobbed from a different place. Serves can range from a flat drive to a ball that comes flying down at a steep angle toward the lower left side of the screen.

For a more strenuous game, click the mouse pointer in the long "speed bar" below the playing screen before you start your next game. You'll see a little indicator appear where you clicked. The closer to the right end of the bar you set the indicator, the faster the balls will travel. By using the indicator, you can "handicap" yourself.

You've probably figured out that knocking out a *row* of apples so that you can hit a ball behind the apples and off the back wall is the best way to rack up a high score in MacBall. Aside from that strategic consideration, becoming a pro at MacBall mostly involves being able to control where the ball goes so you can knock out a column of apples or pick off the odd apple or two when most of the apples are gone.

How MacBall works

MacBall is a good example of a simple program structure. At the beginning, it performs a number of initialization steps. It draws the apple, ball, and paddle pictures and saves them in arrays for future use. It installs the MacBall menu, draws a title screen, shows a screen of instructions, then draws the playing screen. After setting up these initial parameters, it goes to the main game loop. The program is outlined in Figure 4, which you should refer to while reading the following sections.

Initialization

dimension and initialize variables, constants, and patterns	**Init 1**
draw and save pictures for future use	**Init 2**
(**FormApple**, **FormBall**, **FormPaddle**)	SR 15, 16, 14
install MacBall menu	**Init 3**
show title, instruction, and playing screens	**Init 4**
(**TitleScreen**, **Instructions**, **DrawScoreArea**)	SR 12, 11, 7

Main Program

WHILE true (interrupted by menu event choice to quit)	**Main 1**
enable Play Game and See Demo items in MacBall menu	
set up ball, paddle and apples for new game (**StartGame**)	SR 1
disable Play Game and See Demo menu items until end of game	
WHILE there are balls left to play	**Main 2**
give player a chance to move paddle,	
then start a new ball in a random direction (**NewBall**)	SR 2
move paddle, ball, check for apple hit or ball loss (**PlayBall**)	SR 4
if ball speed not user-set, increase for next ball (**IncSpeed**)	SR 3
WEND	
WEND	

Menu Events

MenuEvent: branch to appropriate subroutine	**ME 0**
GameMenu: reset and play game	**ME 1**
DemoMenu: play demo game	**ME 2**
BasQuit: quit to BASIC	**ME 3**
DeskQuit: quit to Mac Desktop	**ME 4**

Subroutines

StartGame:	**SR 1**
set up initial screen	
draw new speed bar (**DrawSpeed**)	SR 9
set up orchard (**DrawApples**)	SR 13
WHILE waiting for choice of Play Game from MacBall menu	
allow input of ball speed (**CheckSpeed**)	SR 8
WEND	
NewBall:	**SR 2**
subtract ball from those remaining	
show current speed (**DrawSpeed**)	SR 9
allow movement of paddle before ball release (**MovePaddle**)	SR 10
set random direction of ball movement	
IncSpeed: increase speed if not user-set	**SR 3**

(continued)

FIGURE 4. *Program outline*

```
PlayBall:                                                    SR 4
  WHILE player hasn't missed ball, or in demo mode
    move the ball (UpdateBall)                               SR 6
    move the paddle (MovePaddle)                             SR 10
    if an apple has been hit:
      remove apple, increase score, bounce ball (CheckApple) SR 5
    if ball hits paddle, bounce ball, make a sound
    if ball hits wall, bounce ball, make a sound
  WEND
  if ball has missed paddle, make a sound and remove image of ball

CheckApple:                                                  SR 5
  if apple was hit, make a sound and remove apple
  increase score
  if last apple was hit, draw a new set of apples

UpdateBall:                                                  SR 6
  draw ball at new position of ball
  remove ball at old position

DrawScoreArea: draw initial score area                       SR 7

CheckSpeed:                                                  SR 8
  set ball speed based on location of pointer in speed box
  display new speed (DrawSpeed)                              SR 9

DrawSpeed: display new speed                                 SR 9

MovePaddle:                                                  SR 10
  read position of mouse pointer
  if pointer in game window, show paddle, else show pointer
  if new paddle position is different than last:
    display paddle at new position
    erase paddle at old position

Instructions: show instructions                              SR 11

TitleScreen: show first title screen                         SR 12

DrawApples: display new set of apples, reset apple array     SR 13

FormPaddle: define shape of paddle and save in array         SR 14

FormApple: define shape of apple and save in array           SR 15

FormBall: define shape of ball and save in array             SR 16
```

Figure 4. Program outline (continued)

Initialization and drawing objects

First, arrays for a number of purposes are dimensioned [Init 1]. One use of arrays here is to specify images. We dimension arrays of bits for three images: the ball (*ballPic*), the paddle (*padPic*), and the apple (*applePic*). Since an array is the logical data structure for dealing with characteristics of a number of identical items, several arrays are used to handle the three columns of apples on the screen. There will be up to 27 apple images on the screen at a time, and each is subject to being hit and removed by the ball. The array *apHere* is used to indicate whether a given apple is still present: It is essentially an array of logical (true/false) values. Two more arrays (*apC* and *apR*) hold the coordinates of the apple's column (x) and row (y), respectively. A single two-dimensional array could be used here, producing code that would be more compact but a little harder to understand. The choice is a matter of programmer preference or style. Finally, we have a pen pattern for the ball (*grayPat*) and paddle netting (*padPat*).

After the arrays comes the initialization of constants. The significant ones to note are those that define important areas of the screen. *maxX* and *maxY* are the horizontal (x) and vertical (y) boundaries within which the ball can travel. *minApX* is the x coordinate of the first column of apples: We'll need this to know when to start checking to see if the ball has hit an apple. (We don't check for a hit until we know that the ball is in the vicinity of the apples.) The maximum number of balls, the minimum speed, and the boundaries of the speed-selection bar are also given.

In [Init 2] we define the size and style of the window. Then the subroutines FormApple, FormBall, and FormPaddle are called to draw and save the apple, ball, and paddle images. As usual, all three subroutines GET their images to store them in their respective arrays, then use PUT to erase them on the screen.

Using QuickDraw's PAINTOVAL function, FormApple [SR 15] draws the apple as two adjacent ovals and then draws a third, inverted oval to take the "bite" out of the right side of the apple—a nice trick. Finally, the stem of the apple is drawn as three lines and a single point. FormBall [SR 16] simply fills an oval with the gray pattern for the ball and then draws a circle around the pattern to give the ball a definite boundary (you wouldn't want to bat around a fuzzy blob, would you?).

FormPaddle [SR 14] draws the paddle in three parts. The paddle itself is an oval like the ball but filled with a different pattern. The handle looks like it contains five lines, but there are actually only three. The first line, from coordinates (10,30) to (9,50) appears broken because at some

arbitrary point the routine used by the LINE statement has to "jump" one pixel to the left to go from an x coordinate of 10 to one of 9. The other side of the handle is drawn in the same way, with the "jump" in the same place. This is a trick that you can exploit in your own programs.

The MacBall menu is set up and turned on with the lines of code at [Init 3]. TitleScreen [SR 12] is called in [Init 4]. Note the use of LOCATE to position the pen for drawing the two character strings *MacBall* and *Knock out the Apples.* This handy statement automatically moves to a preconfigured column and row position corresponding to the size of the font used, making it unnecessary to use pixel coordinates. The paddle, ball, and three nice, large apples are then drawn to complete the title screen.

The preliminary instruction-screen subroutine, instructions [SR 11] is called next. The window area is set, and the instructions are printed on the screen along with a Continue button, which lets you proceed from the instruction screen to the game.

The initial game-screen subroutine, DrawScoreArea [SR 7], is called next. The area at the bottom of the screen that will give the score and show the current ball speed is first set up. The initial score is 0, and the speed bar is empty. When the player clicks the mouse pointer in the speed box to select the speed, the pointer's (x,y) coordinates are read and converted into the distance in pixels that the ball will travel at every update. After the score area is drawn, we set the initial paddle y coordinate and PUT the paddle there. Note, however, that the paddle x coordinate (10) never changes, so the paddle can be moved only up and down.

A generic game structure

Before we get to the main part of MacBall, let's step back for a moment and look at some general aspects of the structure of the kind of games we present in this book. If you've studied several of these games, you've no doubt observed similarities in their structure. With minor variations, all of the games follow this basic pattern:

```
WHILE player wants to play
  set up new game
  WHILE there are more (balls, spaceships, whatever)
    WHILE not out of play
      update positions of screen objects
      check for scoring events
    WEND (one play)
  WEND (one game)
WEND (program)
```

You can compare the preceding outline with the program outlines for MacGurkha, MacDart, and the other games to see how they fit into this pattern. The use of the WHILE...WEND statement makes it easy to specify what characterizes a given stage of the game and thus what must happen for the program to go on to the next stage. This structure is obscured in older forms of BASIC that have to use leapfrogging IF...THEN GOTO statements and don't have named labels for subroutines. Most games break down into a multilayered WHILE...WEND structure because the player has relatively few options and is usually doing only one thing at a given stage of play. Special events like firing a laser can be handled by setting mouse- or keyboard-event interrupts and checking to see whether they cause a termination of the current WHILE...WEND condition.

Actual games will usually have several more layers of "nested" WHILE...WEND loops and occasionally other kinds of structures. For example, the "one play" loop in the MacBall program (PlayBall) uses its own WHILE...WEND loop to move the ball and paddle on the screen. These additional layers are simply further refinements that break the code down into discrete events.

By now you should be able to outline a game of your own design, following this same pattern. Even complex video games that have to keep track of many objects can be outlined in this way.

Main program

Now let's get back to MacBall. The main part of the program starts by setting *cursFlag* to true, then starts an endless loop which is interrupted only if the player decides to quit from the MacBall menu. (By the way, all menu events are handled by the MenuEvent subroutine [ME 0]; see "MacCursor" for a description of menu event-handling.) Then, the Play Game and See Demo menu items are enabled. StartGame [SR 1] is called to set up the new game. This subroutine initializes the ball velocity (which has two components, *xVel* and *yVel*) and the number of balls already played (which is 0 at the beginning of a new game). The variable *userSpd* is a logical variable that indicates if the speed of the balls will be controlled by the program (*userSpd* = *false*) or by the player (*userSpd* = *true*). It is initially set to *false* at the beginning of this subroutine.

Next, DrawSpeed [SR 9] is called. This subroutine, which draws the current speed bar, begins by figuring the value of *newSX* based on the values of *xVel*, *minXVel*, and *sBoxX*. It then erases the old speed bar, draws a new one, and then sets the value of *oldSX* to *newSX*.

After setting the score to 0, the paddle is drawn and DrawApples [SR 13] is called. It draws an "orchard" of 27 apples in a 3 column by 9 row relationship on the right side of the screen. This subroutine stores each apple's x and y coordinates in the appropriate arrays and sets all the elements of the *apHere* array to *true* to indicate that all the apples are present.

A FOR...NEXT loop in StartGame then draws five balls at the bottom of the screen by taking advantage of CHR$(165), a special character consisting of a small filled circle, or "bullet." These ball symbols represent the number of balls remaining to the player, not counting the ball about to be in play (thus the total of six balls per game).

Now it's time to find out what the player wants to do. The program uses TEXTMODE(1) to prevent printing blanks at the end of each printed line, and then asks the player to choose an option from the MacBall menu, or to set the speed in the speed bar, if that hasn't already been done. The next few lines check the logical value of *cursFlag* and the program sits in a WHILE NOT...WEND idle state until the player decides to choose a speed (see the *IF MOUSE(0) < 0* line) or the Play Game or Demo options from the MacBall menu. If the *MOUSE(0) < 0* condition is fulfilled, the mouse button has been pressed, so CheckSpeed [SR 8] is called.

CheckSpeed first obtains the mouse x and y coordinates via MOUSE(1) and MOUSE(2). The coordinates are then checked to see if they are within the speed box area. If they aren't, the player was presumably doing something other than trying to set the speed, so the subroutine returns. Otherwise, the flag *userSpd* is set to *true,* and *xVel* is scaled down to an appropriate value for the ball speed (a ball traveling at 300+ pixels per jump, for instance, would appear to teleport about the screen and make for a very frustrating game!). DrawSpeed [SR 9] is used to erase the old speed bar and draw the new one. The new value of *newSX* is saved as *oldSX* so that the current speed bar can be erased when a new speed is set.

It's important to realize that this program involves two concepts of motion: speed and velocity. *Speed* is the magnitude of the motion regardless of direction: It is expressed as the number of pixels the object (in this case, the ball) is moved each time it is updated. *Velocity* is speed plus direction: A velocity (*xVel*) of −30 is motion at the rate of 30 pixels per update toward the left side of the screen, while an *xVel* of 30 is motion at a rate of 30 pixels per update to the right side of the screen. (We're concerned only with velocity along the x axis here; we'll show later how the y velocity is derived.)

Back in StartGame, the program is still waiting for the player to either choose an option from the MacBall menu, or change the speed. Once Demo or PlayGame is chosen, a 0 is moved into position to show that the initial score is zero and the little message box is erased. Control now returns to the main program loop, where the PlayGame and Demo menus are now disabled. The program checks to see if there are any balls left to play and, if there are, moves into the playing phase.

Play loop

Assuming the player wants to play, the program now enters the inner game loop [Main 2]. This play loop will be executed as long as the player hasn't run out of balls.

The play loop begins by calling NewBall [SR 2] to put a new ball in play. First, the representation of the previous ball beneath the playing screen is erased by printing a blank in the appropriate place. The variable *ball* holds the number of balls played so far; the first time around, that is 0, so the blank is printed far enough to the right so that none of the five balls is erased. As the player misses the balls with the paddle and they go out of play, the expression *190 – ball * 10* decreases (gives a lower x coordinate), and successive blanks are printed toward the left side of the screen at the proper intervals to erase each successive ball symbol (which, you will remember, is a regular ASCII character and so can be erased by printing a blank over it).

A quick call to DrawSpeed [SR 9] puts the speed bar at the bottom of the screen with the current speed of the ball shown.

A FOR...NEXT loop then calls MovePaddle [SR 10] 100 times, giving a reasonable time delay for the player to adjust the paddle position. This subroutine starts by reading the mouse y position. The curious statement *dummy = MOUSE(0)* shouldn't make *you* feel like a dummy—it is used here because, although the value returned by MOUSE(0) is unimportant (the mouse button probably isn't being pushed, and we're not checking for a click now, anyway), MOUSE(0) has the additional function of updating all the values that will be returned by calls to MOUSE(1), MOUSE(2), and so on. Since the mouse may have just been moved, it's important to get the latest news on the value of MOUSE(2) (the current mouse y coordinate), when it is asked for in the next line of code. (Since the paddle can be moved only up and down, the x coordinate is unimportant.)

MovePaddle first checks to see whether the logical value of *MOUSE(2) > 0* is the same as the value of *cursFlag*. This is used to check on

the cursor position to see if it is on the playing screen, or in the menu area. If the cursor isn't on the playing screen, then the base of the paddle is set to the nearest boundary of the playing screen (top or bottom). This new y coordinate (*padY1*) is then checked to see if it differs from the old position stored in *padY*. If it doesn't, the paddle isn't being moved, and control returns to NewBall [SR 2]. If the values are different (in other words, the paddle is or was moved), the new paddle is drawn, the old one is erased, and the current paddle y coordinate is saved for future use.

NewBall sets the initial y axis velocity to a random value between 2 and 7. This means that the ball will always drop, but its rate of descent will vary. *yVel* makes use of both the INT (integer) and the RND (random number) functions, to generate a random value between 2 and 7.

Next, NewBall sets the x axis velocity by taking the negative of the absolute value of *xVel* to ensure that the x component of the velocity is negative, since the ball will be coming toward the paddle from the apple area on the right side of the screen.

By setting these two velocity values when the ball is launched, it will always move down and toward the left side of the screen, but the steepness of the slope will vary due to the random variation in the y component of the ball's velocity.

Finally, the starting ball's x and y coordinates are set: The x position is always just to the left of the first row of apples, but the y position is randomized, so we don't know where the ball is going to come from. Control is then returned to the main program loop.

Now, as the umpire would say, it's time to play ball—so PlayBall [SR 4] is called by the main program loop. This subroutine starts by setting the *hit* flag to *false* (the ball is just starting toward the paddle and hasn't hit any apples yet). *oldXB* and *oldYB* are set to *xBall* and *yBall* respectively for future reference.

A WHILE...WEND loop is used to handle the play of the ball. The ball remains in play as long as its x coordinate (*xBall*) remains greater than 15 (if it's less than 15, the ball's gotten by the paddle) or the program is in Demo mode (where the ball is bounced off the left screen boundary—more on this later—and stays in play even if it misses the paddle).

The real key to the entire game comes in the next few lines. The ball position is updated by adding the current x velocity to the ball's x coordinate and the y velocity to the y coordinate. UpdateBall [SR 6] is then called to draw the ball in its new position, and MovePaddle [SR 10] moves the paddle to the new mouse y coordinate if the player has moved the mouse in the meantime.

Next a check is made to see if the ball has entered the area of the "apple orchard." If it has, it's time to check to see whether an apple has been hit. Since the ball will often hit a number of apples in succession after hitting the first one, the check is also automatically done once the first apple has been hit by the current ball (thus the *AND NOT hit* specification).

The check is done in CheckApple [SR 5] by dividing the ball's x and y coordinates by the number of columns and rows respectively to find which column and row the ball has entered. This is used to look up a value in the *apHere* array. If the value in the *apHere* array at this column and row is *true,* it means an apple is present and has been hit by the ball. In this case, a sound is produced, the apple is erased, and *apHere(col,row)* is set to *false* to indicate that there is no longer an apple at that spot. The X velocity is reversed (*xVel,* multiplied by −1), making the ball appear to bounce. The *hit* flag is set to *true* (it may, of course, already be true), and 1 is added to the score, which is updated on the display. Every 27 apples (*score MOD 27 = 0*) a full batch of apples has been cleaned out, so DrawApples [SR 13] is called to refill the orchard.

Eventually the ball is going to bounce off either a wall or an apple and head back toward the paddle, so PlayBall next checks for the ball hitting the paddle. If this check is negative, the ball didn't hit the paddle and the routine drops to the label NoPadHit. If the ball is close enough to hit the paddle, its x velocity is reversed in order to bounce it, and its x position (*xBall*) is set to 40. The y velocity will depend where on the paddle the ball hit: *yBall* is subtracted from the y coordinate of the center of the paddle (*padY − 15*) and multiplied by the constant 0.6. This means that the farther from the center of the paddle the ball hit, the higher the y velocity (which will be positive or negative depending on whether the ball hit toward the top or bottom of the paddle), the steeper the angle at which the ball will move away from the paddle, and the faster the ball will travel. If you have trouble visualizing this, refer to Figure 3, or hit the ball a few times off different parts of the paddle to really experience the effect.

Next, there's a check for the ball having hit a wall. If the ball is close enough to the right wall (or the left if we're in Demo mode), the ball's x velocity is reversed. If the ball has gotten up to the top wall or down to the bottom one, the y velocity is reversed.

After completion of this section, if the user hasn't quit, control goes back to the top of PlayBall's WHILE...WEND loop. If the game is a Demo, or *xBall* is greater than 15, play continues. But if *xBall* isn't greater than 15, the ball has gotten by the paddle and control falls through

the bottom of the loop, which means that the ball goes out of play. The ball is erased, and a beep informs the player that he or she has flubbed it.

Control returns to the main program loop after the ball has gone out of play, and IncSpeed [SR 3] is then called. If the ball speed was set initially by the player, control returns to the main program routine. If the speed wasn't set by the player, the absolute value of *xVel* is incremented by 3, and control returns to the main program routine. Then the next ball (if there is one) is played. When all the balls have been played, a new game is started by Start Game (with the score reset to 0). This continues until the player quits, via the MacBall menu.

Suggestions for MacBall

You could modify MacBall so the player gets a new ball every time a full set of apples is knocked out. This would allow good players to play longer and get higher scores, but it might make the game too easy.

Another possibility would be to have one or more "poison apples" randomly selected. These apples (which would be filled with a pattern different from that of the regular apples) would cause the player to lose the ball if hit *from any direction except behind.* This could make the game considerably more challenging. Other ideas you might consider include adding gravity to the ball (like MacDart), or allowing the score to grow as large as you wish, instead of resetting it each time. Or, you could also add a fourth row of apples, or even design a subroutine that places a magic apple in the orchard that would turn into several apples when hit by a ball.

MacBall program listing

```
'* * * *
```

```
'********************************************************* MAIN LOOP
  cursFlag = true                                                    MAIN 1
  WHILE true                              'play until Quit selected from menu
    MENU 6,1,1                          'enable Play Game and Demo menus
    MENU 6,2,1
    GOSUB StartGame                   'get Game or Demo, initialize balls etc.
    MENU 6,1,0                          'disable Play Game and Demo menus
    MENU 6,2,0
    WHILE ball < maxBalls                                'while balls remaining   MAIN 2
      GOSUB NewBall
      GOSUB PlayBall
      GOSUB IncSpeed
    WEND
  WEND

'********************************************************* MENU EVENTS
MenuEvent:                                                           ME 0
  MENU 6,0,0
  item = MENU(1)
  ON item GOSUB GameMenu, DemoMenu, , BasQuit, DeskQuit
  MENU 6,0,1
  RETURN

GameMenu:                                          'reset and play game   ME 1
  playGame = true
  RETURN

DemoMenu:                                                  'play demo     ME 2
  demo = true
  RETURN

BasQuit:                                                   'quit to BASIC ME 3
  MENU RESET
  END

DeskQuit:                                                  'quit to Mac Desktop ME 4
  MENU RESET
  SYSTEM

'********************************************************* SUBROUTINES
StartGame:                '_____________________________ start new round of balls  SR 1
  xVel = minXVel : yVel = 7          'initialize ball's x and y velocity
  ball = 0                                          'no balls played yet
  userSpd = false                  'userSpd true if user has set speed
  GOSUB DrawSpeed                                   'show initial speed
  score = 0
  PUT (10,padY), padPic                             'erase old paddle
```

```
padY = 100 : PUT(10,padY), padPic                          'draw new paddle
GOSUB DrawApples                                           'set up apples
CALL MOVETO(100,275) : PRINT "BALLS: ";
FOR n =1 TO 5 : PRINT CHR$(165); " "; : NEXT

LINE (boxX,boxY) - (boxX + 230, boxY + 35), , b            'create message box
CALL TEXTMODE(1)                                           'OR mode
CALL MOVETO(boxX + 5, boxY + 13)
PRINT "Choose an option from the MacBall menu"
CALL MOVETO(boxX + 5, boxY + 30)
PRINT "or set the speed in the speed bar."

IF NOT cursFlag THEN CALL SHOWCURSOR
cursFlag = true
demo = false : playGame = false
WHILE NOT demo AND NOT playGame                            'idle until user chooses
   IF MOUSE(0) < 0  THEN GOSUB CheckSpeed                  'change speed?
WEND

LINE (boxX,boxY) - (boxX + 230, boxY + 35), 30, bf         'erase message box
CALL TEXTMODE(0)                                           'back to COPY mode
CALL MOVETO(45,275) : PRINT "0";
RETURN
```

SR 2

```
NewBall:                '_____________________________________ set up to play new ball
  CALL MOVETO (190 - ball * 10, 275) : PRINT " ";          'remove one ball
  ball = ball + 1
  GOSUB DrawSpeed                                          'show current speed
  FOR n = 1 TO 100                          'allow a little paddle movement before release
    GOSUB MovePaddle
  NEXT
  yVel = INT(RND(1) * 6) + 2                               'yVel in range 2...7
  xVel = -ABS(xVel)                         'ball starts out going towards paddle
  xBall = 335 : yBall = 250 - RND(1) * 220
  oldXB = xBall : oldYB = yBall
  RETURN
```

SR 3

```
IncSpeed:               '_____________________________ increment ball speed if not user set
  IF userSpd THEN NoSChange
  xVel = ABS(xVel) + 3                     'user didn't set speed, so increase it
NoSChange:
  RETURN
```

SR 4

```
PlayBall:               '_____________________________________ play until user misses ball
  hit = false                                              'means we haven't hit an apple yet
  oldXB = xBall : oldYB = yBall : PUT (xBall,yBall), ballPic
```

```
    WHILE demo OR xBall > 15
      xBall = xBall + xVel : yBall = yBall + yVel
      GOSUB UpdateBall
      GOSUB MovePaddle
      IF (xBall >= minApX) AND NOT hit THEN GOSUB CheckApple          'hit an apple?
      IF xBall >= 30 OR (yBall > 30 + padY OR yBall < padY - 10) THEN NoPadHit
      xVel = -xVel : xBall = 40                          'hit paddle...set new xVel and yVel
      d = yBall - padY - 15 : yVel = d * .6
      SOUND 500,1
      hit = false
NoPadHit:
      IF xBall < 15 OR xBall > maxX THEN SOUND 1000,1 : xVel = -xVel : hit = false
      IF yBall < 10 OR yBall > maxY THEN SOUND 1000,1 : yVel = -yVel
    WEND                                                  'end while ball in play

    FOR n = 800 TO 500 STEP -50                                    'ball dead noise
      SOUND n,1
    NEXT
    PUT (xBall,yBall), ballPic                  'remove last image of ball before next ball
    RETURN

CheckApple:              '_____________________________ check to see if apple was hit
                                                                    'col = apple column
    col = INT((xBall - minApX) / 31) + 1 : IF col > 3 THEN col = 0
    row = yBall / 27 + (yBall => 257)                    'row location, in integer division
    IF NOT apHere(col,row) THEN NoApple
    FOR n = 1 TO 4 :  SOUND 800,1 : NEXT

    PUT (apC(col),apR(row)), applePic              'erase apple, mark as gone, incr. score
    apHere(col,row) = false
    xVel = -xVel : hit = true : score = score + 1
    CALL MOVETO(45,275) : PRINT STR$(score);
                                                                  'deliver new crop of apples
    IF score MOD 27 = 0 THEN GOSUB DrawApples : PUT (xBall,yBall), ballPic
NoApple:
    RETURN

UpdateBall:              '_____________________________ update ball to new position
    PUT (xBall,yBall), ballPic                                          'draw new ball
    PUT (oldXB,oldYB), ballPic                                          'erase new ball
    oldXB = xBall : oldYB = yBall                                       'save new position
    RETURN

DrawScoreArea:           '_____________________________ draw initial score area
    CLS
    LINE (5,8) - (maxX + 20, maxY + 10), , b                    'draw border & speed box
```

SR 5

SR 6

SR 7

```
    LINE (sBoxX - 1, sBoxY - 1) - (sBoxX + 164, sBoxY + 10), , b
    CALL TEXTFACE(32)                                   'condensed face
    CALL MOVETO (230,275) : PRINT "SPEED";
    CALL MOVETO(10,275) : PRINT "Score: 0";
    RETURN

SR 8
CheckSpeed:          '_____________________ change speed based on mouse x pos
    x = MOUSE(1) : y = MOUSE(2)
    IF x < sBoxX OR x > sBoxX + 160 OR y < sBoxY THEN NoCS
    userSpd= true                                       'in speed box, so change it
    xVel = (x - sBoxX) / 8 + minXVel
    GOSUB DrawSpeed
NoCS:
    RETURN

SR 9
DrawSpeed:           '_____________________________ draw current speed bar
    newSX = (ABS(xVel) - minXVel) * 8 + sBoxX
    LINE (oldSX,sBoxY) - (oldSX + 3, sBoxY + 9), 30, bf     'erase old speed bar
    LINE (newSX,sBoxY) - (newSX + 3, sBoxY + 9), 33, bf     'draw new speed bar
    oldSX = newSX
    RETURN

SR 10
MovePaddle:          '_____________ move paddle based on where pointer location
                                                    'if pointer above window, show cursor
    dummy = MOUSE(0) : padY1 = MOUSE(2) - 45
    IF (MOUSE(2) < 0) = cursFlag THEN CursorOK
    IF cursFlag THEN CALL HIDECURSOR ELSE CALL SHOWCURSOR
    cursFlag = NOT cursFlag
CursorOK:
    IF padY1 < 0 THEN padY1 = 0 ELSE IF padY1 > 235 THEN padY1 = 235

    IF padY1 = padY THEN NoPadMove
    PUT (10,padY1), padPic : PUT (10,padY), padPic      'draw new, erase old pos
    padY = padY1                                        'set new paddle location
NoPadMove:
    RETURN

SR 11
Instructions:        '_____________________________ show instructions
    WINDOW 2, , (16,45) - (495,315), 2
    PRINT
    PRINT "                    Instructions for MacBall"
    PRINT
    PRINT "   Hit the ball with the paddle to knock out as many apples as you can."
    PRINT " If you don't set the speed yourself, each time you miss a ball the speed"
    PRINT " is increased."
    PRINT "   At the beginning of the game you make a choice of what to do from the"
    PRINT " MacBall menu. Demo just shows you how the game works. The paddle"
    PRINT " doesn't have to hit the ball; the ball just never disappears off the left"
    PRINT " side of the screen."
    PRINT "   Pull down the MacBall menu and quit the game any time you want."
```

```
    PRINT
    CALL INITCURSOR
    BUTTON 1, 1, "Continue", (190,240) - (280,260)
    WHILE DIALOG(0) <> 1 : WEND
    BUTTON CLOSE 1: WINDOW CLOSE 2
    RETURN

TitleScreen:          '_____ draw title screen
    CLS
    CALL TEXTFONT(0) : CALL TEXTSIZE(36)
    LOCATE 1,2 : PRINT "MacBall!"
    LOCATE 2,2 : CALL TEXTSIZE(12)
    PRINT "Knock out the Apples!"
    CALL TEXTFONT(1)
    PUT (10,150) - (60,250), padPic
    PUT (250,90) - (270,110), ballPic
    FOR n = 0 TO 2
      PUT (350, 10 + n * 80) - (430, 82 + n * 80), applePic
    NEXT
    FOR t = 1 TO 10000 : NEXT
    RETURN

DrawApples:           '_____ draw and initialize Apple array
                                'set up apple array in (column, row) order
                              'set up x,y coordinates for apples and draw apples
    FOR row =1 TO 9
      apR(row) = row * 27 - 13                          'y coordinates
      FOR col = 1 TO 3
        apHere(col,row) = true                          'apple is here
        apC(col) = (col - 1) * 31 + minApX              'x coordinates
        PUT(apC(col), apR(row)), applePic, PSET         'draw Apple
      NEXT col
    NEXT row
    RETURN

FormPaddle:           '_____ form paddle and save in padPic
    r(0) = 0 : r(1) = 0 : r(2) = 32 : r(3) = 25
    CALL PENSIZE(2,1)
    CALL FILLOVAL(VARPTR(r(0)), VARPTR(padPat(0)))
    CALL FRAMEOVAL(VARPTR(r(0)))
    LINE (10,30) - (9,50)
    LINE -(15,50)
    LINE -(14,30)
    GET (0,0) - (25,50), padPic : PUT (0,0), padPic     'save into array & erase
    CALL PENSIZE(1,1)
    RETURN
```

SR 12

SR 13

SR 14

SR 15

```
FormApple:          '_____ form apple shape and put into Apple
  r(0) = 19 : r(1) = 17 : r(2) = 39 : r(3) = 31                    'left oval
  CALL PAINTOVAL(VARPTR(r(0)))
  r(1) = 27 : r(3) = 41                                            'right oval
  CALL PAINTOVAL(VARPTR(r(0)))
  r(0) = 20 : r(1) = 36 : r(2) = 34 : r(3) = 55                    'bite
  CALL PAINTOVAL(VARPTR(r(0)))
  CALL INVERTOVAL(VARPTR(r(0)))
  LINE (29,19) - (33,15)                                           'stem
  LINE -(31,15)
  LINE -(29,19)
  PSET (31,16), 33
  GET (14,14) - (44,40), applePic                  'get image into applePic
  PUT (14,14), applePic                            'and erase it from screen
  RETURN
```

SR 16

```
FormBall:           '_____ form ball picture
  r(0) = 0 : r(1) = 0 : r(2) = 10 : r(3) = 10
  CALL FILLOVAL(VARPTR(r(0)), VARPTR(grayPat(0)))
  CALL FRAMEOVAL(VARPTR(r(0)))
  GET (0,0) - (10,10), ballPic                     'put ball in array BallPic
  PUT (0,0), ballPic                               'erase ball from screen
  RETURN
```

MacGurkha

During World War II a British officer had a tough assignment for the legendary Nepalese Gurkha riflemen: He wanted them to make a parachute drop. The officer was somewhat surprised when only about half of the ten thousand Gurkhas volunteered for the mission, since these troops were known for their absolute fearlessness and their ability to carry on under any

conditions. But later, after he explained to them that each man would be provided with a parachute before jumping out of the plane, the rest of the Gurkhas quickly volunteered, too.

Well, your modern Gurkha is guaranteed a parachute, and no one is trying to shoot him out of the sky. The job still isn't a piece of cake, though, if you expect to get your Gurkha successfully into the landing zone: There are blimps to watch out for, the parachute tends to drift, and you have to know when to open the chute and how much to guide the Gurkha into the target area. As you'll see, your score for a successful jump will depend on a fine sense of timing, and the willingness to take a chance sometimes—true Gurkha fearlessness!

How to play MacGurkha

MacGurkha starts with the title screen shown in Figure 1. A larger version of the plane your Gurkhas will jump from appears and flies across the screen from right to left. In a moment, a little Gurkha figure emerges from the aircraft, and falls headlong to the ground, without his chute ever opening. Woops! don't let that happen to you!

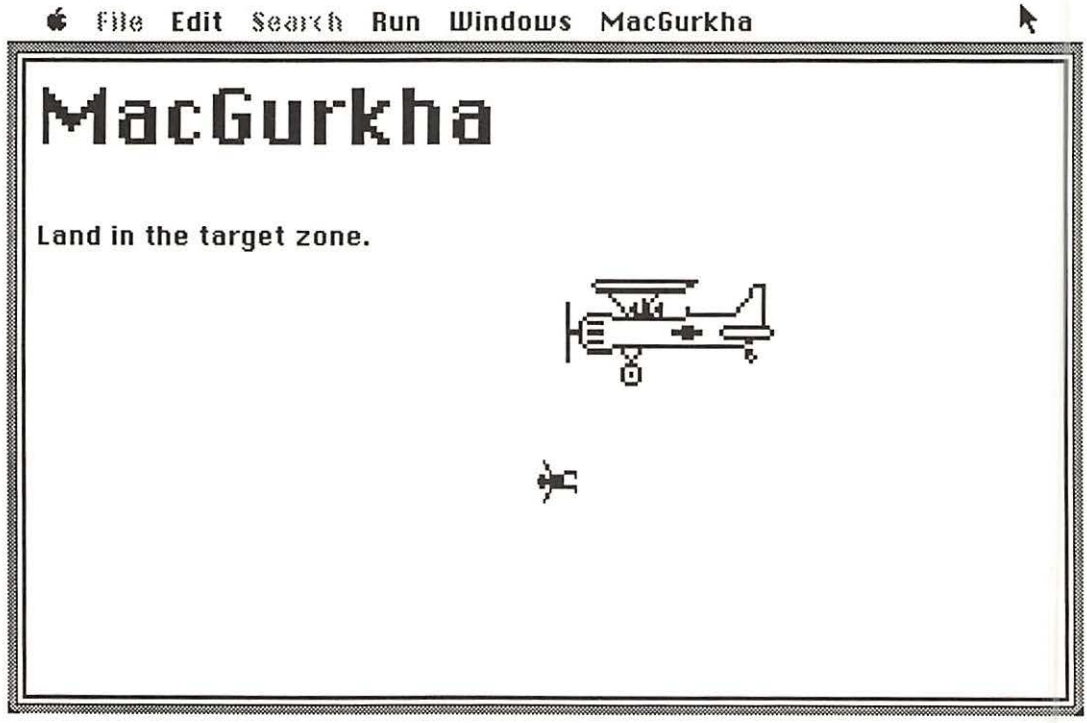


FIGURE 1. *The MacGurkha title screen*

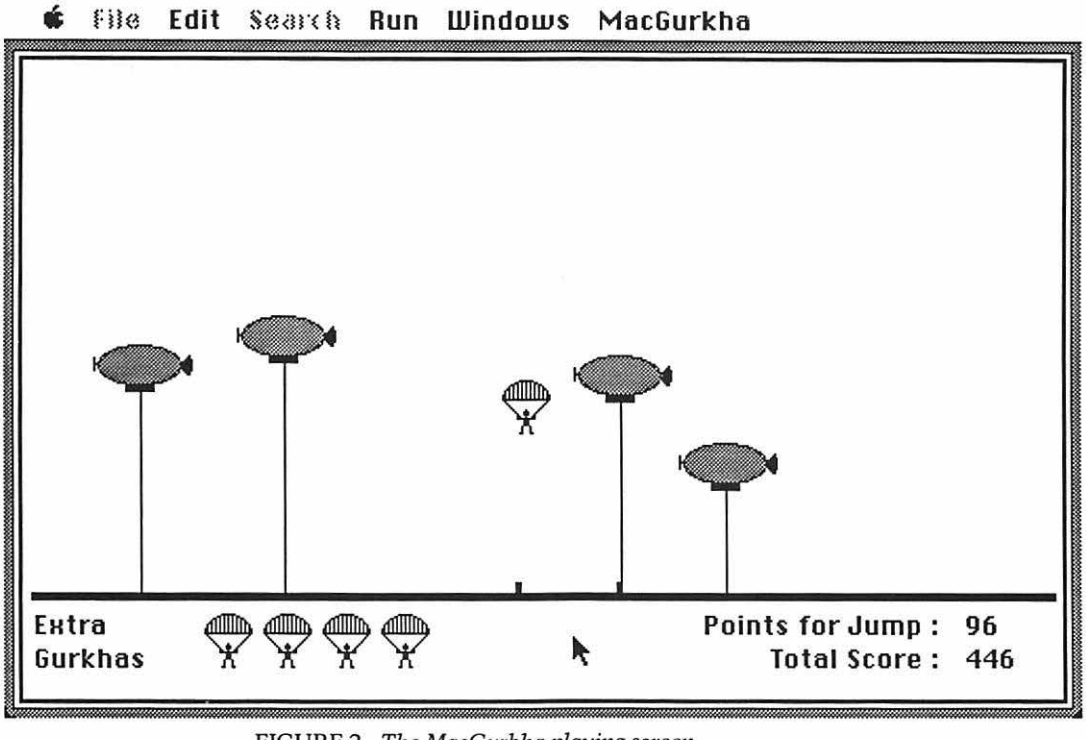


FIGURE 2. *The MacGurkha playing screen*

After a moment, the playing screen shown in Figure 2 appears. Your plane (smaller than the one on the title screen) flies in from the right side of the screen, accompanied by a nice engine sound. At the bottom of the screen, you can see the target area or jump zone, which is designated by two little markers. One or more blimps are also tethered to the bottom of the playing screen. They don't move, but if your Gurkha touches one it's instant death! The score for the last jump and the total score for the game so far are shown at the bottom right, just below the playing screen.

Wait for the plane to fly to the point where you want your Gurkha to jump. You'll have to take the plane's speed into consideration when choosing the release point, because the Gurkha starts out with the plane's forward velocity. This means that the faster the plane is traveling, the more your free-falling Gurkha will tend to move diagonally rather than straight down.

To release the Gurkha, click the mouse button. The plane then disappears, and the Gurkha (with the chute still closed, unless you lingered too long on the mouse button) starts his free-fall descent. When you

think the moment is right, click the mouse once more to open the chute. Once the chute is open, it will tend to drift from side to side randomly.

You steer the chute by moving the mouse pointer left or right while holding the mouse button down. As long as you hold the button down, the chute will move toward the side the pointer is on. (While you're steering, don't forget to look out for blimps!)

If you succeed in making the Gurkha land in the jump zone, you'll hear a bugle call and see your score for the jump as well as your new total score for the game. Your score for the jump actually depends on three separate factors. The longer you wait before opening the chute, the higher the score. Your score is also higher when the jump zone is narrower. On the other hand, using the mouse to steer the chute costs you points, so you should try to steer as little as possible.

The game gets tricky when several blimps are bunched close to the target zone. Sometimes you can drop the Gurkha far enough from the balloons to avoid them and then drift in over the target in a kind of glide, using the Gurkha's forward velocity set by the plane's motion, but you have to cope with the random-drift factor and the fact that time for maneuvering is limited. Since a free-falling chutist presents a smaller profile to the blimps than one with a chute open, free-falling past a blimp and then opening the chute is often a good tactic, although sometimes the chute gets caught in the guy wires. If the blimp is too low, however, you may not have time to maneuver before the Gurkha hits the ground. The trick is to know how far you can let him free-fall (thus increasing your score) before you have to pull the ripcord. At the same time, you want to minimize steering, and these two objectives are sometimes at odds with each other—but it's decisions like these that make the game so interesting. After some practice you can call yourself an honorary Gurkha!

After a jump, note the number of extra Gurkhas displayed in the lower left corner of the screen. Each time you are unsuccessful (you miss the jump zone, don't open the chute, or hit a blimp) you lose one of these Gurkhas. When none are left, you're playing with the last one—you have only one life left. When you run out of lives, the game is over.

How MacGurkha works

The heart of the program is the main game loop at [Main 1]. The outer WHILE...WEND loop lets the player play repeated games until choosing one of the standard menu quit options. The inner WHILE...WEND loop handles new jumps as long as the player has "lives" left. After the

playing screen is set up for a new jump, various subroutines are called in succession to control the stages of the jump: flying the plane, releasing the Gurkha into free-fall, drifting down with the chute open, steering, checking for collision with a blimp, scoring, and so on. The program outline in Figure 3 makes the structure of the program clear.

```
Initialization
  define size of graphics arrays for plane, chute, man                Init 1
  set constants for pattern, logical variables, screen locations
  create playing window
  create and save shapes (MakePictures)                               Init 2 (SR 12)
  install MacGurkha menu, enable menu event trapping
  display title screen (TitleScreen)                                  SR 11
  show instructions (Instructions)                                    ME 2

Main Program
  WHILE true (endless loop interrupted by menu events)                Main 1
    initialize lives, score, jumps
    WHILE lives left                                                  Main 2
      set up playing screen (SetUpScreen)                             SR 4
      set jump points to zero, establish random plane speed
      fly plane until button pressed (FlyPlane)                       SR 5
      start Gurkha's free-fall (FreeFall)                             SR 6
      save free-fall distance for score                               Main 3
      fall with open chute (ChuteFall)                                SR 7
      if Gurkha hit blimp or ground, show hit (ShowHit)               SR 1
      if Gurkha landed in drop zone, show message (MadeIt)            SR 2
      if Gurkha outside of drop zone, show message (Casualty)         SR 3
    WEND
    announce end of game (Announce)                                   Main 4 (SP 1)
    wait for menu event to restart game
  WEND

Menu Events
  MenuEvent: branch to appropriate subroutine                         ME 0

  PlayMenu: play another game                                         ME 1

  Instructions: display instructions                                  ME 2
    create second window
    print instructions
    create Continue button and wait for button click

  BasQuit: quit to BASIC                                              ME 3

  DeskQuit: quit to Mac Desktop                                       ME 4

Subroutines
  ShowHit:                                                            SR 1
    do sound effect
    announce appropriate message (Announce)                           SP 1
                                                                      (continued)
```

FIGURE 3. *Program outline*

```
   subtract a life

MadeIt:                                                    SR 2
   give points (mouse usage, accuracy and length of free fall)
   do sound effect
   announce success (Announce)                             SP 1

Casualty: subtract a life, do sound effect                 SR 3

SetUpScreen:                                               SR 4
   clear playing area
   set initial plane location
   draw landing zone and ground
   update score and lives left (UpdateStatus)              SR 10
   draw plane in starting position
   draw one blimp in random location for each successful jump

FlyPlane:                                                  SR 5
   increment plane location by speed factor
   make sound proportional to speed
   keep moving plane until button press

FreeFall:                                                  SR 6
   WHILE button not pressed, blimp or ground hit
      erase Gurkha in old position
      calculate new position, add random drift
      draw Gurkha in new position
      check for blimp hit (CheckBlimp)                     SR 8
   WEND

ChuteFall:                                                 SR 7
   WHILE Gurkha above ground and not hitting blimp
      erase Gurkha in old position
      if mouse button pressed, alter direction of fall
      add random drift to fall
      draw Gurkha in new position
      check for blimp hit (CheckBlimp)                     SR 8
   WEND

CheckBlimp: determine if Gurkha has struck blimp           SR 8

ClearMouse: clear mouse events                             SR 9

UpdateStatus:                                              SR 10
   display points made this jump, total points in game
   display Gurkhas remaining

TitleScreen:                                               SR 11
   display title and other text
   fly plane until at drop point
   drop Gurkha until he hits ground or button clicked
```

(continued)

Figure 3. Program outline (continued)

MakePictures:	**SR 12**
if MacGurkha.Graphics file on disk, read from file	
if not on disk, read from DATA statements (**ReadArray**)	SP 2
Subprograms	
Announce: display message at top of screen	**SP 1**
ReadArray: read graphics array from DATA statements	**SP 2**

Figure 3. Program outline (continued)

Initialization

In [Init 1] all variables from a-z are declared to be integers by the DEFINT statement, except variables whose names begin with *q*, which are declared to be single-precision real numbers by the DEFSNG statement. In general, variables holding screen coordinates are best set to be integers, because you can't have half a screen pixel anyway. On the other hand, probabilities need to be real numbers, as do variables that involve complex motion or draw curved surfaces. Other processes where fractions often occur and accuracy needs to be preserved through repeated calculations are also best done with real numbers.

Three sets of statements are used to dimension the arrays that will hold the graphics data for the game's three movable objects: the plane (*airPlane*), the Gurkha with an open chute (*openChute*), and the Gurkha with closed chute (*clsChuteP*). The same procedure is used in each case. First, the horizontal dimension or width (*planeH*) of the object is set. Next, the vertical dimension or height (*planeV*) is set. A formula defined by the ArraySize function is then used to determine the number of integer elements that the array will need to hold the graphics image.

As you probably recall if you've worked with BASIC graphics, a graphic image is actually an array of bits (or "bit map") in which each bit corresponds to one screen pixel of the image. The general formula for the number of bytes (8 bits) needed to store a graphics image with GET is given in the Microsoft BASIC documentation under the GET statement. We've modified the variables in that formula to reflect our MacGurkha program:

$$\text{bytes} = 4 + (\text{YB} - \text{YT} + 1) * 2 * \text{INT}((\text{XR} - \text{XL} + 16)/16)$$

Let's see how this formula is used to determine how the first of our images, the airplane, is stored in an array.

YB is the y coordinate of the bottom of the image rectangle; *YT* is the y coordinate of the top. *(YB − YT + 1)* is equal to the height of the rectangle in pixels, or *planeV* in our code. (The coordinate of the top is subtracted from the bottom because y coordinates increase as you move from top to bottom.)

XR is the x coordinate of the right side, and *XL* is that of the left. *(XR − XL + 1)* is the width of the rectangle in pixels, or *planeH* in our code. We add 16 to it, divide by 16, and take the INT in order to round it up to the next full 16-bit word. Graphics memory is organized in 16-bit words laid end-to-end across the screen, and if you have part of a word left over you have to use the whole word. We now have the total in 16-bit words, but because this formula gives us bytes, the quantity is therefore multiplied by 2 to get 8-bit bytes. Finally, four bytes are added for overhead involved in the array representation.

The actual expression in our code is basically the same except it gives a result in words (or 16-bit integer elements), not bytes. Thus the above formula is divided by 2 and the result is represented in simplified form in the function ArraySize. This same procedure is followed for dimensioning the arrays for the other two objects.

Three other constants are defined near the end of [Init 1]: the number of lives a player gets, the altitude the plane flies at, and the location of the ground (the latter two both as y coordinates).

In [Init 2] the title window is created. Here the actual images to be stored in our picture arrays are obtained, and MakePictures [SR 12a] is called. As with MacSpace and some of our other games, we provide the option of using a graphics file from which the program will get its images. This allows you to create your own "custom-made" graphics and have your games use them. If you're interested in doing this, read the chapter on MacInterface to see how that program can be used to create graphics files and data statements for use with other programs.

To implement this option, MakePictures first attempts to load the file *MacGurkha.graphics*. Before attempting to open the file, an ON ERROR statement enables trapping of errors by FileError [SR 12b]. If the file is not found, an error is generated and the flag *fileHere* will be set to *false* to inform MakePictures that the file doesn't exist.

If the file is found, each of the three images is read into the appropriate array. First, the count of the number of bytes in the file is obtained. The string returned by the INPUT$ function is assigned to the variable *image$*. A PICTURE statement displays the image on the screen. This is followed by a GET statement that stores the image from the screen in the

array. You can't directly store the contents of the graphics file in the array, though, because the file contains a sequence of encoded graphics instructions. The image must first be drawn with PICTURE, and then it can be stored by GET as a bit map in the array.

If there is no graphics file, control goes to the label ReadPictures. The subprogram ReadArray [SP 2] is called. It is a subprogram rather than a subroutine so it can simply be given the name of the array to read DATA statements into. This makes it a general-purpose tool you might find handy in other programs that must initialize several arrays from DATA statements. The size of the array is read in first, and then a FOR...NEXT loop is used to read in the array elements.

Note that the limits for this FOR...NEXT loop are given in the form *LBOUND(array)* and *LBOUND(array)* + *size* − *1*. The reason is that, depending on the value given in the OPTION BASE statement in a particular program, arrays can start with their first element being either element 0 or element 1. The function LBOUND returns the correct element number, and adding *size* − *1* gets the last element of the array. This makes the subprogram flexible enough to read arrays starting at either element 0 or element 1 and of any size.

After ReadPictures is finished and returns to MakePictures, the latter returns to [Init 2], where the MacGurkha menu is created. Note that the second and third items (Play Again and Instructions) have a 0 as the last parameter in their MENU statements: These options are deactivated (and dimmed on the screen) when the menu first appears. Since the player hasn't played yet, Play Again is inappropriate at this time. The instructions will be automatically shown following the title screen, so that option, too, is not active now.

Next, the title screen and instructions are shown. TitleScreen [SR 11] is called. After the title text is displayed, a WHILE...WEND loop is used to show the airplane flying across the screen and the unfortunate chuteless Gurkha falling from it. The plane stays at a constant altitude (or y coordinate) of 150, but as the variable *pH* decreases (10 is subtracted from it each time at the bottom of the loop) the plane is drawn farther and farther to the left of the screen. The usual procedure for moving an object on the screen is followed: PUT the object at a position, calculate the new position, PUT the object again at the old position to erase it (which works because PUT's default is to do an XOR with the existing screen contents), and finally PUT the image again at its new position. We also include a short SOUND statement in the loop to evoke the motor's drone.

The IF...THEN statement in the middle of the loop determines when the falling Gurkha will be shown. As long as *pH* is greater than 300, the Gurkha doesn't jump: Control goes to the label NoFall. When *pH* goes below 300, however, the IF statement becomes false and the picture of the "closed-chute" Gurkha is shown. His x coordinate will remain the same as the plane's, so he will be under it as he falls. Each time through the loop, though, his y coordinate is multiplied by 1.03 so he falls a little farther down the screen. At the bottom of the loop, MOUSE(0) is checked to see if the user clicked the mouse button. If so, *pH* is set to −1 and the loop terminates prematurely (presumably leaving the hapless Gurkha in limbo).

Instructions [ME 2] is used to display brief instructions for the player. (These instructions are also available as a menu option between games.) After the instructions are displayed, the Continue button is created, and a WHILE...WEND loop waits for the button to be clicked, at which point the button is removed and the screen is cleared. After returning from the subroutine, we're ready to set up the game itself.

The main program

The main game loop starts at [Main 1]. This sets up a new game when the program is first run, and after each game ends, until the player decides to quit. The form WHILE *true*...WEND means that the loop will never terminate of its own accord, but instead by some external event, in this case when one of the quit options is chosen from the MacGurkha menu.

The player gets a full set of *maxLives* lives. (Five lives are more than most of us get, although fewer than those provided for the average cat.) The number of successful jumps is set to 1, which also determines the number of blimps shown at each play, and the total score is set to 0.

The main play loop

The main play loop starts at [Main 2] and handles one jump each time through. As long as the player has at least one life left, there will be more jumps. SetupScreen [SR 4] clears the playing screen and draws the target zone for the new jump. The playing screen is cleared by using a LINE statement with the box-fill option to white out the playing area.

The location of the left "flag" (*flag1*, the boundary of the target zone) is determined randomly, and the right flag (*flag2*) is located a random distance (but at least 20 pixels) from the left one. The flags and ground are then drawn. Note a nice way to get thick lines: The ground, for

example, is drawn as a filled box three pixels deep. No color is specified because the default of black is wanted.

UpdateStatus [SR 10] is called to show the points gained for the last jump and the total score thus far for the game (both are 0 the first time through, of course). The number of lives left ("Extra Gurkhas") is displayed by a FOR...NEXT loop, which draws the appropriate number of "open chute" figures in the lower left corner of the screen. Note that the horizontal, or x, coordinate to start each figure is offset successively by multiplying the width of the image (*openH*) by the loop index and adding 5 for spacing. Note also that the number of figures shown is actually *lives* – *1*, since you have one life left when you have no "extra" Gurkhas. The other thing that has to be done is to erase a Gurkha that's on the screen from the previous jump if that life has now been lost. This is done by finding where the last Gurkha should currently be (offsetting in the way described above), and then using a LINE statement with the white box-fill option to erase the Gurkha past that position (if any).

After control returns to SetupScreen, the plane is drawn at its starting location (the upper right corner of the screen). A FOR...NEXT loop is then used to place the blimps. The number of blimps used is equal to the number of successful jumps the player has made so far in the game, but is always at least one, the starting value of *jumps*.

The x coordinate for each blimp (*obsX*) is random between 1 and 400, while the y coordinate (the altitude of the blimp) is random but no higher than 25 pixels below the plane and no lower than 40 pixels above the ground. This is reasonable: Since our plane can fly only in a straight line, we don't want to put the blimp directly in its path, but on the other hand, a blimp down on the ground doesn't make sense. The blimp coordinates are placed in *rec%*. A call to the QuickDraw PAINTRECT routine with coordinates offset to just below the blimp draws the blimp's gondola. The blimp's tail fin is drawn by calling another QuickDraw routine, PAINTARC, to draw a small arc segment. (It often takes some experimentation to come up with the best way to draw curved objects.) The propeller is simply a short line, as is the tether. Finally, two more QuickDraw routines, a FILLOVAL and a FRAMEOVAL (for outlining), take care of the "blimp" part of the blimp. After the required number of blimps are placed and drawn, control returns to the main playing loop in [Main 2].

Next, a random plane speed is determined, and it's time to start flying. FlyPlane [SR 5] is called to start the jump approach. The plane is simply flown in a straight line by the WHILE...WEND loop until the mouse button is clicked, moving the plane across the screen by subtracting

its speed from the x coordinate each time through the loop. If the plane gets within the value of its speed on the left side of the screen (so it would go off the screen next time through the loop), it is "wrapped around" to the right side for another pass. The sound made each time through the loop gives the engine noise, which has a higher pitch when the plane is faster.

Once the mouse button is clicked, it's time to heave the Gurkha from the plane. FlyPlane returns, and after a short delay loop (time to check the chute pack again and avoid the sergeant's boot) the Gurkha starts falling. The Gurkha's x and y coordinates start at the plane's position at the time of the release. The *hitBlimp* and *hitGround* flags are set to *false*.

FreeFall [SR 6] handles the fall of the Gurkha until the chute is opened. The coordinates of the bottom center of the figure (*hotX,hotY*) are determined: This is the "hot spot," analogous to the mouse cursor's hot spot, whose coordinates are used to check for collisions with blimps or the ground. A WHILE...WEND loop with a rather complicated condition is entered. FreeFall continues until one of the following conditions is met:

1. A blimp is hit (as indicated by *hitBlimp* being set to *true* by *checkBlimp* [SR 8] at the end of the loop;
2. The mouse button is clicked (checked by the *MOUSE(0)* > −*1* condition in the WHILE statement);
3. The Gurkha hits the ground without ever having opened his chute (splat!).

First, a sound whose pitch is a function of altitude is generated. The Gurkha (with closed chute) is drawn at the opening coordinates (*manX,manY*). As he falls, the SOUND statement's pitch decreases as the y coordinate increases, producing the familiar "falling bomb" whistling sound (remember, the y coordinate increases as the altitude decreases).

The Gurkha is erased at his "old" position, and his new coordinates are then determined. He will fall a constant 4 pixels (we're not trying to simulate gravity here). A random-drift factor is calculated: This adds some uncertainty to the game and simulates gusts of wind, the way the chute is manipulated, and so on. The plane's speed is subtracted from the x coordinate, and then the plane speed is reduced by multiplying it by 0.9. The effect of this will be that the Gurkha starts out with a forward speed equal to that of the plane, but the effect of this speed will become progressively less, a rough simulation of wind resistance canceling the forward speed. The x coordinate of the Gurkha is checked for being less than the left screen boundary, and wrapped around the edge of the screen if necessary. Finally, the Gurkha is drawn in his new position and we then check to see if he has collided with a blimp.

CheckBlimp [SR 8] does this. It first checks to see if the "hot spot" position on the Gurkha is too close to the ground for him to hit a balloon—in that case, the subroutine simply returns. Otherwise the POINT function is checked: If it returns a 33 (corresponding to the color black), the Gurkha has collided with a blimp. Why? Because the blimps are the only objects (other than the Gurkha himself) drawn on the screen more than 30 pixels from the ground, and thus being reported as black by the POINT function. So, instead of having to record the positions of all the blimps in an array and having to check them individually for collisions, we can simply check to see if the Gurkha's hot spot (the bottom-center of the rectangle containing the Gurkha image) is black. Note that this also means there's a small chance that a Gurkha's hot spot will happen to be on a blimp's *tether* when it is checked, and that will also kill him. If the Gurkha hits a blimp, the flag *hitBlimp* is set to *true*.

We then return to the top of the loop and the Gurkha continues to fall, unless he hits a blimp, reaches the ground, or has his chute clicked open. Normally, the loop is exited by the player clicking on the mouse button. After the loop ends, the program checks to see if the ground was hit, and if so, sets *hitGround* to *true*. But if neither a blimp nor the ground was hit, the Gurkha is simply erased pending drawing him again with the chute open. We then return from FreeFall to [Main 3] in the main playing loop. The number of pixels the trooper has free-fallen is stored as *ffDist*, which will be part of the score the player will receive for a successful jump. The variable *mCntrl*, which will be used to record the number of times the player uses the mouse button to steer the Gurkha, is initialized to 0.

However, before continuing the jump, we have to deal with the possibility that the Gurkha has already bought the farm by hitting a blimp or the ground, as indicated by the flags *hitBlimp* or *hitGround* being *true*. In either case, ShowHit [SR 1] is called. An "alarming" sound is generated, and the appropriate announcement is made via the Announce subprogram [SP 1]. We again use a subprogram rather than a subroutine in order to make a general-purpose tool: Any string can simply be provided to the subprogram as a parameter, without having to assign it to a global string variable first. Note the SHARED clause indicates that *altitude* from the main program will be used by the subprogram: It's used to offset the rectangle where the message will be printed. That way, if you change the height at which the plane flies, you don't have to fix anything at all in this subroutine. The QuickDraw ERASERECT and MOVETO routines are used to clear out anything in the area and then position the string far enough to

the left to fit its length. After returning from Announce, ShowHit subtracts one life from the player's total. After returning to the playing loop, a jump to the label NextJump aborts the jump.

If the Gurkha has avoided the blimps or a chuteless landing, ChuteFall [SR 7] is called. A new "hot spot," similar to that used for the closed-chute Gurkha, is established for collision-detection purposes. Now the "open chute" Gurkha is drawn. The mouse button is checked, and, if it has been or is being held down (*MOUSE(0) < 0*), the Gurkha's x coordinate is adjusted according to the mouse pointer's x coordinate (returned by MOUSE(1)), and using the SGN (sign function) to find out if this quantity is positive or negative. If it is positive, the mouse pointer's x coordinate is greater than the Gurkha's. The Gurkha should be moved to the right, so 3 is added to the Gurkha's x coordinate. If the quantity is negative, 3 is subtracted from the x coordinate to move the Gurkha toward the left. The count of mouse control usage *mCntrl* is increased by 1, thus lowering the potential score for the jump.

Next, random drift is calculated, similar to that used in free-fall, except that it's greater, since an open chute drifts much farther than a closed one. This is randomly added to or subtracted from the x coordinate. A constant fall of 3 pixels is then added to the y coordinate. The x coordinate is wrapped around if the left boundary of the screen was reached. The Gurkha is drawn in his new position, and a short delay loop is executed. This delay loop both simulates the slow fall of a parachute and gives the player time to do steering with the mouse if desired. CheckBlimp is then called again to check for a collision.

When ChuteFall is exited, control returns to [Main 3] in the main playing loop. The fall is at an end because one of three things has happened: (1) The Gurkha hit a blimp (*hitBlimp* is *true*), (2) the Gurkha is on the ground in the target zone, or (3) the Gurkha is on the ground but has missed the target zone.

We've already described what happens when a blimp is hit. If a blimp wasn't hit, the Gurkha is on the ground and it's time to see whether he's landed in the target zone. The hot spot of the Gurkha picture is checked to see if it's between the two target markers. If it is, the Gurkha made a successful jump, so MadeIt [SR 2] is called. MadeIt calculates the score for the jump. As we mentioned before, this is based on free-fall distance minus target size minus mouse control. Note that negative scores are converted to 0. You can adjust the other constants used to suit yourself, perhaps multiplying everything by a thousand to get suitably arcade-like

scoring! The score for the jump is added to the total score for the game. A "bugle call" is played, and the versatile Announce subprogram is used to print the message "You made it." Control then goes to NextJump.

If the jump wasn't successful, control drops through to a call to Casualty [SR 3]. Casualty subtracts one of the player's lives (just as in the case of hitting a blimp or the ground), makes a sound somewhat like a Bronx cheer, and calls Announce to print "You missed!" Once again we arrive at the NextJump label.

Regardless of which of the three paths was taken, we have now arrived at the label NextJump. This section of code calls UpdateStatus (which we've already discussed) to update the player's score and number of lives. Then, after a delay, the program calls ClearMouse [SR 9], which clears out any leftover mouse events.

The main game loop continues while there are lives left. When the player's last Gurkha is lost, control falls through to the end-of-game section [Main 4]. The Play Again and Instructions menu options are then re-enabled, and the program waits for the player to make a selection. If Play Again is selected, the Play Again and Instructions options are again disabled and control returns to the top of the outermost loop, and a new game is set up.

Now that you've read through all this, take a break. Why not play a game or two of MacGurkha?

Suggestions for MacGurkha

You can do a number of interesting things with MacGurkha for fun and practice. For a start, change the way the Gurkha falls with the chute closed (free-fall) to make it more realistic. Try using a trajectory like that in MacDart: Give the Gurkha the plane's forward speed as his horizontal (x) velocity and use gravity (as in MacDart) for his falling (y) velocity. Because of air resistance, the Gurkha shouldn't continue to accelerate indefinitely, but instead will tend toward a "terminal velocity." You could make this happen by coding a limit for the y velocity or by using a smaller gravity constant than that in MacDart. Experiment!

Wind has an effect on the way a real parachutist falls, especially when the chute is open. You could modify OpenChute to include a randomly generated wind (which would remain constant for the duration of the jump). The wind would have a 50-50 chance of being to the left or the

right side of the screen and would be added as a positive or negative number to the Gurkha's x velocity. The wind speed and direction could be displayed at the bottom of the screen, or you could draw a waving flag to give a visual indication of the wind's direction and speed.

The interaction between the falling Gurkha and the blimps could be modified according to your expectation of how the game should reflect "reality." For example, you might want the Gurkha with an open chute to snag his chute on a guy wire of a balloon *every* time he tried to drift past one, instead of only occasionally. You would have to change the code in CheckBlimp in order to do a more extensive level of *collision detection.* This would slow the program down considerably, which could be offset by the fact that the Gurkha is drifting slowly in the wind. A change in the strategy of the program would be needed, however, since in many cases the landing zone is completely covered by balloons. This would be done by changing SetUpScreen so that balloons would never be drawn within a certain distance from the landing zone, but would not be too far away, since a totally clear landing path wouldn't be too exciting a goal to reach.

You can also, of course, change the way the scoring works. You could have the target zone shrink automatically after each successful jump (say by 10 percent) and the score bonus increase by 10 percent each time. A failed jump would reset the target zone to its normal size.

MacGurkha program listing

```
'*****************************************************************
'                          MacGurkha
'                 Land the Gurkha in the jump zone!
'*****************************************************************

'************************************************** INITIALIZE
  RANDOMIZE TIMER
  DEFINT a-z
  DEFSNG q

  DEF FN ArraySize(xWide,yHigh) = INT(1 + xWide / 16) * (yHigh + 1) + 2

  planeH = 50 : planeV = 23
  DIM airPlane(FN ArraySize(planeH,planeV))
  openH = 23 : openV = 26
  DIM openChute(FN ArraySize(openH,openV))
  closedH = 14 : closedV = 9
  DIM clsChuteP(FN ArraySize(closedH,closedV))

  DIM rec(3), grayPat(3)
  false = 0 : true = NOT false
  maxLives = 5                          'maximum number of lives player gets
  altitude = 5                                    'altitude of plane
  ground = 250                                    'y coordinate of ground
  FOR n = 0 TO 3 : grayPat(n) = &HAA55 : NEXT     'initialize gray pattern

  WINDOW 1, "MacGurkha", (12,32) - (500,330), 2
  GOSUB MakePictures

  MENU 6, 0, 1, "MacGurkha"                       'install MacGurkha menu
  MENU 6, 1, 0, "Play Again"
  MENU 6, 2, 0, "Instructions"
  MENU 6, 3, 0, "-"
  MENU 6, 4, 1, "Quit to BASIC
  MENU 6, 5, 1, "Quit to Desktop"
  ON MENU GOSUB MenuEvent : MENU ON

  GOSUB TitleScreen
  GOSUB Instructions

'************************************************** MAIN PROGRAM
  WHILE true                            'play game until user quits from menu
    lives = maxLives
    jumps = 1 : score = 0
    WHILE lives > 0                                 'loop while lives left
      GOSUB SetupScreen
      points = 0
      qPlaneSpd = (RND(1) * 10) + 2     'sing. precision num for plane speed
      GOSUB FlyPlane
```

INIT 1

INIT 2

MAIN 1

MAIN 2

```
        FOR t = 1 TO 500 : NEXT
        manX = plane                                    'start free-fall from plane location
        manY = altitude + planeV                        'starting y location of paratrooper
        hitBlimp = false : hitGround = false
        GOSUB FreeFall

MAIN 3

        ffDist = manY - altitude                                    'free-fall distance
        mCntrl = 0                                          'amount of mouse control used
        IF NOT (hitBlimp OR hitGround) THEN GOSUB ChuteFall

                                                            'do one of three following events
        IF hitBlimp OR hitGround THEN GOSUB ShowHit : GOTO NextJump
        IF manX + hotX > flag1 AND manX + hotX < flag2 THEN GOSUB MadeIt : GOTO  NextJump
        GOSUB Casualty
NextJump:
        GOSUB UpdateStatus
        FOR t = 1 TO 5000 : NEXT
        GOSUB ClearMouse
      WEND                                                  'while lives left

MAIN 4

      CALL Announce("GAME OVER")
      playAgain = false
      MENU 6, 1, 1                              'enable Play Again and Instructions menu
      MENU 6, 2, 1
      WHILE NOT playAgain : WEND
      MENU 6, 1, 0                              'disable Play Again and Instructions menu
      MENU 6, 2, 0
    WEND

'********************************************** MENU EVENTS
ME 0
MenuEvent:
    MENU 6, 0, 0
    item = MENU(1)
    ON item GOSUB PlayMenu, Instructions, , BasQuit, DeskQuit
    MENU 6, 0, 1
    RETURN

ME 1
PlayMenu:               '_____ user wants to play again
    playAgain = true
    RETURN

ME 2
Instructions:           '_____ display instructions
    WINDOW 2, , (16,55) - (495,325), 2
    PRINT "                     Instructions for MacGurkha"
    PRINT
    PRINT "   Your mission: to bail a Gurkha out of the airplane, avoid the balloon"
    PRINT " obstacles, and guide him into the landing zone between the vertical bars."
    PRINT "   The planes fly across the screen at different speeds.  To nudge the"
    PRINT " Gurkha out of the plane, click the mouse button once.  Since a Gurkha's"
    PRINT " forward momentum depends on the plane's speed, you should eject him"
    PRINT " sooner the faster the plane is travelling."
```

```
    PRINT "    Once your Gurkha is out of the plane and free-falling, you can pop open"
    PRINT " his parachute by clicking the mouse button again.  After the chute is open,"
    PRINT " you can guide the Gurkha by holding down the mouse button and dragging"
    PRINT " the mouse."
    PRINT "    Your score is determined by three factors:  1) The width of the landing"
    PRINT " zone,  2) how close the Gurkha is to the ground when you open his chute, "
    PRINT " and  3) how much you must use the mouse to guide the Gurkha into the "
    PRINT " landing zone.";
    PRINT
    CALL INITCURSOR
    BUTTON 1, 1, "Continue", (190,240) - (280,260)
    WHILE DIALOG(0) <> 1 : WEND
    BUTTON CLOSE 1 : WINDOW CLOSE 2
    CLS
    RETURN

BasQuit:            '_____ quit to BASIC
    MENU RESET
    END

DeskQuit:           '_____ quit to Mac Desktop
    MENU RESET
    SYSTEM

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
ShowHit:            '_____ gurkha hits blimp
    FOR z = 0 TO 5
        SOUND 120, 3, 255 - (50 * z)
    NEXT
    IF hitBlimp THEN CALL Announce("You hit a blimp!")
    IF hitGround THEN CALL Announce("You hit the ground like a rock!")
    lives = lives - 1
    RETURN

MadeIt:             '_____ hurray!  He hit the jump zone!
                     'points are based on FreeFall distance + Zone width - Mouse control
    points = ffDist + 50 - (flag2 - flag1) - mCntrl / 3
    IF points < 0 THEN points = 0
    score = score + points : jumps = jumps + 1
    FOR n = 1 TO 2 : SOUND 440,3 : SOUND 659,6 : NEXT
    CALL Announce("You made it!")
    RETURN

Casualty:           '_____ landed outside of jump zone
    lives = lives - 1
    SOUND 20,20 : CALL Announce("You missed!")
    RETURN

SetupScreen:        '_____ set up screen for new jump run
    LINE (0,0) - (520, ground + 3), 30, bf                    'clear playing field
    plane = 500                                               'starting x-loc of plane
```

ME 3

ME 4

SR 1

SR 2

SR 3

SR 4

```
    flag1 = INT(300 * RND(1)) + 25                          'get x for flag 1
    flag2 = flag1 + INT(50 * RND(1)) + 20                   'get x for flag 2
    LINE (flag1 - 2, ground - 5) - (flag1,ground), , bf     'draw first flag
    LINE (flag2, ground - 5) - (flag2 + 2, ground), , bf    'and second flag
    LINE (1,ground) - (500, ground + 3), , bf               'draw ground
    GOSUB UpdateStatus
    PUT (plane,altitude), airPlane

    FOR n = 1 TO jumps                                      'draw blimps
      obsX = INT(400 * RND(1)) + 1
      obsY = INT((ground - altitude - 65) * RND(1)) + altitude + 25
      rec(0) = obsY + 18 : rec(1) = obsX + 13
      rec(2) = obsY + 23 : rec(3) = obsX + 27
      CALL PAINTRECT(VARPTR(rec(0)))                        'draw blimp gondola

      rec(0) = obsY + 3 : rec(1) = obsX + 33
      rec(2) = obsY + 17 : rec(3) = obsX + 45
      CALL PAINTARC(VARPTR(rec(0)),45,90)                   'fin
      LINE (obsX - 2, obsY + 6) - (obsX - 2, obsY + 12)     'propeller
      PSET (obsX - 1, obsY + 9)
      LINE (obsX + 20, obsY + 10) - (obsX + 20, ground)     'tether

      rec(0) = obsY : rec(1) = obsX                         'and body
      rec(2) = obsY + 20 : rec(3) = obsX + 40
      CALL FILLOVAL(VARPTR(rec(0)), VARPTR(grayPat(0)))
      CALL FRAMEOVAL(VARPTR(rec(0)))
    NEXT
    RETURN

SR 5
FlyPlane:           '_____ fly plane until user presses mouse button
    WHILE MOUSE(0) > -1
      plane = plane - qPlaneSpd
      IF plane < -planeV THEN plane = 500
      PUT (plane, altitude), airPlane                       'draw plane
      SOUND 20 + qPlaneSpd, 1
      PUT (plane, altitude), airPlane                       'then erase it
    WEND
    RETURN

SR 6
FreeFall:           '_____ free fall loop
    hotX = closedH / 2 : hotY = closedV
    PUT (manX,manY), clsChuteP
    WHILE NOT hitBlimp AND MOUSE(0) > -1 AND manY + closedV < ground
      SOUND 3500 - 10 * manY, 1
      PUT (manX, manY), clsChuteP                           'erase old man
      manY = manY + 4                                       'make him fall a little
      drift = INT (3 * RND(1))
                                                            'introduce random-drift factor
      IF RND(1) < .5 THEN manX = manX - drift ELSE manX = manX + drift
      manX = manX - qPlaneSpd : qPlaneSpd = qPlaneSpd * .9
      IF manX < 0 THEN manX = 500
      PUT (manX,manY), clsChuteP                            'draw new man
      GOSUB CheckBlimp
```

```
    WEND
    IF manY + closedV >= ground THEN hitGround = true
    IF NOT (hitBlimp OR hitGround) THEN PUT(manX,manY), clsChuteP
    RETURN

ChuteFall:          '_____ loop for floating open chute                    SR 7
    hotY = openV: hotX = openH / 2
    PUT (manX, manY), openChute                          'draw initial chute
    WHILE manY + hotY < ground AND NOT hitBlimp
      PUT (manX, manY), openChute                        'erase existing chute
                                                         'add mouse control
      IF MOUSE(0) < 0 THEN manX = manX + SGN(MOUSE(1) - manX) * 3: mCntrl = mCntrl + 1

      drift = INT(7 * RND(1))                  'introduce random-drift factor
      IF RND(1) < .5 THEN manX = manX - drift ELSE manX = manX + drift
      manY = manY + 3                                    'go down a little
      IF manX < 0 THEN manX = 500
      PUT (manX, manY), openChute                        'draw new chute
      FOR t = 1 TO 50: NEXT                        'small delay to slow chute
      GOSUB CheckBlimp
    WEND
    RETURN

CheckBlimp:         '_____ check to see if man has hit blimp               SR 8
    IF manY + hotY > ground - 31 THEN RETURN
    IF POINT(manX + hotX, manY + hotY) = 33 THEN hitBlimp = true
    RETURN

ClearMouse:         '_____ clear mouse event queue                         SR 9
    WHILE MOUSE(0) <> 0 : WEND
    RETURN

UpdateStatus:       '_____ update status displays                          SR 10
    CALL MOVETO(320, ground + 20) : PRINT "Points for Jump : " points
    CALL MOVETO(320, ground + 36) : PRINT "      Total Score : " score;
    CALL MOVETO(2, ground + 20) : PRINT "Extra"
    CALL MOVETO(2, ground + 36) : PRINT "Gurkhas";
    FOR n = 1 TO lives - 1
      PUT(55 + n * (openH + 5), ground + 10), openChute, PSET
    NEXT
    IF lives < 1 THEN NoneLeft
    onePast = 55 + lives * (openH + 5)
    LINE(onePast, ground + 10) - (onePast + openH, ground + 10 + openV), 30, bf
NoneLeft:
    RETURN

TitleScreen:        '_____ display title screen                            SR 11
    CLS
    CALL TEXTFONT(0) : CALL TEXTSIZE(36)
    LOCATE 1,1 : PRINT "MacGurkha"
    LOCATE 2,1 : CALL TEXTSIZE(12)
    PRINT "Land in the target zone."
```

```
    pH = 500 : mY = 150
    WHILE pH > 0
      PUT (pH,100) - (pH + 100,150), airPlane
      SOUND 30,1
      IF pH > 300 THEN NoFall
      PUT (pH,mY) - (pH + 20, mY + 20), clsChuteP
      PUT (pH,mY) - (pH + 20, mY + 20), clsChuteP
      mY = mY * 1.03
NoFall:
      PUT (pH,100) - (pH + 100, 150), airPlane
      pH = pH - 10
      IF MOUSE(0) <> 0 THEN pH = -1
    WEND
    RETURN
```

SR 12a

```
MakePictures:          '_____ make picture arrays
                       'if MacGurkha.Graphics exists, read it, else read DATA

    fileHere = true                    ' On error will change to false if not here.
    ON ERROR GOTO FileError                          'set up error trapping
    OPEN "MacGurkha.graphics" FOR INPUT AS #1        'is file present?
    ON ERROR GOTO 0                                  'disable error trapping
    IF NOT fileHere THEN ReadPictures                'no, read from DATA

    CLS                                              'get plane graphics from file
    INPUT #1, byteCount
    image$ = INPUT$(byteCount,1)
    PICTURE(0,0), image$
    GET(0,0) - (planeH - 1, planeV - 1), airPlane
    CLS

    image$ = INPUT$(1,1)                             'get closed chute picture
    INPUT #1, byteCount
    image$ = INPUT$(byteCount,1)
    PICTURE(0,0), image$
    GET (0,0) - (closedH - 1, closedV - 1), clsChuteP
    CLS

    image$ = INPUT$(1,1)                             'get open chute picture
    INPUT #1, byteCount
    image$ = INPUT$(byteCount,1)
    PICTURE(0,0), image$
    GET (0,0) - (openH - 1, openV - 1), openChute
    CLS

    CLOSE 1
    GOTO BuildPictEnd
ReadPictures:          '_____ MacGurkha.Graphics isn't on disk; read from DATA
    RESTORE AirPlaneData : CALL ReadArray(airPlane())
    RESTORE ClsChutePData : CALL ReadArray(clsChuteP())
    RESTORE OpenChuteData : CALL ReadArray(openChute())
BuildPictEnd:
    RETURN
```

SR 12b

```
FileError:              '_____ set FileHere to false if file not found
   IF ERR <> 53 THEN ON ERROR GOTO 0          'unknown error, print and halt
   fileHere = false
   RESUME NEXT
```

SP 1

```
SUB Announce(temp$) STATIC          '_____ display given string
   SHARED altitude
   DIM r(3)
   r(0) = 0 : r(1) = 0 : r(2) = altitude + 20 : r(3) = 500
   CALL ERASERECT(VARPTR(r(0)))
   CALL MOVETO(250-(LEN(temp$) / 2 * 8), altitude + 15)
   PRINT temp$
   ERASE r
   END SUB
```

SP 2

```
SUB ReadArray(array(1)) STATIC          '___read given array from DATA statements
   READ size
   FOR n = LBOUND(array) TO LBOUND(array) + size - 1
      READ num : array(n) = num
   NEXT
   END SUB
```

DAT 1

```
AirPlaneData:           '_____ DATA for airplane picture
DATA 95
DATA 50 , 23

DATA 511, -2, 0, 0, 512, 12, 14, 0, 511, -16
DATA 18, 0, 32, 1024, 18, 0, 16, 10240, 34, 0
DATA -32760, -19968, 66, 0, -32763, -18936, 130, 0, -30750, -1521
DATA -254, 0, -30689, -16, 2, 0, -26752, 0, 2, 0
DATA -28672, 28, 2047, 0, -2176, 127, 2048, -32768, -28672, 28
DATA 2047, 0, -26752, 0, 48, 0, -30689, -1, -64, 0
DATA -30748, 16384, 48, 0, -32766, -32768, 40, 0, -32767, 0
DATA 16, 0, 3, -32768, 0, 0, 4, 16384, 0, 0
DATA 5, 16384, 0, 0, 4, 16384, 0, 0, 3, -32768
DATA 0, 0, 0
```

DAT 2

```
ClsChutePData:          '_____ DATA for closed chute picture
DATA 12
DATA 14 , 9

DATA 8192, 4096, 2168, 28552, -128, 28664, 2056, 4096, 8192, 0
```

DAT 3

```
OpenChuteData:          '_____ DATA for open chute picture
DATA 55
DATA 23 , 26

DATA 254, 0, 853, -32768, 3413, 24576, 5461, 20480, 13653, 22528
DATA 21845, 21504, 21845, 21504, -10923, 22016, -10923, 22016, -1, -512
DATA 16384, 1024, 8192, 2048, 4096, 4096, 2048, 8192, 1040, 16384
DATA 568, -32768, 313, 0, 403, 0, 511, 0, 56, 0
DATA 56, 0, 56, 0, 68, 0, 68, 0, 68, 0
DATA 198, 0, 0
```

MacSpace

Life is tough in today's Space Navy. You've got plush bucket seats, factory air, and a refrigerator crammed with edible and drinkable goodies. Plus, you've got thousands of microdisks filled with the galaxy's best computer games and other entertainment. Trouble is, just when you've settled down for an evening's fun, the blasted Klaxxon alarm goes off and you've got to strap

yourself into the battle console—mouse at the ready—and save the galaxy once again from the implacable Enemy...the Klaxxon Slime Rulers.

How to play MacSpace

When you load MacSpace and choose Start from the Run menu, the title screen shown in Figure 1 appears. After a little action on the title screen, the screen of instructions in Figure 2 comes up. After you've read them, click the Continue button at the bottom of the screen to get on with the action. As you watch, your Mac becomes the viewscreen of a star cruiser looking out into a sky full of stars, as in Figure 3.

Note that the number of enemies shot is shown at the top of the screen, as is the number of photon torpedoes remaining in your tubes (you start with five, and there's no replacement service out where you are!). At the top left of the screen you'll also see a number of little star cruisers representing the number of player ships (that is, "lives") you have left (not counting the one you're currently using). At the start of the game, you have five cruisers: the one whose viewport you're stargazing from, plus the four others shown at the top of the screen.

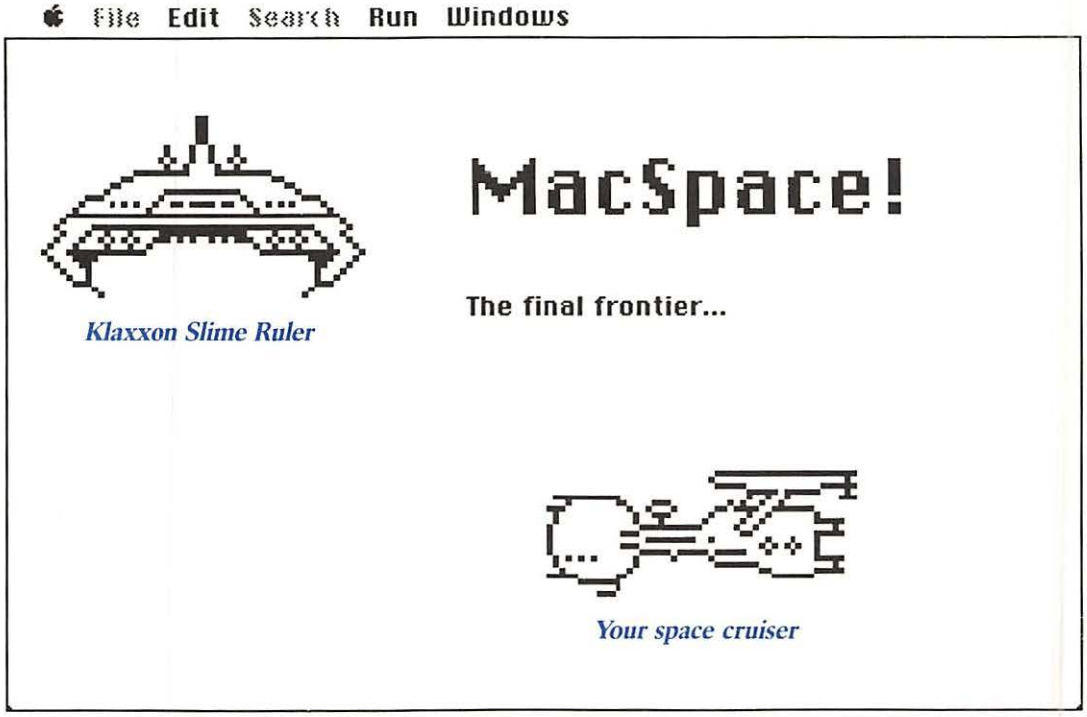


FIGURE 1. *The MacSpace title screen*

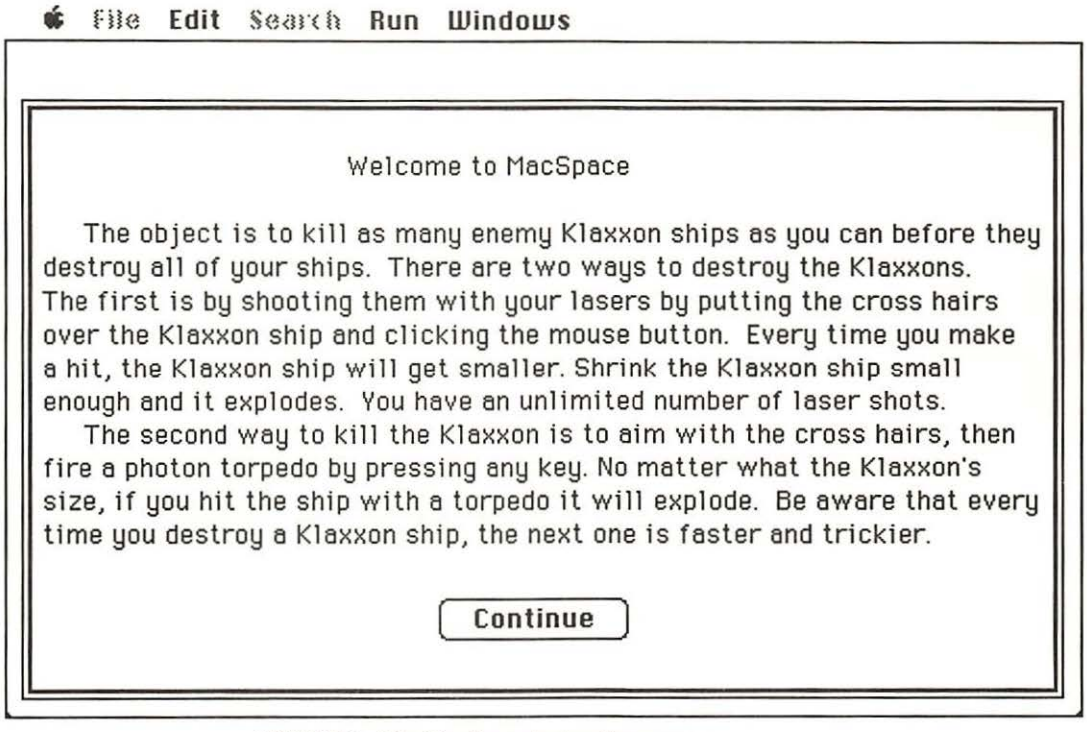


FIGURE 2. *The MacSpace instruction screen*

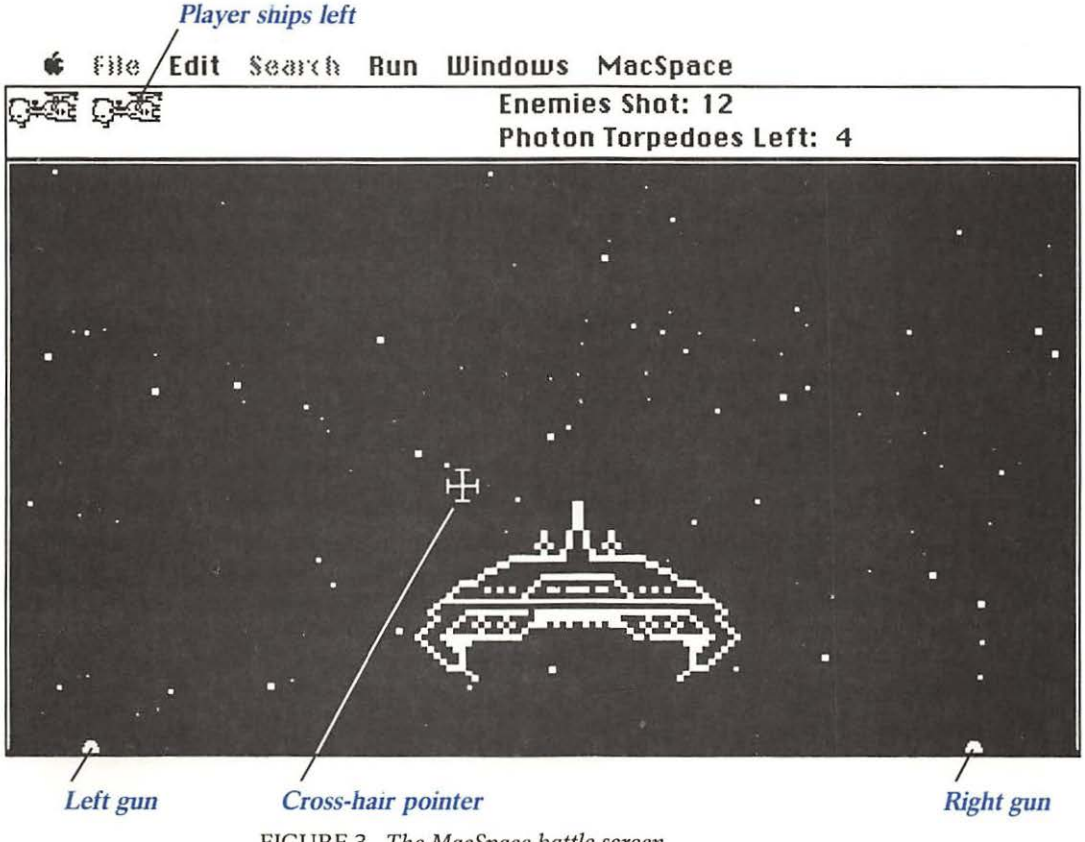


FIGURE 3. *The MacSpace battle screen*

Enemy ships appear one at a time (following the provisions of the Aldebaran Treaty of 2243). As each Klaxxon cruiser approaches, it looms larger and larger in your viewscreen. If the enemy cruiser gets too close, you'll hear a warning sound, and soon the foul Klaxxons are likely to be shooting at you. Confederation scientists haven't figured out how the enemy's weapons work, but you know you've been hit when the whole sky flashes. Every time that happens, you lose a player ship. If you lose all five of your cruisers, the game is over.

Weapons systems

You have two ways of attacking the Klaxxons: lasers and photon torpedoes. You fire the lasers by positioning the cross-hair cursor over the enemy cruiser and then clicking the mouse button to fire. Two beams from your laser guns (which are in the lower left and right corners of the screen) will converge on the target. If you hit the vile Klaxxon cruiser, it shrinks away in cowardly retreat. Repeated hits make the enemy ship retreat farther, but it keeps trying to come closer between shots. Remember that if it gets close enough it can destroy you.

If you make the enemy cruiser go far enough away, it will be destroyed—you'll see it blow up. To ensure that you don't join the ranks of the unemployed, however, a replacement Klaxxon cruiser will be sent your way immediately at no charge to you. It'll appear and approach you from a random location. To make life even more interesting, each new enemy cruiser moves a little faster and gets bigger more quickly than its predecessor. (Isn't it nice to know that you're helping the Klaxxons develop better ships?)

Luckily, you have a second way of combating the slimy forces of evil. If a Klaxxon cruiser is getting big and close and starting to cause serious trouble, you can fire a photon torpedo at the cross-hair location by hitting any keyboard key. When you do, you'll see the two, spike-covered components of the torpedo emerge from the torpedo tubes (which are the same dual-purpose tubes that fire your lasers) and converge on the aiming point. If the torpedo hits, it destroys the enemy cruiser regardless of the ship's size. But don't waste your torpedoes—remember that you've only got five per game!

Battle tactic

As you've probably figured out by now, the object of the game is to destroy as many Klaxxon star cruisers as possible before you run out of ships.

Keep an eye on the top of the screen to note how many player cruisers and photon torpedoes you have left, as well as the number of enemies you have already destroyed.

The best tactic for defeating a slimy Klaxxon is to get the cursor over the enemy cruiser and then click as rapidly as possible, shifting the cursor as necessary to keep the enemy in your sights. Slow shooting just gives the rotten Klaxxons time to recover and grow bigger. As the enemy cruisers get faster, however, there may not be enough time to get the cursor over the Klaxxon ship and keep it there. That's when knowing where to intercept the onrushing enemy cruiser becomes important.

Here's another trick: If you find a big Klaxxon cruiser shooting at you and your cursor is way out of position, fire a photon torpedo anyway. Even though the torpedo will miss, the enemy freezes while it's in flight. You can use that time to get the cursor over the startled Klaxxon and fire lasers or another torpedo at it as soon as the first torpedo has finished its flight. This tactic is wasteful of resources, but it just might save your life.

When the Klaxxon cruisers are relatively slow, an occasional photon torpedo released at the right time can be effective; but as the enemy spaceships get faster, it becomes harder to hit them with the relatively slow-moving torpedoes. You should probably save one or two torpedoes for emergency situations, such as when a Klaxxon has gotten big enough to fill the screen and is shooting at your last ship.

You should also keep in mind another nasty trick the Klaxxons have: When a Klaxxon cruiser comes close enough, it can get in under your viewscreen so that you can't see it or shoot at it. Unfortunately, it can still shoot at you. This doesn't happen too often, but when it does, all you can do is keep the cursor down at the bottom of the screen and shoot when part of the ship pops up.

When you've finished a game, you can pull down the MacSpace menu and choose Play Again. At any time during or after a game, you can choose Quit to BASIC or Quit to Desktop to end the game and return to the selected environment.

How MacSpace works

As you can see in the program outline in Figure 4, after the arrays and constants are initialized, the menu installed, and the mouse interrupt for firing the lasers enabled, the program enters a WHILE...WEND loop and the game action begins. Laser fire is handled by a mouse interrupt. At the end of the game, the Play Again menu option is made available so that the player can play again or quit.

Initialization

define size of graphics and cursor arrays	**Init 1**
set constants for logical variables, screen locations	
create playing window	
initialize special cross hairs cursor	**Init 2**
create and save ship shapes (**MakeShips**)	SR 18
create and save torpedo shape (**MakePhoton**)	SR 17
display title screen (**TitleScreen**)	SR 15
show instructions (**Instructions**)	SR 16
install MacSpace menu, enable menu event-trapping	
enable mouse event-trapping	

Main Program

WHILE true (endless loop interrupted by menu events)	**Main 1**
initialize torpedoes, score, ships	
set target cursor	
draw playing screen (**DrawView**)	SR 12
place initial enemy (**NewEnemy**)	SR 11
WHILE ships left	**Main 2**
handle mouse events, then queue them (**FireLasers**)	SR 6
if key pressed, fire torpedo (**FirePhoton**)	SR 7
calculate enemy's new position (**MoveEnemy**)	SR 2
display enemy's new position (**UpdateEnemy**)	SR 1
if enemy close enough, sound warning (**Warning**)	SR 5
if close enough, randomly determine if enemy fires (**EnemyShot**)	SR 3
WEND	
announce end of game	**Main 3**
wait for menu event to restart game	
WEND	

Menu Events

MenuEvent: branch to appropriate subroutine	**ME 0**
PlayMenu: set flag for playing again	**ME 1**
BasQuit: quit to BASIC	**ME 2**
DeskQuit: quit to Mac Desktop	**ME 3**

Subroutines

UpdateEnemy: update enemy's location on screen	**SR 1**
MoveEnemy: calculate where enemy should be next	**SR 2**
EnemyShot:	**SR 3**
do sound effect	
determine if enemy scores a hit	
if so, remove player's ship (**PlayerKilled**)	SR 4
PlayerKilled:	**SR 4**
flash entire window, do sound effect	
subtract a life (**DrawExtra**)	SP 1

(continued)

FIGURE 4. *Program outline*

Warning: do sound effect for enemy too close	**SR 5**
FireLasers:	**SR 6**
if laser hits, make enemy smaller (**CheckHit, UpdateEnemy**)	SR 8, 1
if enemy small enough, destroy it and replace (**EnemyKilled**)	SR 9
FirePhoton:	**SR 7**
get current pointer coordinates	
if no torpedoes left, do sound effect and return	
calculate path of torpedoes, animate them, do sound effect	
check for torpedo hit (**CheckHit**)	SR 8
if so, destroy enemy (**EnemyKilled**)	SR 9
display number of torpedoes left (**UpdatePhotons**)	SR 14
CheckHit: determine if pointer is at location of enemy	**SR 8**
EnemyKilled:	**SR 9**
increment score	
explode enemy (**ExplodeEnemy**)	SR 10
show new score (**UpdateScore**)	SR 13
place new enemy (**NewEnemy**)	SR 11
ExplodeEnemy:	**SR 10**
invert oval around enemy	
make four expanding circles, do sound effect	
restore enemy to original condition and erase it	
NewEnemy:	**SR 11**
generate random location for enemy ship	
each new enemy grows and moves faster	
establish initial direction	
DrawView:	**SR 12**
display ships remaining (**DrawExtra**)	SP 1
display enemy ships destroyed, torpedoes remaining	
draw black sky, fill with stars	
UpdateScore: display updated score	**SR 13**
UpdatePhotons: display number of torpedoes remaining	**SR 14**
TitleScreen: draw title screen	**SR 15**
Instructions: display initial instructions	**SR 16**
MakePhoton: create and save shape of photon torpedo	**SR 17**
MakeShips:	**SR 18**
load shapes from disk, or read from arrays (**ReadArray**)	SP 2
Subprograms	
DrawExtra: draw or erase one of player's ships	**SP 1**
ReadArray: read graphics array from DATA statements	**SP 2**

Figure 4. Program outline (continued)

Now let's take a look at the structure and operation of the program in more detail.

Initialization and constants

First, arrays are dimensioned [Init 1] and constants are assigned their values. Note here the use of DEFINT and DEFSNG. These statements set all the variables to integer, except for variables starting with a *q*, which will be single precision. Next, the coordinates of the combination laser guns/photon torpedo tubes and the screen boundaries are initialized. The WINDOW statement sets the boundaries of the Output window. Other constants give the number of stars, player ships, photon torpedoes, factors used in determining hits, and the aspect ratio (ratio of height to width) for drawing the Klaxxon ship.

Since this is a "shoot 'em up" game, the program initializes a new cross-hair gunsight cursor in [Init 2] by using two FOR...NEXT loops and some additional statements that put bit patterns into the array *crossHairs*. The mask for this cursor (in elements 17 through 32 of the *crossHairs* array) is set to 0 so the screen pixels under the cursor will be inverted. This will display the cursor as white against the black background. The "hot spot"—the part of the cursor that will be read as the actual cursor location—is set to the center (8,8) of the cross hairs. This is where the gunsight will be aiming when the mouse button is pressed. The actual creation of the new cursor from the initialized pattern will be done when the main game loop begins. (You could change this section to allow use of cursors created with MacCursor.)

GETting the picture

The code at [Init 3] supplies needed bit-mapped picture data to the arrays for the images of the enemy and player ships and the photon torpedo. It begins by calling MakeShips [SR 18]. This subroutine first checks the disk for a file named *MacSpace.graphics*. If you have created your own custom graphics for MacSpace, they should be in this file. (The MacInterface chapter contains complete instructions for creating graphics in MacPaint and using them in our games and your own BASIC programs, and includes an example of alternate ships for MacSpace.)

After setting up an ON ERROR GOTO statement to trap file errors, the program attempts to open the graphics file. If an error is found, control goes to FileError [SR 18c]. The most likely error that can occur is File Not Found, which has a code number of 53 (see Appendix B of the

BASIC manual for a complete list of error messages and codes). If this error turns up, it means that the *MacSpace.graphics* file is not on the disk. If any other kind of error is found, the program halts. If the file isn't present, the *fileHere* flag is set to *false*.

If the file was found, the encoded QuickDraw graphics commands for the picture of the enemy star cruiser are read into the string-variable *image$*. The PICTURE statement is used to execute these graphics commands and draw the picture on the screen. The GET statement then reads the picture from the screen and stores it in the array *ePict*. The same procedure is followed for obtaining the picture of the player ship, which ends up in the array *pPict*.

Because the GET statement stores a picture as an array of bits, and the PUT statement will be used later to transfer the bits directly to the screen, fast animation becomes feasible. These statements draw graphics much more quickly than is possible with a series of BASIC graphics statements, or even the PICTURE statement with a string.

If the file is not found, *fileHere* is set to *false* and ReadPictures [SR 18b] calls the general-purpose subprogram ReadArray [SP 2] to read the numbers defining the screen bit image directly into the appropriate arrays. We provide this method of getting the pictures so you can just type the program and run it without having to create special graphics.

The player's star cruiser will merely make a cameo appearance on the title screen and will then be used at the top of the playing screen to indicate the number of ships the player has left during play. The only objects representing the player on the main screen are the view window, the cross-hair cursor, and the guns.

After MakeShips finishes, the code at [Init 3] calls a second subroutine, MakePhoton [SR 17]. This subroutine uses the QuickDraw PaintOval routine to draw the torpedo body, with the two LINE statements providing the four "spikes" protruding from the torpedo. Again, a GET statement stores this picture from the screen to an array, *photonPict*.

The program next takes care of drawing the title screen by calling two more subroutines. The first, TitleScreen [SR 15], includes a simulated battle sequence resulting in the destruction of the enemy ship. The laser fire is animated by the FOR...NEXT loop, which READs the end points for the lines of the laser beams from DATA statements and gives the effect of fire homing in on the Klaxxon cruiser. The second subroutine, ExplodeEnemy [SR 10], then blows up the enemy. After a short delay, [Main 3] calls the second subroutine, Instructions [SR 16], which displays the onscreen instructions for playing the game.

Next, the MacSpace menu is installed. The MENU statements title the menu and create three possible options: Play Again, Quit to BASIC, and Quit to Desktop. The ON MENU GOSUB statement causes all menu choices to call MenuEvent [ME 0]. This subroutine first makes the whole menu *inactive* (the last 0 in the MENU statement does this). It's important to make a menu inactive while a menu event is being handled so the user can't make conflicting choices, such as choosing an item repeatedly because "nothing has happened yet." Similarly, particular menu items should be deactivated when they would be inappropriate selections. For example, before play begins, the menu is active but the option Play Again is inactive (note that last 0). After all, you can't "play again" when you haven't played at all yet. The two quit options (Quit to BASIC and Quit to Desktop) will always be active when the menu itself is active, since the player might want to quit at any time, even in the course of play.

MenuEvent gets the numeric value of the selection from the MENU function (with a parameter of 1) and assigns the selection number to *item*. The *ON* item GOSUB statement then calls the appropriate subroutine to perform the action requested.

Events and interrupts: Keys to game design

An *interrupt* is an action that suspends whatever process is going on at the time of interruption and sends control to a specified part of the code (usually a subroutine). An *event* is an action that the system treats as a request for an interrupt. The Macintosh handles three main kinds of interrupts:

- Menu interrupts: The user has chosen an active item from an active menu.
- Dialog interrupts: The user has clicked a button in a dialog window, changed edit fields, or done something with a window.
- Mouse interrupts: The user is performing some sort of action with the mouse button (single- or double-clicking, dragging, and so on).

BASIC provides an ON [*event*] GOSUB statement to send control to a "handler" subroutine when the appropriate event occurs. (The actual statements would be ON MENU GOSUB, ON MOUSE GOSUB, and so on.) The handler subroutine then uses the appropriate function to determine exactly what kind of selection was made (whether the mouse button was single- or double-clicked, for example). A further ON...GOSUB is usually used to actually perform the action requested. We just saw an example of this structure in our MacSpace menu.

Just before the game action begins in [Init 3], an ON MOUSE GOSUB statement specifies that FireLasers [SR 6] be called if the mouse button is pressed. Since this is the only button press processed in this game, we don't need an intermediate handling routine to sort out what has happened. But are you wondering why we have set up an interrupt rather than just using an IF...THEN statement in the main game loop to check whether the button was pushed?

The use of an interrupt is crucial for fast games that have a number of statements being executed in the main game loop. If we simply "poll" the mouse button (check it once in a while) with an *IF MOUSE(0)* statement, looking for a 1 to be returned indicating that the button was clicked, the program can't respond to the player's pushing the mouse button *until the loop comes around to the IF statement*—which might be a while. In the meantime, the enemy is still moving and the game situation continuing to change. The ON MOUSE GOSUB statement sets up the program to "invisibly" and constantly check the mouse button, thereby guaranteeing that wherever the program is in the loop, a mouse click will bring instant response—which is what you'd expect from a laser gun. With the polling approach, you might get an agonizing delay before the gun is fired. The photon torpedo, on the other hand, is activated by an IF statement that finds when a key has been pressed. Since photon torpedoes are used relatively rarely, and are traditionally slower than lasers anyway, an interrupt is not needed here. A good general rule for designing interactive games is to use an interrupt when response to player input must be immediate, regardless of what's going on at the time. It's also useful when you don't want a loop to be slowed down by polling the mouse; for example, when a loop generates a musical tone.

The main program loop

We now come to the heart of the program [Main]. The number of photon torpedoes and the total number of ships allotted to the player is set to the maximum values specified in the constants *maxPhotons* and *maxShips*. The SETCURSOR statement turns the cursor into the cross-hair shape that was defined in the array *crossHairs*. The view of space as seen from the player's starship viewscreen is created by a call to DrawView [SR 12]. This subroutine first calls DrawExtra [SP 1] to draw the four player ships in reserve. The strings Enemies Shot: and Photon Torpedoes Left: are printed to set up the "scoreboard" at the top of the screen, and the UpdateScore [SR 13] and UpdatePhotons [SR 14] subroutines are called to provide the starting values of 0 and 5, respectively.

The LINE statement with the *bf* option fills the entire window with the black void of space. Since we want objects drawn as white against this black background, a pen transfer mode of XOR (exclusive OR) is used for drawing. This has the desired effect of inverting objects and making them white on black.

The two guns are drawn by setting up temporary rectangles around their coordinates and using calls to the QuickDraw PAINTOVAL routine to draw the gun tubes. Finally, a sky full of stars with random coordinates and sizes ranging from 1 to 3 pixels in diameter is created. After returning from DrawView, the outer loop in the main program calls NewEnemy [SR 11], which draws an enemy ship with a random position and direction, but heading toward the player's ship.

An inner WHILE...WEND loop [Main 2] now resolves the battles between the player and successive Klaxxon ships. As the enemy cruiser approaches, BASIC automatically checks for a mouse interrupt and calls the FireLasers [SR 6] if one occurs. The MOUSE STOP statement following MOUSE ON prevents FireLasers from being executed in the middle of the graphics-initialization stage, which would interfere with the graphics. MOUSE STOP records any mouse event but suspends execution of the appropriate GOSUB until the next time MOUSE ON is executed back at the top of the inner loop. This gives us the benefit of interrupts—being always able to detect player activity—without having to deal with possible interference between an interrupt and another routine that is executing when the interrupt is detected.

If there *is* a button press, FireLasers [SR 6] then gets the current mouse-pointer (x,y) coordinates (more precisely, the coordinates of the defined hot spot at the center of the cross hairs) using the MOUSE(1) and MOUSE(2) functions and then draws lines representing laser fire from the fixed gun coordinates (*gun1X,gun1Y*), and (*gun2X,gun2Y*) to this spot, using calls to the QuickDraw MOVETO and LINETO routines. FireLasers then calls CheckHit [SR 8] to check whether the hot spot is within the last recorded boundaries of the Klaxxon spaceship: If so, a hit was made. In this case, FireLasers makes the enemy ship smaller by the current value of *eSizeDec*. It then calls UpdateEnemy to show the new, more compact model of Klaxxon star cruiser. FireLasers then checks the new size of the enemy; if it's less than the value *eHitSize*, the enemy has been destroyed (we'll see how this works in a moment).

Next in the loop, INKEY$ peeks at the keyboard buffer. If the returned string is anything other than a null string, a key has been pressed.

A photon torpedo will therefore be fired (via FirePhoton [SR 7]), assuming there's at least one torpedo left in the player's arsenal.

FirePhoton [SR 7] works in a similar way. The current mouse x and y coordinates are obtained, and the supply of torpedoes is checked. If there aren't any left, a "plinking" sound tells the player so, and the subroutine is exited. Otherwise, the number of photon torpedoes is reduced by one. Next, the slopes from the gun coordinates to the hot spot are calculated, and the little shapes representing the torpedo are animated (drawn, erased, and redrawn) along these slopes, giving the effect of the torpedo moving toward the target. CheckHit [SR 8] is then called, and if the enemy spaceship is hit it is destroyed via EnemyKilled [SR 9]. Whether the player hits or misses, UpdatePhotons [SR 14] is called to display the number of photon torpedoes remaining.

If either FireLasers or FirePhoton results in the enemy being destroyed, EnemyKilled [SR 9] is called. This subroutine adds one to the total of enemy ships destroyed and then calls ExplodeEnemy [SR 10], which creates the explosion by first using the QuickDraw INVERTOVAL routine to invert the enemy ship and then FRAMEOVAL to make the four expanding circles that represent the explosion. The hapless Klaxxon is erased, and we then return to EnemyKilled.

EnemyKilled next calls UpdateScore [SR 13], which simply displays the new score. Finally, NewEnemy [SR 11] is called, and a new enemy ship is set up with a random starting location and direction (there is an endless supply of enemy ships). To keep the game interesting, the variables *eSizeInc* and *eMoveInc* are increased by a fixed amount so that the new enemy ship will both move faster and get bigger faster than previous ships. Since *eSizeDec* (the amount by which the ship "shrinks" when hit) is inversely proportional to *eSizeInc*, the number of laser hits needed to destroy the enemy ship at a given size decreases during the game, to compensate a little for the added difficulty of hitting the target.

After checking for and resolving the player's attacks, the inner play loop moves the enemy ship with MoveEnemy [SR 2] and updates its position with UpdateEnemy [SR 1]. The enemy ship is "jumped" rather than smoothly animated. (Perhaps the Klaxxons discovered that they lost fewer ships if they installed a computer-controlled miniwarp drive along with their impulse engines to make their course less predictable.) If the previous Klaxxon ship was destroyed by the player's fearless bombardment, this will be the replacement enemy ship. The size of the enemy spaceship is then checked; if it is large enough, Warning [SR 5] is called and a warning sound is made to alert the player.

Once the Klaxxon ship is close enough for the warning to be sounded, there is a chance that it will fire at the player. This chance is determined by the variable *qEFireProb*. Enemy fire is handled by EnemyShot [SR 3], and the chance of a hit is controlled by the variable *qEHitProb* in that subroutine (remember, we've defined variables beginning with *q* to be single precision). If the player is hit, PlayerKilled [SR 4] flashes the whole window by inverting it (the graphics aren't erased, just inverted), produces an accompanying sound (a downward sweep of notes), and reduces the count of remaining player cruisers by one. In this case, DrawExtra draws a number of ship symbols at the top of the screen equal to the number of player ships remaining.

We now return to the top of the inner game loop. If the player's last ship has been destroyed, control falls into the bottom of the outer loop [Main 3]. There, the cursor is changed back into the standard arrow pointer, and the *playAgain* flag is set to *false*. The MacSpace menu is activated (note the last 1 in the MENU statement) and a WHILE...WEND loop waits for a menu interrupt, which at this point can be a selection of Play Again or one of the two quit options. If Play Again is selected, PlayMenu [ME 1] is called. The PlayMenu routine simply sets *playAgain* to *true*. Then the WHILE...WEND loop is exited, control returns to the top of the main loop, and another round of play with a full supply of player ships and photon torpedoes is set up.

Suggestions for MacSpace

Readers who have designed arcade-type games for other machines will notice one task this program *doesn't* have to do: update the player's gunsight position and redraw it as it is moved. This task is avoided because the gunsight is just our everyday Mac mouse pointer in disguise, and its display is taken care of by the system as usual without any programmer effort being needed. On most other systems you would have to read joystick or paddle coordinates, possibly convert them to the correct screen coordinates, and erase and redraw the gunsight. You would probably have timing problems as well, caused by the unavailability of interrupts.

We've already discussed how the judicious use of interrupts enables us to be constantly aware of player actions and control the timing of the program's response. MacSpace illustrates how the use of interrupts and powerful graphics routines makes it much easier to write interactive games in the Macintosh environment.

The following are some suggestions for customizing MacSpace. First, the chance of an enemy shot hitting the player doesn't vary with distance. To make the game a bit more realistic, you could have EnemyShot check the current size of the Klaxxon ship (as an indication of relative distance) and increase the chance of its hitting the player as the enemy cruiser gets bigger (and thus closer). You could also randomize the number of player ships and/or photon torpedoes. As an even more ambitious modification, you could have the program create and manage several enemy ships at once. You could also provide some new and more fiendish weapons for the Klaxxon demons if you find that the game's getting too easy. For example, you could design enemy torpedoes that can hit your ship (represented by the cursor position) and have a chance of disabling your laser guns or photon torpedo tubes or blanking out the viewscreen for a random number of seconds.

Finally, really amazing effects could be created by using MacAnimate to create an animated sequence of images to use when the Klaxxon is blown up. Laser hits could be represented by debris flying off the affected part of the ship, and a torpedo hit by total destruction of the craft by blowing it to smithereens!

MacSpace program listing

```
'* * * *
```

```
  GOSUB TitleScreen                                    'draw title screen
  FOR t = 1 TO 5000 : NEXT
  GOSUB Instructions

  MENU 6, 0, 1, "MacSpace"                             'install MacSpace menu
  MENU 6, 1, 0, "Play Again"
  MENU 6, 2, 0, "-"
  MENU 6, 3, 1, "Quit to BASIC
  MENU 6, 4, 1, "Quit to Desktop"
  ON MENU GOSUB MenuEvent : MENU ON
  ON MOUSE GOSUB FireLasers                    'all mouse events call FireLasers

'********************************************************* MAIN PROGRAM
  WHILE true                                                          MAIN 1
    photonsLeft = maxPhotons
    ships = maxShips : score = 0
    eSizeInc = 0 : eMoveInc = 0
    SETCURSOR(VARPTR(crossHairs(1)))                  'make cursor a cross hairs
    GOSUB DrawView                                          'draw player's view
    GOSUB NewEnemy                                          'place initial enemy

    WHILE ships <> 0                                  'loop while player has ships left   MAIN 2
      MOUSE ON : MOUSE STOP                      'handle and then queue mouse events
      IF INKEY$ <> "" THEN GOSUB FirePhoton
      GOSUB MoveEnemy
      GOSUB UpdateEnemy
      IF eSize > 50 AND eSize - eSizeInc < 55 THEN GOSUB Warning
      IF eSize > 50 AND RND(1) < qEFireProb THEN GOSUB EnemyShot
    WEND

    CALL INITCURSOR                                   'out of ships, this game over   MAIN 3
    CALL TEXTMODE(3) : CALL TEXTSIZE(24) : CALL TEXTFACE(9)
    CALL MOVETO(120,140) : PRINT "END OF BATTLE"
    CALL TEXTMODE(0) : CALL TEXTSIZE(12) : CALL TEXTFACE(0)
    playAgain = false
    MENU 6, 1, 1                                      'enable Play Again menu item
    WHILE NOT playAgain : WEND                        'loop until menu interrupt
    MENU 6, 1, 0                                      'disable Play Again
  WEND

'********************************************************* MENU EVENTS
MenuEvent:                                                            ME 0
  MENU 6, 0, 0
  item = MENU(1)
  ON item GOSUB PlayMenu, , BasQuit, DeskQuit
  MENU 6, 0, 1
  RETURN

PlayMenu:          '_____________________________ user has chosen to play again   ME 1
  playAgain = true
  RETURN
```

ME 2
```
BasQuit:                '_____ user wants to quit to BASIC
  WINDOW CLOSE 1
  MENU RESET
  END
```

ME 3
```
DeskQuit:               '_____ quit to Mac Desktop
  MENU RESET
  SYSTEM
```

```
'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBROUTINES
```

SR 1
```
UpdateEnemy:            '_____ update enemy's location on screen
  endX = enemyX + eSize : endY = enemyY + INT(eSize * qEAspect)
  PUT(oldX,oldY) - (oldEndX,oldEndY), ePict                    'place new enemy,
  PUT(enemyX,enemyY) - (endX,endY), ePict                      'and erase old
  oldX = enemyX : oldY = enemyY : oldEndX = endX : oldEndY = endY
  RETURN
```

SR 2
```
MoveEnemy:              _____ calculate where enemy should be next
  enemyX = enemyX + eMoveInc * eXDir
  enemyY = enemyY + eMoveInc * eYDir
  IF enemyX < 1 OR enemyX > 400 THEN eXDir = eXDir * -1 : enemyX = oldX
  IF enemyY < scrnTop OR enemyY > 300 THEN eYDir = eYDir * -1 : enemyY = oldY
  eSize = eSize + eSizeInc                                     'change enemy's size
  RETURN
```

SR 3
```
EnemyShot:              '_____ enemy fires a shot!
  enemyShots = enemyShots + 1
  FOR n = 1 TO 3
    SOUND 10000,1 : SOUND 9000,1 : SOUND 8000,1
  NEXT
  IF RND(1) < qEHitProb THEN GOSUB PlayerKilled                'probability of hit
  RETURN
```

SR 4
```
PlayerKilled:           '_____ player has been hit and killed
  FOR n = 1 TO 4                                               'flash entire window
    FOR n = 2000 TO 1000 STEP -100 : SOUND n,.5 : NEXT
    CALL INVERTRECT(VARPTR(viewRect(1)))
    FOR t = 1 TO 100 : NEXT
    CALL INVERTRECT(VARPTR(viewRect(1)))
    FOR t = 1 TO 100 : NEXT
  NEXT
  ships = ships - 1 : eSize = 5
  CALL DrawExtra(ships - 1)
  RETURN
```

SR 5
```
Warning:                '_____ sound warning, enemy is getting close
  FOR n = 1 TO 4 : SOUND 200,1 : SOUND 100,1 : NEXT
  RETURN
```

SR 6

```
FireLasers:          '_____ mouse events come here: fire laser
  test = MOUSE(0)                    'do this to set mouse x and y coords
  mouseX = MOUSE(1) : mouseY = MOUSE(2)          'get mouse x and y coords
  IF mouseY < scrnTop THEN mouseY = scrnTop
  SOUND 8000,2
  CALL PENMODE(penXor)
  CALL MOVETO(gun1X,gun1Y) : CALL LINETO(mouseX,mouseY)          'draw two
  CALL MOVETO(gun2X,gun2Y) : CALL LINETO(mouseX,mouseY)          'lines...
  CALL MOVETO(gun1X,gun1Y) : CALL LINETO(mouseX,mouseY)          'erase two
  CALL MOVETO(gun2X,gun2Y) : CALL LINETO(mouseX,mouseY)          'lines
  CALL PENMODE(penCopy)
  GOSUB CheckHit                                    'pointer on enemy?
  IF NOT hit THEN LMiss                          'nope, better luck next time
  SOUND 50, 3
  eSize = eSize - eSizeDec                                   'yes, make
  IF eSize < 0 THEN eSize = 5                              'enemy smaller
  GOSUB UpdateEnemy
  IF eSize < eHitSize THEN GOSUB EnemyKilled          'hit if enemy small enough
LMiss:
  RETURN
```

SR 7

```
FirePhoton:          '_____ fire photon torpedoes!
  test = MOUSE(0)                          'get current pointer coordinates
  mouseX = MOUSE(1) : mouseY = MOUSE(2)
                          'if no more photons then you can't fire them
  IF photonsLeft = 0 THEN SOUND 5000,1 : SOUND 6000,1 : RETURN
  photonsLeft = photonsLeft - 1
  x1 = gun1X : y1 = gun1Y : x2 = gun2X : y2 = gun2Y
  xInc1 = INT((mouseX - gun1X) / fSteps)          'calculate slope of
  yInc1 = INT((mouseY - gun1Y) / fSteps)                'laser path
  xInc2 = INT((mouseX - gun2X) / fSteps)
  yInc2 = INT((mouseY - gun2Y) / fSteps)
  FOR inc = 1 TO fSteps                                 'and follow path
    x1 = x1 + xInc1 : x2 = x2 + xInc2
    y1 = y1 + yInc1 : y2 = y2 + yInc2
    SOUND (fSteps - inc) * 500, .5
    PUT (x1,y1) - (x1 + 16, y1 + 16), photonPict
    PUT (x2,y2) - (x2 + 16, y2 + 16), photonPict
    PUT (x1,y1) - (x1 + 16, y1 + 16), photonPict
    PUT (x2,y2) - (x2 + 16, y2 + 16), photonPict
  NEXT inc
  GOSUB CheckHit                          'no matter what enemy size,
  IF hit THEN GOSUB EnemyKilled           'if a hit then enemy is dead
  GOSUB UpdatePhotons
  RETURN
```

SR 8

```
CheckHit:            '_____ is current pointer position on top of enemy?
  hit = true                                      'return hit = true if it is
  IF mouseX<oldX OR mouseX>oldEndX OR mouseY<oldY OR mouseY>oldEndY THEN hit = false
  RETURN
```

SR 9

```
EnemyKilled:          '_____ direct hit on enemy!
  score = score + 1
  GOSUB ExplodeEnemy
  GOSUB UpdateScore
  GOSUB NewEnemy                                  'and make new one
  RETURN
```

SR 10

```
ExplodeEnemy:         '_____ show enemy exploding
  t1Rect(1) = oldY - 10 : t1Rect(2) = oldX - 10   'set rect to surround
  t1Rect(3) = oldEndY + 10 : t1Rect(4) = oldEndX + 10   'enemy
  CALL INVERTOVAL(VARPTR(t1Rect(1)))              'invert enemy
  CALL PENMODE(penXor)
  FOR n = 1 TO 4                                  'then make 4 expanding circles
    SOUND 1000,1
    t1Rect(1) = t1Rect(1) -10 : t1Rect(2) = t1Rect(2) - 10
    t1Rect(3) = t1Rect(3) +10 : t1Rect(4) = t1Rect(4) + 10
    CALL FRAMEOVAL(VARPTR(t1Rect(1)))
    SOUND 1000,1
    CALL FRAMEOVAL(VARPTR(t1Rect(1)))
  NEXT
  CALL PENNORMAL
  t1Rect(1) = oldY - 10 : t1Rect(2) = oldX - 10   'restore enemy
  t1Rect(3) = oldEndY + 10 : t1Rect(4) = oldEndX + 10   'to what it was originally
  CALL INVERTOVAL(VARPTR(t1Rect(1)))
  PUT(oldX,oldY) - (oldEndX,oldEndY), ePict       'and erase it
  RETURN
```

SR 11

```
NewEnemy:             '_____ screen just has stars; place enemy somewhere
  enemyX = INT((350) * RND(1))                    'generate random
  enemyY = INT((250 - scrnTop) * RND(1) + scrnTop)   '(x,y) coordinates,
  eSize = 10                                      'enemy size always starts out same
  oldX = enemyX : oldY = enemyY
  oldEndX = oldX + eSize : oldEndY = oldY + eSize * qEAspect
  PUT (oldX,oldY) - (oldEndX,oldEndY), ePict      'draw initial enemy

  eSizeInc = eSizeInc + 1                         'each new enemy grows and moves faster
  eSizeDec = eSizeInc * 4
  eMoveInc = eMoveInc + 1

  IF RND(1) < .5 THEN eXDir = -1 ELSE eXDir = 1   'set direction he is moving
  IF RND(1) < .5 THEN eYDir = -1 ELSE eYDir = 1
  RETURN
```

SR 12

```
DrawView:             '_____ draw player's viewing screen
  CLS
  PENNORMAL
  FOR n = 1 TO ships - 1
    CALL DrawExtra(n - 1)
  NEXT
```

```
    CALL TEXTFONT(0)
    LOCATE 1,30 : PRINT "Enemies Shot: "
    LOCATE 2,30 : PRINT "Photon Torpedoes Left:"
    GOSUB UpdateScore
    GOSUB UpdatePhotons
    LINE(0, scrnTop - 2) - (520, scrnTop - 1), , bf
    CALL FRAMERECT(VARPTR(viewRect(1)))
    CALL INVERTRECT(VARPTR(viewRect(1)))
    CALL PENMODE(penXor)
    t1Rect(1) = gun1Y - 5 : t1Rect(2) = gun1X - 4                    'show two guns
    t1Rect(3) = gun1Y + 5 : t1Rect(4) = gun1X + 4
    CALL PAINTOVAL(VARPTR(t1Rect(1)))
    t1Rect(1) = gun2Y - 5 : t1Rect(2) = gun2X - 4
    t1Rect(3) = gun2Y + 5 : t1Rect(4) = gun2X + 4
    CALL PAINTOVAL(VARPTR(t1Rect(1)))

    FOR n = 1 TO stars                                               'draw stars in sky
      starX = INT((500) * RND(1))                                    'generate random
      starY = INT((290 - scrnTop) * RND(1) + scrnTop + 1)            '(x,y) coordinates,
      starR = INT(3 * RND(1) + 1)                                    'and size from 1 to 3
      t1Rect(1) = starY : t1Rect(3) = starY + starR                  'set up rectangle
      t1Rect(2) = starX : t1Rect(4) = starX + starR
      PAINTOVAL(VARPTR(t1Rect(1)))                                   'and paint it
      SOUND (starX + starY) * 15, .25
    NEXT
    CALL PENNORMAL
    RETURN

UpdateScore:          '_____________________________ display updated score
    LOCATE 1,42 : WRITE score
    RETURN

UpdatePhotons:        '_____________________________ update number of photons left
    LOCATE 2,50 : WRITE photonsLeft
    RETURN

TitleScreen:          '_____________________________ draw title screen
    CLS
    oldX = 10 : oldY = 30 : oldEndX = oldX + 165 : oldEndY = oldY + 165 * qEAspect
    PUT(oldX,oldY) - (oldEndX,oldEndY), ePict                        'place large enemy
    PUT(250,200) - (415,275), pPict                                  'and player ship
    TEXTFONT(0) : TEXTSIZE(36)                                       'draw title
    LOCATE 2,10 : PRINT "MacSpace!"
    LOCATE 3,10 : TEXTSIZE(12)
    PRINT "The final frontier..."

    CALL PENMODE(penXor)                                             'animate player
    CALL PENSIZE(3,3)                                                'firing at enemy
    RESTORE GunPoints
```

SR 13

SR 14

SR 15

```
  FOR n = 1 TO 4
    READ ex, ey                                          'read endpoints
    SOUND 8000,2
    CALL MOVETO(253,235) : CALL LINETO(ex,ey)            'draw two
    CALL MOVETO(280,215) : CALL LINETO(ex,ey)            'lines...
    CALL MOVETO(253,235) : CALL LINETO(ex,ey)            'erase two
    CALL MOVETO(280,215) : CALL LINETO(ex,ey)            'lines
    FOR t = 1 TO 1000 : NEXT
  NEXT
  CALL PENMODE(penCopy)
  GOSUB ExplodeEnemy                                     'blow up enemy
  RETURN
```

SR 16

```
Instructions:          '_____ show user some instructions
  WINDOW 2, , (16,55) - (495,325), 2
  PRINT
  PRINT "                    Welcome to MacSpace"
  PRINT
  PRINT "    The object is to kill as many enemy Klaxxon ships as you can before they"
  PRINT "destroy all of your ships.  There are two ways to destroy the Klaxxons."
  PRINT "The first is by shooting them with your lasers by putting the cross hairs"
  PRINT "over the Klaxxon ship and clicking the mouse button.  Every time you make"
  PRINT "a hit, the Klaxxon ship will get smaller. Shrink the Klaxxon ship small"
  PRINT "enough and it explodes.  You have an unlimited number of laser shots."
  PRINT "    The second way to kill the Klaxxon is to aim with the cross hairs, then "
  PRINT "fire a photon torpedo by pressing any key. No matter what the Klaxxon's"
  PRINT "size, if you hit the ship with a torpedo it will explode.  Be aware that every"
  PRINT "time you destroy a Klaxxon ship, the next one is faster and trickier."
  PRINT
  CALL INITCURSOR
  BUTTON 1, 1, "Continue", (190,230) - (280,250)
  WHILE DIALOG(0) <> 1 : WEND
  BUTTON CLOSE 1 : WINDOW CLOSE 2
  RETURN
```

SR 17

```
MakePhoton:            '_____ build picture of photon torpedo
  CLS
  t1Rect(1) = 11 : t1Rect(2) = 11
  t1Rect(3) = 18 : t1Rect(4) = 18
  PAINTOVAL(VARPTR(t1Rect(1)))
  LINE(14,8) - (14,20)
  LINE(8,14) - (20,14)
  GET(6,6) - (22,22), photonPict
  RETURN
```

SR 18a

```
MakeShips:             '_____ make two ship picture arrays
  'if MacSpace.graphics exists, then read it, else read from DATA statements
  fileHere = true                          'on error will change to false if not here
  ON ERROR GOTO FileError                  'set up error trapping
  OPEN"MacSpace.graphics" FOR INPUT AS #1  'is file present?
  ON ERROR GOTO 0                          'disable error trapping
  IF NOT fileHere THEN ReadPictures        'no, read from DATA
```

```
    INPUT #1, byteCount                                    'get enemy picture
    image$ = INPUT$(byteCount,1)
    PICTURE (85,90), image$
    GET (85,90) - (140,125), ePict
    CLS

    noUse$ = INPUT$(1,1)                                   'and player picture is right behind it
    INPUT #1, byteCount
    image$ = INPUT$(byteCount,1)
    PICTURE (85,90), image$
    GET (85,90) - (140,115), pPict
    CLS
    CLOSE 1
    GOTO BuildPictEnd

ReadPictures:                          'MacSpace.graphics isn't on disk: read from DATA
    RESTORE EPictData : CALL ReadArray(ePict())
    RESTORE PPictData : CALL ReadArray(pPict())
BuildPictEnd:
    RETURN

FileError:                  '_____ return fileHere = false if file not found
    IF ERR <> 53 THEN ON ERROR GOTO 0                      'unknown error: print and halt
    fileHere = false
    RESUME NEXT

SUB DrawExtra(num) STATIC                  '_____ draw (or erase) extra ship
SHARED pPict()
    x = (num MOD 5) * 40
    y = INT(num / 5) * 15
    PUT(x,y) - (x + 35, y + 20), pPict
    END SUB

SUB ReadArray(array(1)) STATIC                 'read given array from DATA statements
    READ size
    FOR n = LBOUND(array) TO LBOUND(array) + size -1
      READ num : array(n) = num
    NEXT
    END SUB

GunPoints:                             'data for (x,y) endpoints for title screen's gun firing
    DATA 200, 50, 60, 250, 60,150, 70, 70

EPictData:                                  '_____ data for the picture: EPict
DATA  150
DATA  56 , 36
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 24
DATA 0, 0, 0, 24, 0, 0, 0, 24, 0, 0
DATA 0, 24, 0, 0, 0, 24, 0, 0, 0, 548
DATA 16384, 0, 0, 548, 16384, 0, 0, 1316, -24576, 0
```

SR 18b

SR 18c

SP 1

SP 2

```
DATA 0, 578, 16384, 0, 0, 32707, -512, 0, 1, -32768
DATA 384, 0, 6, 0, 96, 0, 8, 1023, -16368, 0
DATA 112, 1024, 8206, 0, 133, 18877, -27999, 0, 256, 4096
DATA 2048, -32768, 1023, -1, -1, -16384, 1024, 0, 0, 8192
DATA 2111, -1, -4, 4096, 1096, -30721, -7918, 8192, 2197, 20133
DATA 29353, 4096, 4360, -28672, 2320, -30720, 9215, -8192, 2047, -15360
DATA 4576, 0, 7, -30720, 2240, 0, 3, 4096, 1088, 0
DATA 2, 8192, 576, 0, 2, 16384, 448, 0, 3, -32768
DATA 32, 0, 4, 0, 16, 0, 8, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0

PPictData:                          '_____ data for the picture: PPict
DATA 150
DATA 56 , 26
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 7
DATA -1, -4096, 0, 8, 0, 8192, 0, 7, -16381, -4096
DATA 0, 0, 16124, 8192, 8188, 0, 9344, 28672, 1030, 7169
DATA 18688, 0, 14337, 8710, -3080, 0, 4096, -25592, 9220, 0
DATA 4096, -30704, 18439, -16384, 8192, 32736, -28672, -32768, 8195, -32768
DATA 24583, -16384, 8192, 16328, 1092, 0, 8195, -32768, 2724, 0
DATA 8192, 32247, -15292, 0, 5440, -32248, 7, -16384, 4096, -32761
DATA -4096, -32768, 2049, 0, 3079, -16384, 15878, 0, 1016, 0
DATA 508, 0, 0, 0, 4, 0, 0, 0, 56, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
DATA 0, 0, 0, 0, 0, 0, 0, 0
```

III. DIVERSIONS

- MacBuild
- MacOrgan
- MacCompose
- MacFinance
- MacMeasure

MacBuild

Truth to tell, not all of us are potential Picassos. Creating drawings from scratch can be hard work, even if you have talent and easy-to-use tools like MacPaint. But have you ever wanted to just doodle with a few shapes and use them as "building blocks"—moving, arranging, and changing their size at will? If you have, and you have a 512K Fat Mac, MacBuild is for you.

MacBuild lets you play with prebuilt shapes and arrange them to form designs as simple or as complex as you wish. You can also create your own building blocks and add them to the set with the Customize option. You can use MacBuild as is for a few relaxing moments now and then, or you can expand its capabilities and create your own graphics "construction sets" after you've studied how the program works.

How to use MacBuild

When the program starts running, you'll see the screen shown in Figure 1. Note that the added MacBuild menu has two main options, Instructions and Customize. Choosing Instructions gives you the window shown in Figure 2. Customize, which we'll describe a little later, is used to create custom graphics shapes to use with the building blocks provided.

The MacBuild screen is divided into two areas, the "shapes" column and the "work" area. To select a shape, simply move the arrow pointer over the one you want to use, hold down the mouse button, and drag the shape into the work area of the screen. If you want to make the

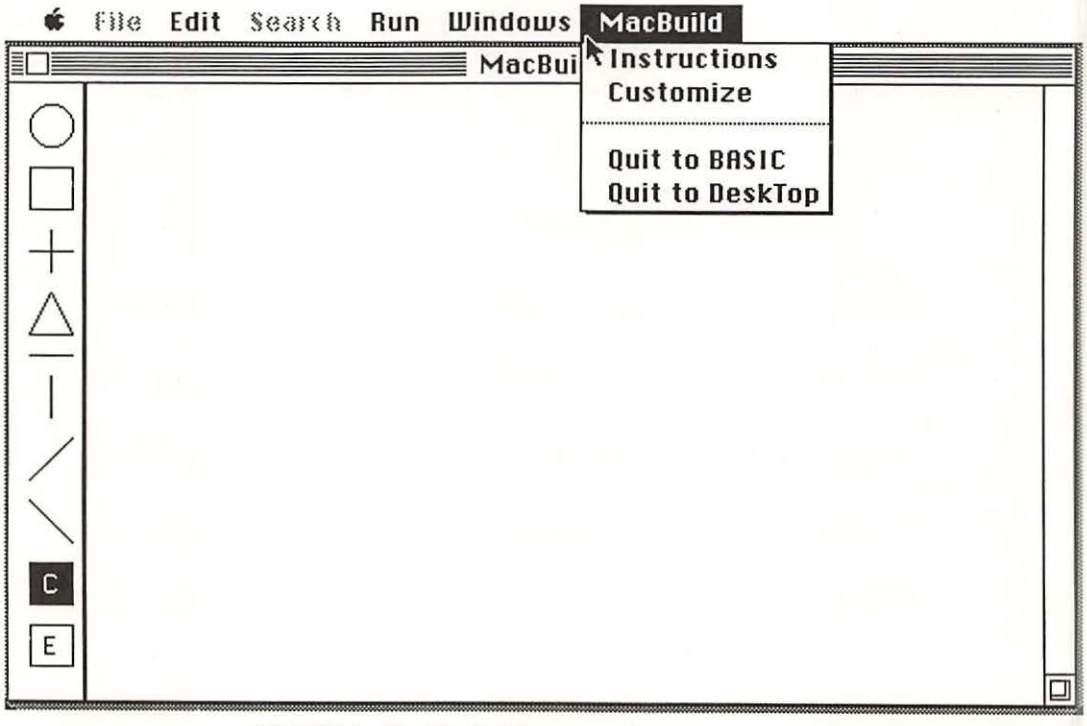


FIGURE 1. *The MacBuild screen and menu*

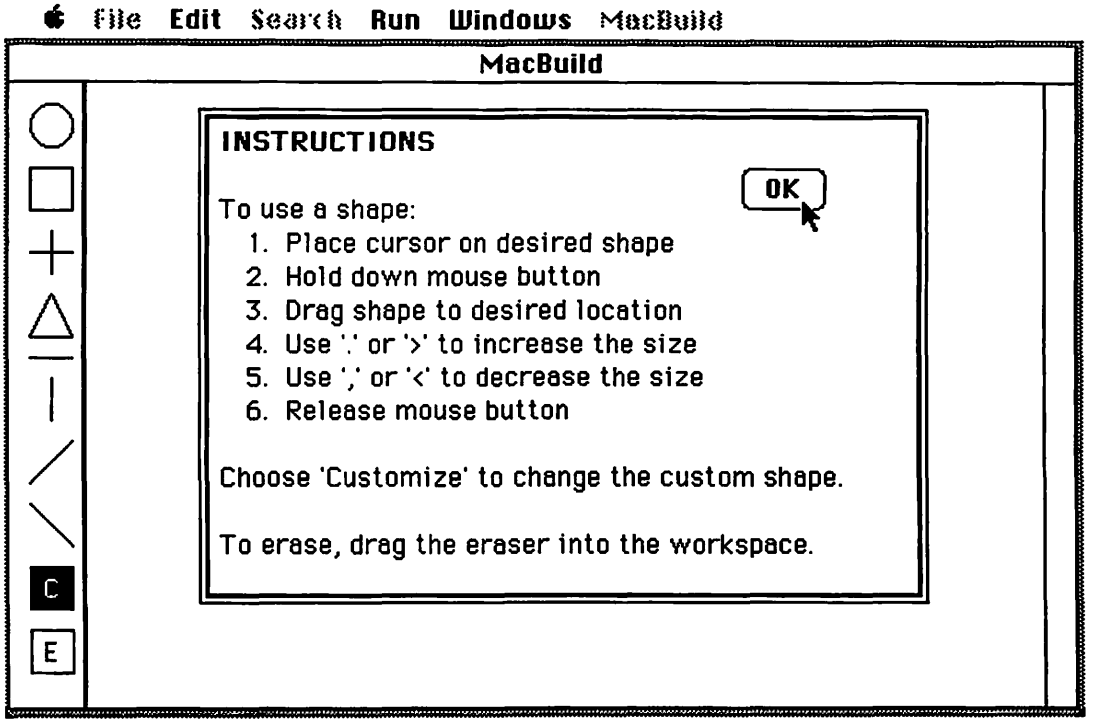


FIGURE 2. *The MacBuild instruction window*

shape larger, hit the period key or the > key (the shifted period). Each time you press the key, the period enlarges the shape by 1 pixel, and the > enlarges it in steps of 10 pixels. Similarly, to make the shape smaller, hit the comma or < key: The comma shrinks the object by 1 pixel each time, and the < shrinks it by 10 pixels.

When the shape has the size you want, and you've moved it to the location you want, you can "set" it there by releasing the mouse button. Once a shape is set, it cannot be picked up, moved, or manipulated further. You can, however, go back to the shape column and get another copy of the basic shape, since they're never "used up."

If you set an object and discover later that you don't want it any more, you can get rid of it with the eraser (the little box with the *E* in it at the bottom of the shapes column). When you select the eraser and drag it into the building area, it becomes a small blinking circle. If you hold down the mouse button, everything you drag the eraser over disappears, just as with MacPaint's eraser.

Figure 3 on the next page shows a sample design we created. We hope it gets your own "idea maker" going!

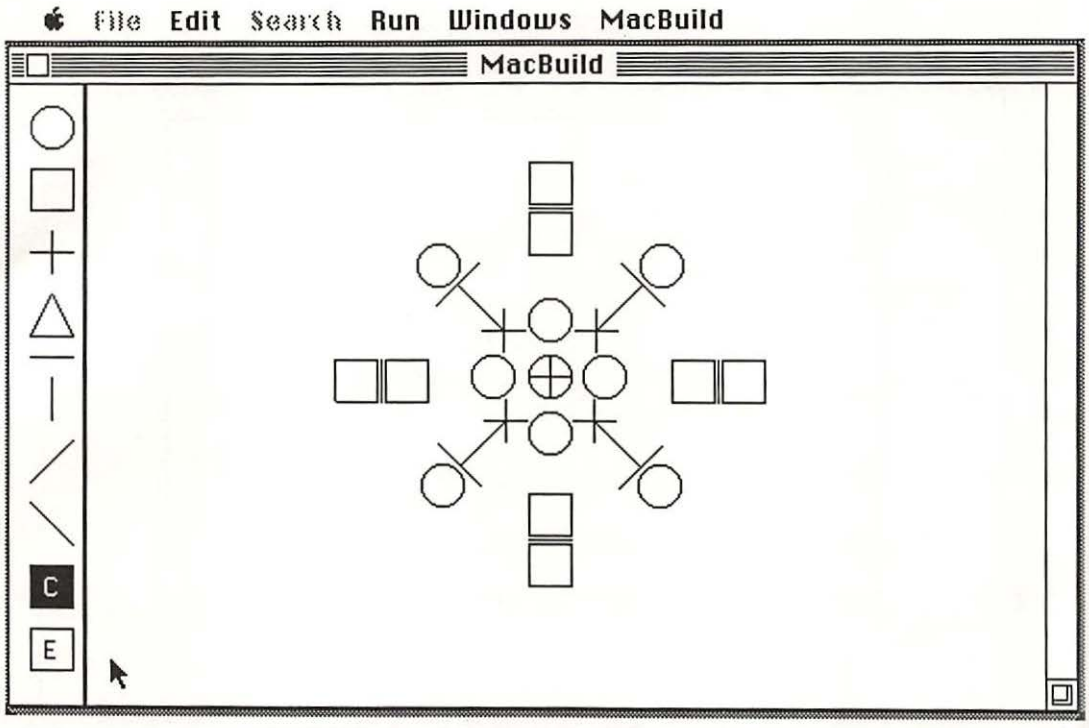


FIGURE 3. *Sample MacBuild design*

Creating a custom shape

The black box with the *C* in it, located just above the eraser, represents the "custom shape." You can define this shape yourself by choosing Customize from the MacBuild menu. Figure 4 shows the editing window that appears on the screen when you choose this option. If you've ever used MacPaint, or have read about our MacCursor or MacAnimate programs, you'll recognize the "FatBits" technique used here.

You start customizing your shape by using the Erase button to remove the *C* that first appears in the editing window. Then, to construct your new shape, simply move the mouse around in the FatBits area and click on the spots where you want black pixels to appear. As you work, you'll see an actual-size image of the custom shape being built up in the shapes column where the boxed *C* had been. If you want to erase a black pixel, simply click on it with the pointer. To completely erase the custom shape, click the Erase button.

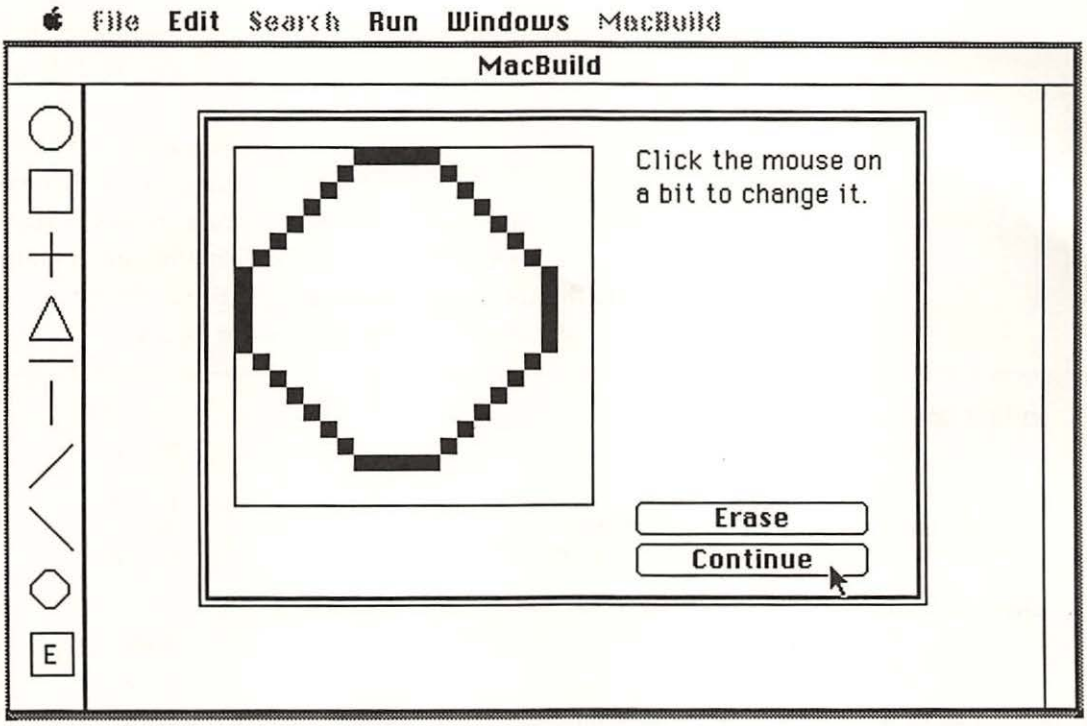


FIGURE 4. *The editing window that appears when Customize is chosen from the MacBuild menu*

When you're satisfied with your custom shape, click the Continue button. Your main work area will then reappear, and any design you were working on will still be there. You can now use the custom shape in exactly the same way you used the predefined ones.

A few additional notes: The custom shape isn't saved at the end of a session, so you'll see the boxed *C* instead of the custom shape if you run the program again. If you want your custom shape again, you'll have to redefine it. Also, if you erase the custom shape and then use the eraser in the main work area, the *C* will also be redrawn.

How MacBuild works

Like most of our other utilities, this program has an endless main loop, but within this loop is another loop that handles the default activity: dragging shapes to the screen, enlarging or shrinking them, and positioning them. It makes sense to make the activity on which the user will be spending the

most time the default activity, so the program remains in this loop until it is interrupted by a menu event. This kind of structure is also used in our MacCursor utility.

The way the "custom shape" is defined, using the FatBits method in which the user clicks squares representing individual pixels to turn them on and off, is also very similar to the way a cursor is created in MacCursor. For this reason, we will cover the shape definition only briefly here and refer you to the MacCursor chapter for additional details.

An outline of MacBuild's structure is shown in Figure 5.

Initialization	
allocate memory	**Init 1**
dimension arrays, define screen constants	
set up title window	**Init 2**
create and save shapes (**DrawShapes**)	SR 6
install MacBuild menu, enable menu event-trapping	**Init 3**
Main Program	
WHILE true (endless loop, interrupted by menu events)	**Main**
wait for button press	
if button pressed in shapes area drag shape (**DragShape**)	SR 1
if button pressed in eraser area, drag eraser (**DragEraser**)	SR 2
WEND	
Menu Events	
on menu event, branch to appropriate subroutine	**ME 0**
Instructions: display instruction window	**ME 1**
save screen area, open second window (**OpenWindow**)	SR 4
create OK button	
print instructions	
wait for click on OK button to continue	
Customize: edit the custom image	**ME 2a**
save screen area, open second window (**OpenWindow**)	SR 4
initialize edit window constants	
create Erase and Continue buttons	
show instruction text	
draw work area, show current shape	
WHILE not finished editing	**ME 2b**
if button pressed and in work area, reverse color of bit	
WHILE button still down	
if still in work area,	
keep drawing in that color (**AffectBit**)	SR 3
WEND	
if Continue button clicked,	
close window and return (**CloseWindow**)	SR 5
if Erase button clicked, erase work area	

(continued)

FIGURE 5. *Program outline*

```
    WEND
    close second window, restore screen (CloseWindow)          SR 5

  BasQuit: quit to BASIC                                        ME 3

  DeskQuit: quit to Mac Desktop                                 ME 4

Subroutines
  DragShape:                                                    SR 1
    hide the cursor
    WHILE button is down
      erase shape at old location
      get new location
      check for keypress to increase or decrease shape size
      draw shape at new location
    WEND
    if shape released in work area, OR it with screen contents
    show cursor

  DragEraser:                                                   SR 2
    WHILE button is still down
      save area under eraser into temporary array
      draw expanding circle to erase small area
      if eraser isn't in work area, restore area under eraser
    WEND

  AffectBit:                                                    SR 3
    send output to Window 1
    change bit on main screen
    get changed image
    send output to editing window and put new image

  OpenWindow:                                                   SR 4
    save area to be replaced by second window
    open window

  CloseWindow:                                                  SR 5
    close window
    restore area under window

  DrawShapes:                                                   SR 6
    create all shapes
    draw border at edge of screen
```

Figure 5. Program outline (continued)

Initialization

All variables are defined as integers: No other kind is needed, and using integers saves memory. Remember that saving memory, even when not crucial for fitting programs into 128K Slim Macs, helps the programs run faster. As the Microsoft BASIC manual points out, the amount of memory

not used by the program code, data, and stack, freed by an appropriate CLEAR statement, determines how much of BASIC can be kept in memory. More BASIC in memory translates to fewer disk accesses, and we all know that repeated Macintosh disk access is no fun!

Two arrays are defined for use with shapes. The *shapes* array holds the bit maps for the eight predefined shapes and the user-definable "custom" shape. The *eArray* array holds the smaller bit map for the eraser, which handles only a small area at a time. (The reason MacBuild only runs on Fat Macs is that these bit-map arrays consume too much of a 128K Slim Mac's memory.)

Most of the remaining statements in this section define screen areas. The first set of coordinates defines the size of the secondary window used as the dialog box for the instructions and the custom cursor definition box. The second set of coordinates (*gX1, gY1,* and so on) defines the area whose contents will have to be saved when the secondary window is used and restored when the window is closed. The variable *safety* is used to make the area saved overlap the secondary window a little to provide a safety margin.

In the final line of [Init 1], the size of the array needed to save the screen contents is determined by a formula given in the Microsoft manual (and described in detail in our chapter on MacGurkha).

Finally, the InBits function is defined so the program can tell if the mouse pointer has been clicked in the FatBits area of the editing window.

Setting up the main screen

The MacBuild title window is set up in [Init 2]. This window contains the shapes column to the left, where the available shapes (including the custom shape and the eraser) are displayed, and the work area, where shapes are assembled to make pictures.

The predefined shapes are drawn via a call to DrawShapes [SR 6]. They are all simple shapes constructed mostly from line statements, line statements with the box option, and a circle statement. The custom shape is drawn as a filled box with the letter *C* in it, and the eraser is drawn as an open box containing the letter *E*. The last line is a double-thickness vertical barrier that separates the shapes column from the work area.

After DrawShapes returns, the shapes are saved into the *shapes* array, using a FOR...NEXT loop. First, the y coordinates of the borders between the shapes are read from the data statements at [Dat]. All the shapes are located in rectangles 20 pixels high except the horizontal line (shape 5),

whose rectangle is only 10 pixels high. Each rectangle starts 5 pixels below the preceding boundary. The GET statement gets each shape into the corresponding element of the *shapes* array. The custom shape also has its boundaries stored in variables at this time; these variables will be used later in working with it. This is done here, rather than back in the constant initialization section, so that the coordinates can be tied into the data statements and thus changed automatically if the latter change (perhaps due to addition of more shapes).

The MacBuild menu is created in [Init 3], which also enables menu event-trapping. Menu events will be handled by our usual MenuEvent subroutine [ME 0].

Main program loop

The main program loop [Main], as previously noted, is an endless loop. At this point, the shapes and work area have been set up, so the user may be taking one of two actions: choosing a menu option or manipulating shapes. If a menu item is chosen, control goes to MenuEvent and the appropriate subroutine is called from there. We'll cover the menu events later.

The user will start manipulating a shape by moving the mouse cursor over it and holding down the mouse button. Therefore, the first thing in the main program loop is a WHILE...WEND loop that simply waits for the mouse button to be held down. When MOUSE(0) returns a value of -1 or less, the button will be down, which means that the user wants to drag a shape into the work area.

Next, MOUSE(1) returns the mouse pointer's x coordinate, and its location is checked to see if it is to the right of the boundary line separating the shapes and the work area. If it is, the pointer's in the work area and there's no shape to select; control goes to the label NotInShapes, and we go back to the top of the main loop and enter the "wait" loop again.

If the mouse pointer *is* in the shapes column when the button is pressed, we need to find out which shape it is over so that the shape can be dragged along with the pointer. After a RESTORE resets the data pointer [Dat], the shape boundaries are read by a WHILE...WEND loop until the boundary just read has a y coordinate greater than or equal to the y coordinate of the mouse pointer's. When this happens, we exit the loop: The variable *shape* is between 0 and 11.

"But there are only ten shapes," you might say. True—but if we stop with the first boundary (*shape* = 0), which is the top boundary of the first shape (the circle), the pointer is *above* this shape, since we stop when a

boundary has a higher y coordinate than the pointer. The second boundary (*shape* = 1) would be just below the circle, so if we stop there, the pointer is over the circle, and so on through the rest of the shapes. *shape* = 10 would be the boundary just below the eraser, so the mouse would be over the eraser. *shape* = 11 would be the bottom of the shapes column below the eraser.

All this means is that if we leave the loop with a shape number between 1 and 9 inclusive, a shape has been selected and DragShape [SR 1] is called. If the shape number is 10, the eraser was selected and DragEraser [SR 2] is called; it is separate because it requires extra processing to handle the erasing function in addition to the dragging function. If the shape number is 0 or 11, the mouse pointer is not over a shape even though it is within the shapes column, so control goes by default to NotInShapes (in other words, this situation is treated just as though the mouse were completely outside the shapes area).

Dragging, sizing, and placing a shape

If a shape other than the eraser is selected, DragShape [SR 1] is called. At the beginning of this subroutine, a call to the QuickDraw HIDECURSOR routine makes the cursor invisible so that the shape is the only thing that moves in response to the mouse drag—in effect, the shape becomes the cursor. The starting mouse-pointer coordinates are stored in the variables *oldX* and *oldY*. Because of the way GET and PUT work with bit-map arrays, the width and the height of the shape (plus 1) are found in the first and second elements of that part of the *shapes* array corresponding to the selected shape. (A note on this: The Microsoft manual says these would be in elements 0 and 1, but in this program we have set OPTION BASE to 1, so all arrays start with element number 1.) These dimensions are assigned to the variables *w* and *h* respectively. A PUT statement draws the shape where the last mouse-pointer location was determined to be.

A WHILE...WEND loop is then used to continue the dragging process as long as the mouse button is down. The loop first checks to see if a key was pressed by getting the current value of INKEY$. If a valid key was pressed, the user wants to either "grow" or "shrink" the currently selected shape. Next, the mouse-pointer location is checked. If it has not changed and no key was pressed, then the mouse hasn't been moved and there is no request for changing the shape's size. In this case, control goes on to the label NoMove and from there back again to the top of the WHILE...WEND loop. At that point things will be checked again to see if a change has occurred.

If the mouse *has* moved and/or a key was pressed, the shape at the old location is erased by being PUT again at that location. (Remember that PUT defaults to an XOR, so a second PUT at the same location erases the object.) The variables *oldX* and *oldY* are then updated by being assigned the new mouse coordinates. Next, any key that was read is checked. If the period key was pressed, the shape is made one pixel higher and wider; if the key was >, an increase of 10 pixels in both dimensions is made. The same method is used for the comma and < keys to decrease the shape's size. In this case, however, ABS (the absolute value) must be used so that the values of height and width don't go below 0, causing subsequent PUT statements to have a rectangle whose second coordinates are to the upper left of the first ones. The shape is then drawn in its new size and position.

This loop continues as long as the mouse button is down. When the button is released, the loop is exited, and, if the mouse pointer is still inside the work area, the shape is drawn in the final pointer position. The PUT statement uses OR so shapes can be combined with existing shapes in the work area without erasing them. You can use other modes (like XOR) if you want to create other effects. The keyboard buffer is also cleared out by a WHILE...WEND loop. This is important because many users like to hold a key down to "zoom" shapes in or out, which tends to leave extra keystrokes in the buffer. Finally the cursor is restored to normal, and the subroutine returns.

Dragging the eraser

The eraser is managed by DragEraser [SR 2]. This subroutine handles dragging in a way similar to that used for the shapes, but here we have to deal with the additional function of erasing the area under the eraser.

Again, the cursor is hidden at the beginning of the subroutine, and a WHILE...WEND loop handles dragging the eraser until the mouse button is released. A GET statement temporarily stores the contents of the screen under the eraser in *eArray*. This is done so that if the eraser goes out of the work area into the shapes area, the contents of the screen under it can be restored rather than erased.

Next, a FOR...NEXT loop is used to create a small circle that grows in radius, extending from one to three pixels out from the mouse-pointer coordinates. The alternating of the default black with white makes this circle appear to blink. The final circle, a white circle with a radius of three pixels, in effect erases the area underneath it. If the mouse-pointer location is in the shapes area rather than in the work area, the erased

contents are restored by PUTting them from *eArray* with the OR option. Otherwise, they stay erased.

When the mouse button is up again, the normal cursor is restored and control returns to the main program loop.

Creating the custom shape

Now that we've covered the default activities of shape manipulation, we'll discuss the main menu option, Customize. The custom shape *can* be used as is (a black block containing the letter *C*), but that isn't very interesting. Normally, the user will want to create his or her own shape and will select Customize from the MacBuild menu to do so. When that happens, MenuEvent [ME 0] calls Customize [ME 2a].

Customize first calls OpenWindow [SR 4] to save the current contents of the main work area and then open a second window, which will be used to contain the editing area for the custom shape. In most of our other programs, there is no need to preserve the contents of a window underneath a new window so that the original window can be restored or "refreshed" later. Here, however, we want the user to be able to leave a set of shapes in the main work area, choose Customize, create a new shape, and then go back to building a picture. Therefore, the *temp* array is dimensioned to *gSize* (which was calculated using the formula mentioned back in [Init 1]), and the contents of the "save" area (whose coordinates were also specified in [Init 1]) are saved into this array. This is a large amount of memory; *gSize* for this size of dialog box is 6465 elements, or about 13K total. The editing window (or dialog box) is then opened.

After returning from OpenWindow, Customize sets up the coordinates for the area within the secondary window that will be used for the custom shape work area. The dimensions are eight times those of the shape's actual size. The function InBits (used in several other programs) will determine whether the mouse pointer is in this work area. Two buttons, Erase and Continue, are then created, and the simple customization instructions are displayed.

Next, the actual work area is drawn with a LINE statement containing the box option, and the current custom shape (which is either the default "C box" or the last custom image defined in the current session) is drawn in the work area. A WHILE...WEND loop is started; the flag

finished is used to exit this loop when the user has completed the custom shape definition and chooses to continue with normal work.

The mechanisms used in Customize's main loop for finding the "bit," or pixel, of the custom image corresponding to the mouse-pointer location, changing the color of the pixel under the mouse cursor, and updating the image are very similar to those used in MacAnimate. Note that in this program the "real size" version of the image is maintained and updated in the custom shape's place in the shapes area. Also note that the Erase button is handled simply by drawing a white box over the work area and then using AffectBit [SR 3] to erase the image.

AffectBit first changes the Output window to the main window in preparation for drawing the real-size custom image in the shapes area. Note that changing the Output window doesn't change the *active* window, which remains the secondary window where the customization work area is. The PSET statement changes the affected bit in the real-size image. (Remember that the "*cus-*" coordinates are those of the custom image in the shapes area, while the "b" coordinates are those of the customization work area.) The new custom image is then saved into the *shapes* array via a GET statement. The second window is again made the Output window, and the image in the customize work area is redrawn at the larger size.

When the user clicks the Continue button, the *finished* flag is set to *true* and the main loop in Customize is exited. CloseWindow [SR 5] is then used both to close the second window, and to restore the contents of the main work area that were covered. These contents are PUT from the *temp* array that was dimensioned in OpenWindow. The ERASE statement then completely eliminates the *temp* array from memory. This means that each time the sequence OpenWindow/do some processing/CloseWindow is performed, the *temp* array is redimensioned, used, and then removed. Thus the array occupies memory only while it is in use. This redimensioning technique, which is not available in most other BASICs, can help save substantial amounts of memory.

The other main menu event, Instructions, is handled by [ME 1]. It also uses OpenWindow to open a second window and save the contents of the main window (if any) and CloseWindow to close the second window and restore the main window's contents. The last two menu events, Quit to BASIC [ME 3] and Quit to Desktop [ME 4], are handled as usual.

Suggestions for MacBuild

One feature you might want to add is the ability to save custom shapes to disk and restore them as desired. You might also want to write a routine that will save a completed design to the Clipboard, so you can transfer it to MacPaint or another application. You could also add a whole second row of shapes or allow several custom shapes to be in use at the same time.

MacBuild could also be the basis for many "construction set" type programs, including educational programs for children.

A Load option could also be added to the MacBuild menu to take sets of images from MacInterface or MacAnimate and use them as the primary shapes. And because saving images as picture strings often takes much less memory than storing them as bit-map arrays, you could try rewriting the program to use picture strings for the shapes.

MacBuild program listing

```
'*****************************************************************
'                          MacBuild
'                  A construction graphics program
'*****************************************************************

  '************************************************** INITIALIZE
  DEFINT A - Z                                                    INIT 1
  OPTION BASE 1
  DIM shapes(50,9)                              'holds shape bit maps
  DIM eArray(20)
  false = 0 : true = NOT false
  white = 30 : black = 33                  'colors used for screen drawing
  lSide = 36                                    'left side of drawing space

  dX1 = 100 : dY1 = 60 : dX2 = 430 : dY2 = 280   'instruction box coordinates
  xOff = 1 : yOff = 40 : safety = 10                          'and offsets
  gX1 = dX1 - xOff - safety                  'coordinates used in saving
  gY1 = dY1 - yOff - safety                             'under inst. box
  gX2 = dX2 + xOff + safety
  gY2 = dY2 + safety
    'calculate array size necessary to save screen under instruction box
  gSize = (gY2 - gY1 + 1) * INT(1 + (gX2 - gX1) / 16) + 2

                                  'InBits returns true if given (x,y) is in FatBits area
  DEF FN InBits(fX,fY) = (fX >= bX1 AND fX <= bX2 AND fY >= bY1 AND fY <= bY2)

  WINDOW 1, "MacBuild", (2,40) - (508,337), 1                     INIT 2
  GOSUB DrawShapes                          'draw shapes on screen
  RESTORE                                     'save to shapes array
  FOR shape = 1 TO 9
    READ yCut                              'shape starts at yCut + 5
    IF shape = 5 THEN height = 10 ELSE height = 20   'horz line only 10 high
    GET(10, yCut + 5) - (30, yCut + 5 + height), shapes(1,shape)
    IF shape <> 9 THEN NotCustom
    cusTop = yCut + 5 : cusLeft = 10
    cusBot = cusTop + height : cusRight = 30
NotCustom:
  NEXT shape

  MENU 6, 0, 1, "MacBuild"                  'install MacBuild menu  INIT 3
  MENU 6, 1, 1, "Instructions"
  MENU 6, 2, 1, "Customize"
  MENU 6, 3, 0, "-"
  MENU 6, 4, 1, "Quit to BASIC"
  MENU 6, 5, 1, "Quit to DeskTop"
  ON MENU GOSUB MenuEvent : MENU ON
```

MAIN

```
'********************************************************* MAIN PROGRAM
  WHILE true                                        'loop until menu selection to quit
    WHILE MOUSE(0) > -1 : WEND                      'wait until mouse button pressed

    IF MOUSE(1) > 30 THEN NotInShapes                   'only if cursor in shape area
    RESTORE                                         'find which shape the cursor is on
    shape = -1 : yCut = -1
    WHILE MOUSE(2) > yCut                           'read yCut until smaller than cursor y
      READ yCut: shape = shape +1
    WEND
    IF shape >= 1 AND shape <= 9 THEN GOSUB DragShape
    IF shape = 10 THEN GOSUB DragEraser
NotInShapes:
  WEND
```

ME 0

```
'********************************************************* MENU EVENTS
MenuEvent:                              'on menu event, branch to appropriate subroutine
  MENU 6, 0, 0                                                      'disable menu
  item = MENU(1)
  ON item GOSUB Instructions, Customize, , BasQuit, DeskQuit
  MENU 6, 0, 1                                                      'restore menu
  RETURN
```

ME 1

```
Instructions:           '_____________________________ display instruction window
  GOSUB OpenWindow
  BUTTON 1, 1, "OK", (250,20) - (290,40)
  CALL TEXTFACE(1)
  PRINT "INSTRUCTIONS"
  CALL TEXTFACE(0)
  PRINT
  PRINT "To use a shape:"
  PRINT "  1. Place cursor on desired shape"
  PRINT "  2. Hold down mouse button"
  PRINT "  3. Drag shape to desired location"
  PRINT "  4. Use '.' or '>' to increase the size"
  PRINT "  5. Use ',' or '<' to decrease the size"
  PRINT "  6. Release mouse button"
  PRINT
  PRINT "Choose 'Customize' to change the custom shape."
  PRINT
  PRINT "To erase, drag the eraser into the workspace."
  WHILE DIALOG(0) <> 1 : WEND
  GOSUB CloseWindow
  RETURN
```

ME 2a

```
Customize:              '_____________________________ edit custom shape
  GOSUB OpenWindow
  bX1 = 10 : bY1 = 10                               'coordinates for custom box
  bX2 = bX1 + 8 * shapes(1,9) : bY2 = bY1 + 8 * shapes(2,9)
  BUTTON 1, 1, "Erase", (200, bY2) - (310, bY2 + 16)
  BUTTON 2, 1, "Continue", (200, bY2 + 20) - (310, bY2 + 36)

  CALL MOVETO(200, bY1 + 10) : PRINT "Click the mouse on"
  CALL MOVETO(200, bY1 + 26) : PRINT "a bit to change it."
```

```
    LINE (bX1 - 1, bY1 - 1) - (bX2 + 1, bY2 + 1), , b
    PUT (bX1,bY1) - (bX2,bY2), shapes(1,9)

    finished = false                                                    ME 2b
    WHILE NOT finished
      status = MOUSE(0) : x = MOUSE(1) : y = MOUSE(2)
      IF status <> -1 OR NOT FN InBits(x,y) THEN NotDown

                                                          'reverse color of current bit
      IF  POINT(x,y) = black THEN color = white ELSE color = black
      WHILE status < 0                                    'while button still held down
        cX = INT((x - bX1) / 8)
        cY = INT((y - bY1)/8)                             'calculate which bit cursor is on
        IF FN InBits(x,y) THEN GOSUB  AffectBit           'affect bit under cursor
        status = MOUSE(0) : x = MOUSE(1) : y = MOUSE(2)
      WEND

NotDown:
      IF DIALOG(0) <> 1 THEN NoButton
      btn = DIALOG(1)
      IF btn = 2 THEN finished = true
      IF btn <> 1 THEN NoErase
      WINDOW OUTPUT 1
      LINE (cusLeft,cusTop) - (cusRight,cusBot), white, bf          'clear shape
      cX = 0 : cY = 0 : color = white                   'initialize for AffectBit
      GOSUB AffectBit
NoErase:
NoButton:
    WEND
    GOSUB CloseWindow
    RETURN

BasQuit:            '_____________________________________ quit to BASIC   ME 3
    MENU RESET
    END

DeskQuit:           '_____________________________ Return to Mac Desktop   ME 4
    MENU RESET
    SYSTEM

'********************************************** SUBROUTINES
DragShape:          '_____________________ drag shape until user releases button   SR 1
    CALL HIDECURSOR
    oldX = MOUSE(1) : oldY = MOUSE(2)
    w = shapes(1,shape) - 1
    h = shapes(2,shape) - 1
    PUT (oldX,oldY),shapes(1,shape)
    WHILE MOUSE(0) <> 0                                 'while button down
      key$ = INKEY$
      IF MOUSE(1) = oldX AND MOUSE(2) = oldY AND key$ = "" THEN NoMove
      PUT (oldX,oldY) - (oldX + w, oldY + h) , shapes(1,shape)      'erase old shape
      oldX = MOUSE(1) : oldY = MOUSE(2)
      IF key$ = "" THEN NoKey
      IF key$ = "." THEN h = h + 1 : w = w + 1
```

```
    IF key$ = ">" THEN h = h + 10 : w = w + 10
    IF key$ = "," THEN h = ABS(h - 1) : w = ABS(w - 1)
    IF key$ = "<" THEN h = ABS(h - 10) : w = ABS(w - 10)
NoKey:
    PUT (oldX,oldY) - (oldX + w, oldY + h), shapes(1,shape)          'draw new shape
NoMove:
  WEND

  PUT (oldX,oldY) - (oldX + w, oldY + h), shapes(1,shape)      'erase last XORed shape
                                  'if button released in work space OR on final shape
  IF  oldX > lSide THEN PUT (oldX,oldY) - (oldX + w, oldY + h), shapes(1,shape), OR
  WHILE INKEY$ <> "" : WEND                                    'clear keyboard buffer
  CALL SHOWCURSOR
  RETURN

SR 2
DragEraser:          '_____ drag eraser around to erase drawing
  CALL HIDECURSOR
  WHILE MOUSE(0) <> 0                                          'while button down
    mX = MOUSE(1) : mY = MOUSE(2)
    IF mX > 4 THEN GET(mX - 4, mY - 4) - (mX + 4, mY + 4), eArray
    FOR n = 1 TO 3
      CIRCLE (mX,mY), n
      CIRCLE (mX,mY), n, white
    NEXT n
    IF mX < lSide + 4 THEN PUT(mX - 4, mY - 4) - (mX + 4, mY + 4), eArray, OR
  WEND
  CALL SHOWCURSOR
  'GOSUB DrawShapes
  RETURN

SR 3
AffectBit:           '_____ affect bit for custom cursor at (cX,cY)
  WINDOW OUTPUT 1                                  'first, set new shape image
  PSET (cusLeft + cX, cusTop + cY), color
  GET (cusLeft,cusTop) - (cusRight,cusBot), shapes(1,9)                'save it
  WINDOW OUTPUT 2                                  'then redraw bit image
  PUT (bX1,bY1) - (bX2,bY2), shapes(1,9), PSET
  RETURN

SR 4
OpenWindow:          '_____ open second window
  DIM temp(gSize)                          'allocate memory to save screen
  GET (gX1,gY1) - (gX2,gY2), temp          'use GET to save bit image
  WINDOW 2, , (dX1,dY1) - (dX2,dY2), 2     'open dialog box
  RETURN

SR 5
CloseWindow:         '_____ close second window
  WINDOW CLOSE 2                           'close dialog box
  PUT (gX1,gY1) - (gX2,gY2), temp, PSET    'redraw screen
  ERASE temp                               'dispose of memory
  RETURN
```

SR 6

```
DrawShapes:              '_____ draw shapes on screen
  CIRCLE (20,20), 10                              'draw circle
  LINE (10,40) - (30,60), , b                     'draw box

  LINE (20,70) - (20,90)                          'draw cross
  LINE (10,80) - (30,80)

  LINE (20,100) - (10,120)                        'draw triangle
  LINE (20,100) - (30,120)
  LINE (10,120) - (30,120)

  LINE (10,130) - (30,130)                        'draw horiz. line
  LINE (20,140) - (20,160)                        'draw vert line
  LINE (10,190) - (30,170)                        'draw slash
  LINE (10,200) - (30,220)                        'draw backslash

  LINE (10,230) - (30,250), , bf                  'draw custom default shape
  CALL TEXTMODE(2) : CALL MOVETO(16,245) : PRINT "C"

  CALL TEXTMODE(0) : CALL MOVETO(16,275) : PRINT "E"
  LINE (10,260) - (30,280), , b

  LINE (lSide - 1, 0) - (lSide,343), , bf         'draw barrier
  RETURN

'_____ y values for boundary limits between shapes
                                  'circ, sqr, cross, tri , hor line, vert line
  DATA 5,   35, 65,    95, 120,    135
                                  'slash, backslash, custom, erase
  DATA 165, 195,       225,   250,  280, 400
```

DAT

MacOrgan

In the last chapter we introduced our Mac music package, MacCompose. We hope that you have been inspired by MacCompose to play excerpts from sheet music, experiment a bit with music theory, or even compose some original melodies of your own.

Having provided a tool for composition, we move to the other half of the musical art: performance.

MacOrgan turns your Macintosh keyboard into a miniature organ with almost two chromatic octaves of single-note keys and three chord keys. We think you'll have fun using it to play simple melodies, including perhaps those you have written using MacCompose. After a few practice sessions with MacOrgan, you just might feel inspired to dress up in white tie and tails, set an elegant crystal vase with a single long-stemmed rose on your Mac, and hold a recital to display your keyboard virtuosity!

How to use MacOrgan

When you run MacOrgan, you'll see the screen shown in Figure 1. Everything you need is on this one screen. As soon as you see the screen, you're ready to play without having to make any menu or button selections. The instructions provide all the information for using the program (the MacOrgan menu contains simply the two standard quit options), but we'll elaborate on them a bit in the following section and give you a few playing tips.

Note that there are two kinds of keys on the MacOrgan keyboard. Most of the top two rows of the Macintosh keyboard are converted to keys

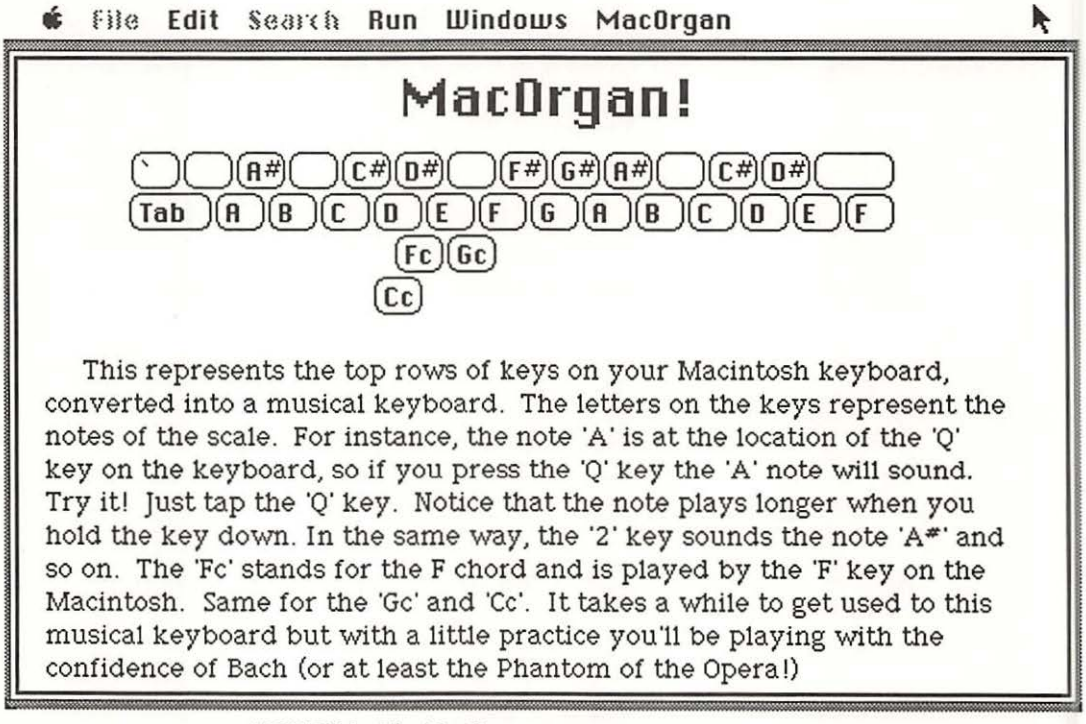


FIGURE 1. *The MacOrgan screen*

that play a single note (only the *lowercase* keys sound notes, so make sure the Caps Lock key isn't locked when you play). You can think of this as a piano keyboard with the keys in the QWERTY row being the white keys and the keys in the number row being the black keys. If you know anything about the piano and organ, you know that the white keys play the whole notes and the black keys the corresponding half notes.

If you type across only the QWERTY row from C to C, you'll hear a *diatonic* musical scale. If you let your finger linger a little longer on some of the keys, you'll notice that their notes last longer the longer your finger presses the key. Finally, if you type across the QWERTY row from C to C and include the half notes in the row above, the result will be a complete, or *chromatic,* scale.

Now look at the keys marked Fc, Gc, and Cc in the figure, which are the F, G, and C keys on the Mac keyboard. The little *c*s indicate that these keys play *chords* (the F chord, G chord, and C chord, as you've probably deduced). These chords are groups of notes (three each in this case) that make a harmonious tone when sounded together. When you briefly press one of these keys, you hear a much richer tone because these keys play three notes at once and use the Macintosh's capability to play several *voices* simultaneously. You can think of a voice as being a separate sound channel that can have its own characteristic tonal color (musicians call this *timbre*). Like the single-note keys, the chord keys continue to sound their tones as long as you hold them down.

Some playing tips

If the music coming out of your Mac is too soft or too loud, you can choose Control Panel from the Apple menu and adjust the sound level by sliding the volume control up and down with the mouse.

Do you want to play from sheet music? We suggest using a simple melody (the melody line in simple "melody-plus-chords" guitar music works best; piano music tends to have too many notes and is confusing for the beginner). Try to pick pieces that fit within two octaves (that is, the lowest and highest notes are no more than 16 full notes apart).

Playing tunes with the correct rhythm take a bit of getting used to, since you have to judge how long to hold down the key to get a note of a given duration. The chord keys in particular tend to run away and play for a long time if held too long.

How MacOrgan works

Once the required initialization has been completed, the program handles only one ongoing activity: playing notes and chords when the appropriate keys are struck. There are only two menu events, which are the standard quit options used in our other programs. The main program is an endless loop that simply processes keys as they are struck. The structure of the program is outlined in Figure 2.

Initialization	
dimension arrays for pitch and organ waveform	**Init 1**
initialize pitch array and note key string	
initialize organ waveform	**Init 2**
set voices	
draw keyboard on the screen (**DrawKeyBoard**)	**Init 3**
display instructions (**Instructions**)	
install MacOrgan menu, enable menu event trapping	
Main Program	
WHILE true (endless loop interrupted by menu events)	**Main**
get character from keyboard	
if a "c", play C chord (**Cchord**)	SR 1
if an "f", play F chord (**Fchord**)	SR 2
if a "g", play G chord (**Gchord**)	SR 3
if a valid key, play corresponding note in organ voice	
WEND	
Menu Events	
MenuEvent: branch to appropriate subroutine	**ME 0**
BasQuit: quit to BASIC	**ME 1**
DeskQuit: quit to Mac Desktop	**ME 2**
Subroutines	
Cchord: play C chord	**SR 1**
Fchord: play F chord	**SR 2**
Gchord: play G chord	**SR 3**
DrawKeyBoard:	**SR 4**
display "MacOrgan" title	
draw large backspace and tab keys (**DrawBox**)	SP 1
for each key,	
read its position and label	
put label at specified position on screen	
draw box around the key (**DrawBox**)	SP 1
Instructions: display instructions	**SR 5**
Subprograms	
DrawBox: assign coordinates to array and draw round-cornered box	**SP 1**

FIGURE 2. *Program outline*

Setting up arrays, menu, and screen

Two arrays are used by MacOrgan, and they are dimensioned in [Init 1]. The first is *pitch,* which holds the actual pitch (in cycles per second) of the 21 single notes that are available on the keyboard. The second array is *waveOrgan%,* which holds the specifications for a waveform with an "organ" sound. Later we'll see how this and the other waveforms are used in the four "voices" to create chords and notes.

The actual acoustic frequencies (in cycles per second) of the 21 notes are set next. The first note, A, is set to the standard 440 cycles. This and the rest of the notes represent an ascending sequence. You may know that a note in the next higher octave has a frequency of exactly twice the frequency of the lower note. For example, the second A on our keyboard has an acoustic frequency of 880. Another way of putting this is that each octave represents an added power of 2 (since increasing the power of 2 by 1 is the same as doubling). Because there are 12 notes a half step apart in an octave, the frequency of each note is 2 to the 1/12 power times the preceding one. So in the formula used in the FOR...NEXT loop here each element of *pitch* is assigned the value of the preceding one times 2 to the 1/12 power.

The last two lines in [Init 1] obtain the ASCII characters corresponding to the single-note keys (the chord keys are handled separately). The characters are contained in a DATA statement [Dat 2] that is simply READ and assigned to the string-variable *key$.* Besides the benefit of being more compact in both memory and listing space than using an array and a FOR...NEXT loop to read in individual characters, the storing of the characters in a single string allows the BASIC INSTR function to determine both if a character represents a valid note key, and to return the note's position in the sequence without a loop being required.

If you compare the characters in [Dat 2] that are assigned to *key$* with the keyboard, you'll see that the characters are in ascending order of musical note (that is, chromatic-scale order), rather than being one keyboard row followed by the other. This is so the character sequence will match the note sequence. You may also notice that the first character, a question mark, isn't actually one of the notes; it is a "dummy character" whose function will be explained when we look at how a key is converted to a note to be played.

In [Init 2] the characteristic tone color for single notes is defined. In connection with this, we'll briefly review the parameters of the SOUND statement and the use of waveforms and voices. A more complete treatment of sound on the Macintosh can be found in Chapter 18 of *Microsoft Macinations* (Microsoft Press, 1985).

The SOUND statement has two required parameters: *frequency* (or pitch) and *duration.* There are two optional parameters: *volume* and *voice.* In MacOrgan, the pitch obtained from the *pitch* array element corresponds to the key pressed, and the duration is fixed (6 for chords, 3 for single notes). The actual duration seems to vary with the length of time the key is held down because the Macintosh keys auto-repeat while held down, and what is heard as a long, continuing note is actually a series of notes played in rapid succession.

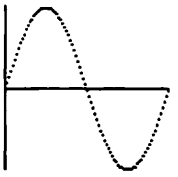
The optional *volume* parameter is not used, so the volume is controlled by the default setting set by the user on the Macintosh Control Panel. The *voice* parameter *is* used, however. The Macintosh can play up to four independent "voices," each of which can have its own tonal characteristics. MacOrgan uses the first voice (called voice 0 by BASIC) for the single notes, and the other three for the three notes used to form chords.

The single-note voice is defined by the values in the array *waveOrgan%*. Each element in this integer array has a value that indicates the relative "height" or amplitude of the wave at that point. The statements in the FOR...NEXT loop calculate the values of two sine waves: a dominant frequency and a frequency that is both one-third the amplitude and four times the dominant frequency. This results in a complex waveform somewhat similar to that produced by an organ. The shape of this waveform, the formula that produced it, and those of other common waveforms are shown in Figure 3.

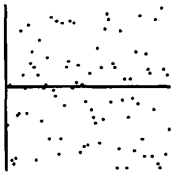
After the organ waveform is defined, the WAVE statements are used to associate waveforms with the corresponding voices. The first voice (0) is assigned the waveform defined in *waveOrgan%*. The other three voices are assigned the predefined wave type SIN (or "sine wave"). This waveform has a curved shape like that shown in Figure 3, and has a full, "mellow" sound.

The MacOrgan window is opened in [Init 3]. As mentioned earlier, there is only one screen that will appear in this window. The elements of the screen are drawn next. First, DrawKeyboard [SR 4] is called to draw a representation of the part of the Macintosh keyboard used to play music. The title "MacOrgan" is displayed at the top in a large text size.

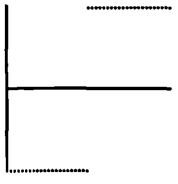
There are two keys that are wider than the rest: the Tab and Backspace keys. Neither of these keys is used to play a note, but *all* keys in the top two rows are represented, even those that don't have notes associated



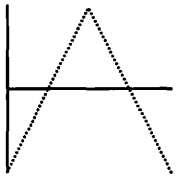
```
DIM waveSine%(255)                          'sine wave...flute-like
FOR n = 0 TO 255
   waveSine%(n) = 127 * SIN((n/256) * 6.2838)
NEXT n
```



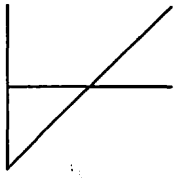
```
DIM waveHiss%(255)                  'random noise...hissing, buzzing
FOR n = 0 TO 255
   waveHiss%(n) = RND * 256 - 128
NEXT n
```



```
DIM waveSqr%(255)                       'square wave...computer-like
FOR n = 0 TO 127
   waveSqr%(n) = -128
   waveSqr%(255 - n) = 127
NEXT n
```



```
DIM waveTri%(255)                        'triangle wave...oboe-like
FOR n = 0 TO 127
   waveTri%(n) = (n * 2) - 128
   waveTri%(255 - n) = (n * 2) - 128
NEXT n
```



```
DIM waveSaw%(255)                        'sawtooth wave...violin-like
FOR n = 0 TO 255
   waveSaw%(n) = n - 128
NEXT n
```

```
DIM waveOrgan%(255)          'addition of sine waves...organ-like
FOR n = 0 TO 255
   majorVoice = 96 * SIN((n/256) * 6.2838)
   minorVoice = 32 * SIN((n/64) * 6.2838)       '1/3 vol, 4x freq
   waveOrgan%(n) = majorVoice + minorVoice      '2 voices into 1
NEXT n
```

FIGURE 3. *Some common waveforms and their formulas*

with them; this allows the "musical" keys to be placed in the right context on the keyboard. These two wide keys are drawn by separate sequences using calls to the DrawBox subprogram [SP 1]. DrawBox takes four integers which are passed to it when it is called, representing the upper left and lower right coordinates of a rectangle with round corners. Since variables and numbers that are passed to a subprogram must be of an explicit type, we define *x* and *y* to be integers in [Init 1]. Operations done with these variables, such as defining screen locations, are therefore forced to return integer values. DrawBox takes these integer values and reassigns them to the *rect* array before using the FRAMEROUNDRECT QuickDraw routine to draw the keys as round-cornered rectangles.

Since the rest of the keys are the same size, a FOR...NEXT loop is used to draw them. For each key the (x,y) screen location and name string are read from the data statements at [Dat 1]. A MOVETO places the QuickDraw pen at the specified coordinates, the name string in *key$* is printed, and the key is outlined with a call to the DrawBox subprogram using coordinates relative to the (x,y) location.

After DrawKeyboard is finished and returns, Instructions [SR 5] is called to display the instructions in the bottom half of the screen. The only difference between the instructions in this program and those found in most others in this book is that the instructions here are not in a separate window selected as a menu option but appear and remain on the screen throughout the user's session with the program.

Next, the MacOrgan menu is installed and menu event-trapping enabled. The menu is even more limited than that of the average fast-food joint, as it has only two options: the standard Quit to BASIC and Quit to Desktop options.

The main program loop

The main program is an endless loop. It starts by getting the next keystroke to be processed from the keyboard buffer (INKEY$) and assigning it to *play$*. Three IF...THEN statements then check to see if the key is a chord key (C, F, or G). If it is, the appropriate chord subroutine (Cchord [SR 1], Fchord [SR 2], or Gchord [SR 3]) is called. These subroutines are identical except for the frequencies of the three notes that make up the chord to be SOUNDed.

Next, we check for non-chord keys. The INSTR function determines if the character representing the key struck (*play$*) is in the string containing all the possible valid single-note keys (*keys$*). If the key pressed isn't one in the string, INSTR returns 1; otherwise, it returns the position

where the character representing the key pressed was found in *keys$*. You can now see the reason for the "dummy" first character we put in *keys$*: Since 1 is returned if a character is not found, we want 2 instead of 1 to be the position of the first valid character. Putting the dummy character at the start of the string bumps all the positions up by one and enables us to test for $n > 1$ to determine if a valid character was found, and then to use $n - 1$ to get the actual position of the note represented by the character in the musical scale.

If a valid character is found, the note is played using a SOUND statement with the pitch found in the $(n - 1)$ element of PITCH, since the true *relative* position of the note is 1 less, due to the dummy character. Since the characters in *keys$* represent the 21 notes in ascending pitch order, they correspond to the pitches in the *pitch* array.

The playing of notes and chords continues until a Quit menu option is chosen. These standard menu options are self-explanatory, so we won't elaborate on them.

Suggestions for MacOrgan

The range of the organ could be extended about two octaves simply by including the bottom two rows of keys (except for keys designated as chord keys). No modification other than extending the appropriate loops and data statements would be needed.

You could add additional chords (perhaps as an alternative to the above). If you don't know what notes are used to construct particular chords, consult a beginning music text (many "how-to-play-the-guitar" variety of books also have this information). If you modify the loop in [Init 2] to print the pitches of the notes, you could construct a table of notes and frequencies to use in setting up the SOUND statements to play chords. Note that some fancier kinds of chords have more than three notes.

If you're feeling ambitious, you could combine the above two projects and use the uppercase of a key to refer to a chord and the lowercase to refer to a single note.

You can experiment with voices by changing the values put in the *waveOrgan%* array and listening to the resulting notes. You could have a two-dimensional array with different voices simulating different instruments (it would probably take some tinkering and/or reading a book on electronic sound theory) so you could set different voices as you play a selection, perhaps by using Option-key sequences.

MacOrgan program listing

```
'*****************************************************************
'                          MacOrgan
'                 Play your Macintosh like an organ!
'*****************************************************************

'************************************************** INITIALIZE
DIM pitch(21), waveOrgan%(256)                    'for pitch and wave
DEFINT x-y
false = 0 : true = NOT false

pitch(0) = 440                                    'establish pitch for A
FOR n = 1 TO 21                          'assign next 21 pitches to ascending notes
   pitch(n) = pitch(n - 1) * 2 ^ (1 / 12)
NEXT n

RESTORE KeyASCII                                  'get ASCII equivalents for notes
READ keys$

FOR t = 0 TO 255                  'define multiple sine waveform for 'organ' sound
   majorVoice = 100 * SIN((t / 256) * 6.2838)
   minorVoice = 34 * SIN((t / 64) * 6.2838)       '1/3 volume, 4x frequency
   waveOrgan%(t) = majorVoice + minorVoice
NEXT

WAVE 0, waveOrgan%                        'establish waveforms for all 4 voices
WAVE 1, SIN
WAVE 2, SIN
WAVE 3, SIN

WINDOW 1, , (10,32) - (502,330), 2
GOSUB DrawKeyboard                                'draw screen
GOSUB Instructions

MENU 6, 0, 1, "MacOrgan"                          'install MacOrgan menu
MENU 6, 1, 1, "Quit to BASIC
MENU 6, 2, 1, "Quit to Desktop"
ON MENU GOSUB MenuEvent : MENU ON

'************************************************** MAIN PROGRAM
WHILE true
   play$ = INKEY$                                 'get code of key pressed
   IF play$ = "c" THEN GOSUB Cchord               'if it's a chord, play it
   IF play$ = "f" THEN GOSUB Fchord
   IF play$ = "g" THEN GOSUB Gchord
   n = INSTR(keys$,play$)
   IF n > 1 THEN SOUND pitch(n - 1), 3, , 0       'no vol. param with waveforms
   WEND
```

INIT 1

INIT 2

INIT 3

MAIN

```
'*********************************************************** MENU EVENTS
MenuEvent:                          'on menu event, branch to appropriate subroutine
  MENU 6, 0, 0
  ON MENU(1) GOSUB BasQuit, DeskQuit
  MENU 6, 0, 1
  RETURN

BasQuit:          '_____________________________________ quit to BASIC
  MENU RESET
  END

DeskQuit:         '_____________________________________ quit to Mac desktop
  MENU RESET
  SYSTEM

'*********************************************************** SUBROUTINES
Cchord:           '_____________________ pressing c on keyboard gives this chord
  SOUND 329.6, 6, , 1
  SOUND 392, 6, , 2
  SOUND 523.25, 6, , 3
  RETURN

Fchord:           '_____________________ pressing f on keyboard gives this chord
  SOUND 349.23, 6, , 1
  SOUND 440, 6, , 2
  SOUND 523.25, 6, , 3
  RETURN

Gchord:           '_____________________ pressing g on keyboard gives this chord
  SOUND 293.66, 6, , 1
  SOUND 392, 6, , 2
  SOUND 493.88, 6, , 3
  RETURN

DrawKeyboard:     '_____________________ display image of keyboard
  RESTORE KeyDefs
  CALL TEXTFONT(0) : CALL TEXTSIZE(24)
  LOCATE 1,12 : PRINT "MacOrgan!"          'print large 'MacOrgan' on screen
  CALL TEXTSIZE(12)
  CALL MOVETO(55,75) : PRINT "Tab"
  CALL DrawBox(50, 61, 89, 79)
  FOR keys = 1 TO 29
    READ  x, y, key$                       'get key location and name
    CALL MOVETO(x,y) : PRINT key$          'go there and print key's note name
    CALL DrawBox(x - 4, y - 14, x + 19, y + 4)   'draw box around key
  NEXT
  CALL DrawBox(376, 41, 414, 59)           'backspace
  RETURN
```

ME 0

ME 1

ME 2

SR 1

SR 2

SR 3

SR 4

SR 5

```
Instructions:                 '_____ display instructions
  CALL TEXTFONT(2) : CALL MOVETO(20,150)
  PRINT " This represents the top rows of keys on your Macintosh keyboard,"
  PRINT " converted into a musical keyboard. The letters on the keys represent the"
  PRINT " notes of the scale. For instance, the note 'A' is at the location of the 'Q'"
  PRINT " key on the keyboard, so if you press the 'Q' key the 'A' note will sound"
  PRINT " Try it! Just tap the 'Q' key. Notice that the note plays longer when you"
  PRINT " hold the key down. In the same way, the '2' key sounds the note 'A#' and "
  PRINT " so on. The 'Fc' stands for the F chord and is played by the 'F' key on the "
  PRINT " Macintosh. Same for the 'Gc' and 'Cc'. It takes a while to get used to this"
  PRINT " musical keyboard but with a little practice you'll be playing with the"
  PRINT " confidence of Bach (or at least the Phantom of the Opera!)";
  RETURN
```

SP 1

```
SUB DrawBox(left%, top%, right%, bottom%) STATIC
  rect%(0) = top% : rect%(1) = left% : rect%(2) = bottom% : rect%(3) = right%
  CALL FRAMEROUNDRECT(VARPTR(rect%(0)), 12, 12)
  END SUB
```

DAT 1

```
KeyDefs:                      '_____ define key location and label
  DATA 55, 55, "", 80, 55, "", 105, 55, "A#", 130, 55, ""
  DATA 155, 55, "C#", 180, 55, "D#", 205, 55, "", 230, 55, "F#"
  DATA 255, 55, "G#", 280, 55, "A#", 305, 55, "", 330, 55, "C#"
  DATA 355, 55, "D#", 95, 75, "A", 120, 75, "B", 145, 75, "C"
  DATA 170, 75, "D", 195, 75, "E", 220, 75, "F", 245, 75, "G"
  DATA 270, 75, "A", 295, 75, "B", 320, 75, "C", 345, 75, "D"
  DATA 370, 75, "E", 395, 75, "F", 180, 95, "Fc", 205, 95, "Gc"
  DATA 170,115, "Cc"
```

DAT 2

```
KeyASCII:                     '_____ string values for notes: given as A, A#, B, C, etc.
                              ' "?" is a dummy character, included so INSTR returns 1 if given null$
  DATA "?q2we4r5ty7u8i9op-[=]\"
```

MacCompose

Nearly all of us are musical to some degree—even if we don't think so. True, it's probably been years since we paraded up and down the piano keyboard in lock-step with the persistent commands of the sainted Miss Crumwiddie. The $49 Sears Roebuck electric guitar outfit we bought in a burst of adolescent enthusiasm on the imagined road to stardom may rust silently in a

cobwebbed closet. But chances are that we still remember something of the fundamentals of music and retain the desire to make music ourselves now and then. This book brings you two programs that can help to revive or expand your musical expression: MacCompose and MacOrgan.

MacCompose is an aid to *writing down* music, whether your own compositions or tunes you've copied from sheet music. Once written, MacCompose will play the notes at the click of a button. On the other hand, MacOrgan, which we will cover in the next chapter, is for the *performer* in you: It turns your Mac into an electronic organ and lets you perform music—including music written with MacCompose, of course—at its keyboard. These programs promise neither Carnegie Hall glory nor rock 'n' roll riches, but they are useful little tools for exploring the elements of music and writing and playing simple melodies.

For example, if you just want to hear a favorite tune, you can enter the notes from sheet music and play them. Or, if you don't know much about the elements and structure of music, you can play with melodies, intervals, and rhythms by assembling them on the screen in standard musical notation and then hearing what they sound like. The ability to relate what you *see* to what you *hear* makes MacCompose a useful supplement to a music textbook. Or, if you're one of those amateur musicians who plays by ear or can sight-read only with difficulty, you can enter notes (such as a melody line) from sheet music, let MacCompose play the tune a few times for you, and then pick it up by ear yourself.

How to use MacCompose

Using MacCompose is extremely easy. When you first run the program, the title screen shown in Figure 1 briefly appears. Next, the working screen shown in Figure 2 appears, complete with the custom MacCompose menu containing Instructions, Quit to BASIC and Quit to Desktop. Choosing Instructions displays a window of brief instructions, which we'll elaborate on a bit here.

The center of the screen contains a standard staff with a treble clef. For those of you who don't know anything about musical notation, we'll mention a few fundamentals. The lines on the staff from bottom to top correspond to the notes E, G, B, D, F (Miss Crumwiddie may have told you to remember them as "Every Good Boy Does Fine"). The spaces between the lines, again starting at the bottom, correspond to the notes F, A, C, and E. MacCompose can handle all these plus four extra notes: a C and D below the staff and a G and A above it. That bottom C, by the way,

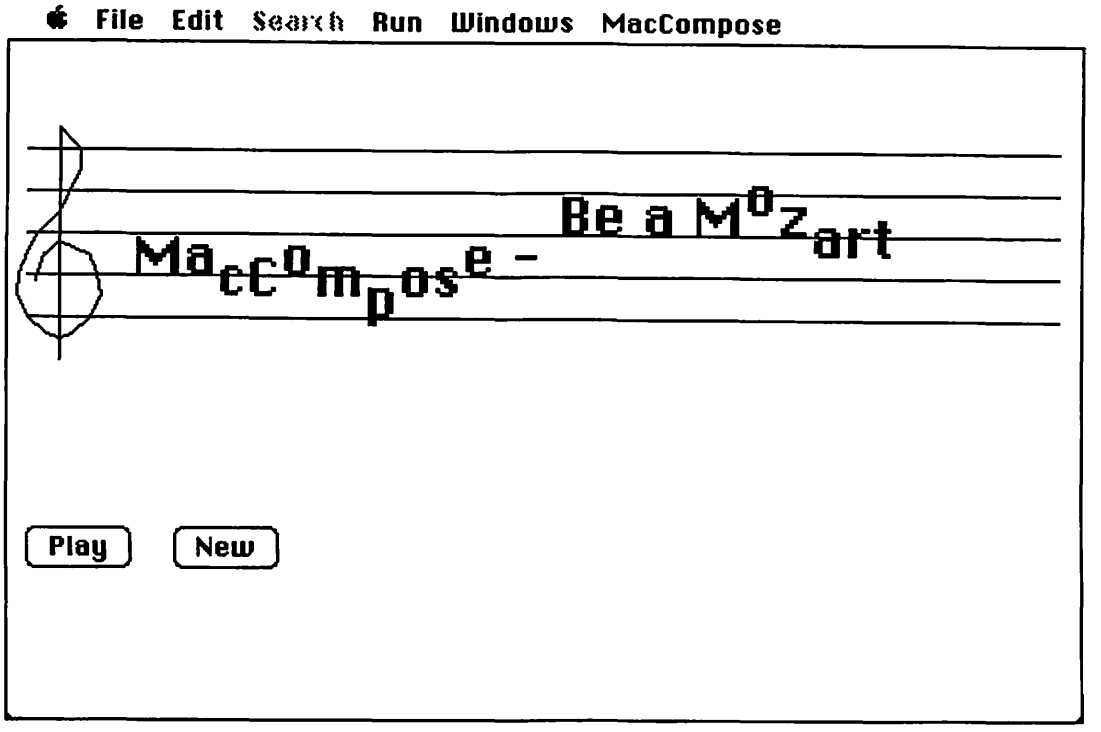


FIGURE 1. *The MacCompose title screen*

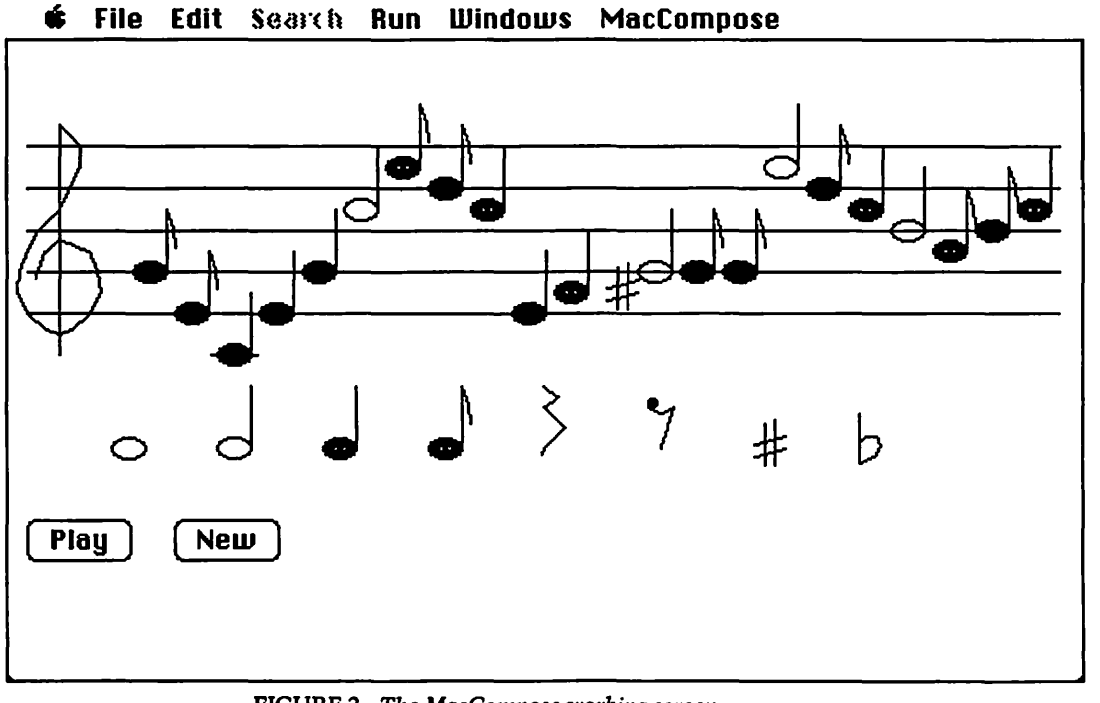


FIGURE 2. *The MacCompose working screen*

roughly corresponds to the middle C on the piano, although a given piano and the Mac may not be in tune with each other.

Along the bottom of the screen are the musical symbols you can put on the staff. The row begins with four notes: whole, half, quarter, and eighth. The remaining symbols, in order, are two rests (silent pauses)—quarter and eighth—and the sharp and flat signs (called *accidentals*). To put a symbol on the staff, place the arrow pointer over it, drag it to the staff, and release it at the vertical position you want it to have. You don't have to worry about horizontal spacing: MacCompose automatically puts the new symbol in the next available space on the staff. If the symbol you place is a note, MacCompose will play it; if it's a rest, you'll hear a faint clicking sound. Rests and accidentals are moved and placed just like notes. A sharp raises the note that precedes it one half-step (or *semitone*) in frequency, and a flat lowers it one half-step.

You'll note that there is no line on the staff low enough to accommodate the low C (middle C). To place this note, simply judge where the appropriate line would be if there were one and then release the note there: The note and line segment will appear as in Figure 2. Use the same kind of judgment to put the D just below the staff or the high G and A above it when necessary.

If you make a mistake, simply move the arrow pointer over the symbol you want to remove and click the mouse button: The symbol will disappear. If you want to clear everything off the staff and start over, click the New button in the lower left corner of the screen.

To play the tune you create, click the Play button; if you want to hear the tune several times, rapidly click the Play button several times. (If you haven't already guessed, our tune in Figure 2 is the beginning of the familiar drinking song, "To Anacreon in Heaven," but some of you might know it under its more recent title, "The Star-Spangled Banner.")

Copying sheet music

Entering and playing sheet music with MacCompose can present some complications. We suggest that, at least at first, you pick sheet music with a simple melody line and a key signature that has no more than one sharp or flat. If the music you want to copy contains notes smaller than those MacCompose provides (such as sixteenth or thirty-second notes), you can multiply all the note values by 2 or 4 so they will fit in the sizes available and still preserve the correct rhythmic relationships. That is, you would change sixteenth and thirty-second notes to eighth notes, eighth notes to quarter notes, and so on.

If your sheet music has notes too high or low to fit in the range handled by the program, you might try transposing the melody to fit. This can be a bit tricky, but you may be able to correct it by ear. Finally, if you encounter dotted notes, try to choose individual notes with the correct values and substitute them. For example, a dotted half note can be replaced with a half note and a quarter note, since the dot adds half again to the value of the note.

We'll admit that MacCompose has some limitations. The staff can hold a maximum of 22 notes, and there are no bar lines, so it is hard to see phrasing. You can't enter chords, either. If you're working with sheet music for piano, we suggest that you pick out the melody line in the treble clef (after you've entered a few notes, you can play them and let your ear help you determine which ones belong in the melody). MacCompose works best with short and simple melodies.

How MacCompose works

This program centers on a main loop that controls the addition and deletion of notes to a melody. Button events control playing the current melody and initializing a new one. Since there are very few menu and button options, the main work of the program is in correctly placing and updating notes, as well as managing complications such as notes on ledger lines and accidentals. Our program outline in Figure 3 shows how these problems are handled. (Incidentally, we save space in the outline by using the term "note" to refer to regular notes, rests, and accidentals; the context should indicate what is being referred to in a given case.)

Initialization	
dimension arrays for note symbols, frequencies, durations, staff image, note type, note position	**Init 1**
initialize duration array	
set sine waveform	
draw and save note symbol images (**FormPics**)	**Init 2** (SR 10)
show title screen (**TitleScreen**)	SR 9
create Play and New buttons, enable button event-trapping	**Init 3**
install MacCompose menu, enable menu event-trapping	
Main Program	
WHILE true (endless loop interrupted by menu and button events)	**Main**
set new tune flag to false	
set number of stored notes to zero	
redraw screen and prepare for new tune (**InitTune**)	SR 1
(continued)	

FIGURE 3. *Program outline*

```
    WHILE new tune not selected
      if mouse button anything but drag, ignore loop
      get current mouse pointer coordinates
      if pointer within staff area, check for note deletion (CheckDelete)      SR 4
      if pointer within note symbol area, drag note to staff (HandleNote)      SR 3
    WEND
  WEND

Menu Events
  MenuEvent: branch to appropriate subroutine                                  ME 0

  Instructions:                                                                ME 1
    open second window
    display instructions
    create button, wait for button click
    close second window

  BasQuit: quit to BASIC                                                       ME 2

  DeskQuit: quit to Mac Desktop                                                ME 3

Button Events
  ButtonID: branch to appropriate subroutine                                   BE 0

  Play: play each note in sequence (PlayNote)                                  BE 1 (SR 6)

  Start: set flag for restarting main loop                                     BE 2

Subroutines
  InitTune:                                                                    SR 1
    initialize note types and position information
    redraw screen (DrawScreen)                                                 SR 2
    initialize frequency array

  DrawScreen:                                                                  SR 2
    draw clef and staff (DrawClef, DrawStaff)                                  SR 11, 12
    draw note symbols below staff
    place any melody present on staff

  HandleNote:                                                                  SR 3
    hide pointer
    move chosen symbol while still dragging
    if pointer in staff area, place symbol at first empty position
    if note placed just above or below staff, draw ledger line (Ledger)        SR 7
    add note to note sequence (AddNote)                                        SR 5
    show pointer

  CheckDelete:                                                                 SR 4
    get note postion on staff from x coordinate
    if note at that position, erase shape, reset arrays
    if ledger line at that location, erase it (EraLedger)                      SR 8
```

(continued)

Figure 3. Program outline (continued)

AddNote: SR 5
store note region number for this note
store note type at this position
increment number of stored notes if note placed at end of tune
if note symbol not sharp or flat, play note (**PlayNote**) SR 6

PlayNote: SR 6
if note symbol is note, play note, adust if sharp or flat
if note symbol is rest, pause for appropriate duration

Ledger: draw ledger line SR 7

EraLedger: erase ledger line SR 8

TitleScreen: SR 9
draw clef symbol (**DrawClef**) SR 11
draw staff (**DrawStaff**) SR 12
place each character of title string on staff at random locations

FormPics: draw all note symbol shapes, save in bit-map array SR 10

DrawClef: read data points, plot and connect points, save image SR 11

DrawStaff: save staff segment equal to one note symbol width SR 12

Figure 3. Program outline (continued)

Initialization and constants

After making sure that there will be enough memory for its arrays, the program establishes the types of all variables except those beginning with *f* or *z* as integer. MacCompose uses the following six arrays for information and graphics:

notePic holds the graphic images for the eight types of symbols;

freq holds the frequencies of the thirteen notes that will fit in the staff area (including the four notes outside the staff proper);

duration holds the duration (length of time for sounding) associated with the four sizes of notes handled (whole, half, quarter, and eighth) and the two sizes of rests (quarter and eighth);

staffPiece holds the graphic image for a segment of the staff one note position wide. This will be used to redraw the background when a note is erased or changed;

noteN holds a number corresponding to the type of note or symbol at each possible position on the staff;

position holds a number corresponding to the scale value (and also the vertical region on the staff) of the note at each possible staff position.

The constant z is based on the fact that musical-scale frequencies have a progression based on powers of 2. The constant will be used to raise or lower to the appropriate frequency when a sharp or flat is encountered.

The FOR...NEXT loop stores the values of the durations of the various notes and rests in the *duration* array. Since the durations shorten by powers of 2, the expression used with INT can set them in turn from 16 for a whole note to 2 for an eighth note. The durations given to the rests are simply assigned from those for the corresponding notes. An alternative, of course, would be to READ them all in from a set of DATA statements. The latter code would be easier to understand, but our code shows the mathematical relationship better.

Drawing the title screen

At [Init 2] FormPics [SR 10] is called so that the symbols for the various notes, rests, and accidentals can be drawn and stored in the *notePic* array. Of particular interest is the drawing of the filled bodies of the quarter and eighth notes by using a series of CIRCLE statements with the radius increased by 1 each time. (An alternative technique would be to use calls to the QuickDraw FRAMEOVAL and PAINTOVAL routines.) If you look closely at the filled notes in Figure 2 that aren't on staff lines, you'll see the tiny "eyes" on either side of their centers that are a consequence of this technique: The circles aren't perfectly concentric. Also note that since the symbols for the accidentals are shorter than those for the notes and rests, y offsets are used to place them lower than the rest of the symbols.

After the symbols are drawn and stored, TitleScreen [SR 9] is called. TitleScreen in turn first calls DrawClef [SR 11] to draw the clef (the symbol that appears at the beginning of the staff). Because the clef is a complicated curve, the subroutine draws it essentially by a "connect the dots" technique. The points along the clef that indicate the gradations of curvature are specified in the DATA statements at ClefPoints [Dat 2], and the points are plotted with PSET statements and connected with LINE statements. This is a rather painstaking procedure, but sometimes there's no practical alternative (although you could use MacPaint and MacInterface to create the image).

TitleScreen then calls DrawStaff [SR 12], which draws the staff, a refreshingly simple procedure. Next, TitleScreen sets up the somewhat

over-optimistic "Be a Mozart" title legend and specifies a large, bold text-font and style. A FOR...NEXT loop draws the title characters with a randomized vertical y location. The expression used with RND will evaluate randomly to −1, 0, or 1 (to see this, plug in some values of RND(1) between 0 and 1). Thus, the progression of character "notes" will vary but will not jump more than two spaces between characters, an arrangement that gives the general impression of a musical phrase. The IF statements and the following statement keep the value of *j* from positioning the character out of the staff area.

After a delay loop is finished, TitleScreen returns to [Init 3]. Next, the Play and New buttons are created and button event-handling is enabled. Then the MacCompose menu is installed and menu event-handling is enabled. (We will cover button and menu events and their handling after we consider the main processing loop.)

The main program

As usual, the main program is an "endless" loop that is exited only when one of the two quit menu options is executed. The loop starts by setting the NewTune flag to *false*. It then calls InitTune [SR 1] to initialize the note information and staff contents.

InitTune starts by setting the number of the maximum note stored in memory to 1 and using a FOR...NEXT loop to set the note values and positions to −1, indicating that there are no notes in memory or on the staff. It next calls DrawScreen [SR 2] to draw the work screen.

DrawScreen starts by drawing the clef and staff with DrawClef and DrawStaff, just as was done for the title screen. DrawScreen then draws the available notes and other symbols below the staff area by using a FOR...NEXT loop to PUT the images from the *notePic* array.

The rest of DrawScreen is a FOR...NEXT loop that draws any stored melody notes on the staff (though there won't be any stored melody the first time through this subroutine). Before we explain how this is done, let's pause to introduce two terms that will be useful in describing the manipulation of notes and the other musical symbols in various parts of this program. A *staff position* is a horizontal segment of the staff that is one note-image wide. It represents a "slot" into which a note can be put. A *note region* is a vertical segment of the staff representing the spot where a note of a given pitch would be put. For example, the space between the bottom line of the staff proper and the next line up is the region for the note F above middle C.

The FOR...NEXT loop starts by getting the x coordinate for the left border of the next staff position. Its next step is to get the y coordinate for the top of the note region where the note (if any) at that position will be found. You may remember that the *position* array holds the number of the note region for the note in each staff position. After the note is PUT on the screen, Ledger [SR 7] is called if the note's y coordinate indicates that it is on a ledger line (the "invisible" line just below or just above the staff proper). The subroutine draws the ledger line through the note.

The whole loop has as its limit *maxN* − *1*. The variable *maxN*, defined as the number of notes saved in memory plus 1, was set to 1 by InitTune. When InitTune calls DrawScreen, there are no notes to draw since we are initializing a new tune, so the FOR...NEXT loop is not executed. But after the user enters some notes, *maxN* will be greater than 1 and this loop *will* be executed when DrawScreen is called; for example, after instructions have been displayed and the work screen needs to be restored.

After DrawScreen is done, InitTune reads in the note frequencies for the 13 tones from the DATA statements in [Dat 1] into the *freq* array. Finally, InitTune returns to the main program loop in [Main].

Placing notes: The inner "work" loop

The default activity in MacCompose is placing or deleting notes in the staff area. The other options, including playing the current melody, are handled by button or menu events that are processed as they occur.

The inner WHILE...WEND loop runs as long as newTune is not *true*. If that flag is set to *true* (by the user clicking the New button), control falls out of the "work" loop and goes back into the outer loop. InitTune will then be executed again to clear the way for building a new melody.

Let's begin our study of the work loop by looking at the way a melody is built up. The work loop first checks MOUSE(0): If it is 0, the user is not dragging a note with the pointer, or clicking a note to delete it, so the rest of the loop is skipped (by jumping to the label Ignore). MOUSE(0) is then read again to see if anything has happened yet, and so on.

Assuming MOUSE(0) isn't 0, a FOR...NEXT delay loop is executed so that if a drag is taking place there will be time for the mouse to be moved a reasonable distance. Then MOUSE(0) is checked again, and its value is stored in the variable *click*.

If *click* is not −1 (a drag in progress) or 2 (a double-click), the rest of the loop is skipped, since the selection is something not involved with the notes. Otherwise, the current pointer y and x coordinates are obtained and assigned to the variables *crntY* and *crntX*.

If the y coordinate is between 35 and 170, the pointer is probably in the staff region (though it may be too far to the left), and the user may be clicking on a note to delete it from the staff. CheckDelete [SR 4] is therefore called to process the deletion.

CheckDelete first gets the note's staff position by dividing the pointer's x coordinate by 20, after subtracting the offset of 40 (representing the distance of the left end of the staff from the left border of the screen). If this is less than 1, the mouse is too far to the left and there is no note to delete, so control jumps to the label WrongNote and the subroutine exits. This also happens if the value in the *position* array for the staff position is -1, since this means that the pointer is on the staff but there is no note at that position. Otherwise, there *is* a note at the staff position and note region containing the pointer. The x and y coordinates for the note image are then obtained, and the note is erased by PUTting it with the XOR option. The *noteN* and *position* arrays are also updated to show that there is now no note at that position. Since the section of the staff under the former note was also erased, the *staffpiece* image is PUT to restore the staff lines at that position. If the erased note was on a ledger line, the line is erased by a call to EraLedger [SR 8], which produces an erasure effect by redrawing the line with color 30 (white).

Back in the main program, we skip to the bottom of the loop if the pointer was in the staff area (it was either a deletion, which we've just processed, or the pointer was out of bounds to the left of the staff). We then check to see if the pointer is too high above the staff to be over a note region or too low to be in the symbol area (the area containing the symbols that can be dragged onto the staff). Again, we skip to the bottom of the loop if that is the case.

Finally, if none of those IF statements is true, we are left with the possibility of a note having been selected and dragged toward the staff. The note number is therefore obtained from the mouse pointer's x coordinate. If it is less than 1 or greater than 8, it's not a valid note or symbol (the mouse is to the left or right of the symbol area), so no processing takes place. Otherwise, a valid symbol is being dragged, and HandleNote [SR 3] is called to process it. The subroutine first hides the cursor, which is the usual practice when having an object drag along with the pointer. A WHILE...WEND loop then moves the symbol (by repeatedly drawing and erasing it in XOR mode) as long as the mouse button is down.

At the end of the drag, the mouse pointer's y coordinate is obtained from MOUSE(2) and assigned to *crntY*. If it is too high or too low to fit on the staff or ledger lines, the subroutine is exited via a jump to the label OutOfRange; otherwise, the note region is obtained from the y coordinate. Note regions are 10 pixels high. There are also two offsets to be figured in: 40 is added to account for the fact that the staff area starts 40 pixels from the top of the screen, and 35 is subtracted because each note image starts that far above the region occupied by the note body. The reason for this is that notes have stems, while accidentals don't—but this doesn't affect their positioning, since their images are the same size as note images.

Now that the vertical note region has been determined, we must find out which horizontal staff position the note will be placed in. This is done by finding the first staff position that has no note in it, starting from the left. This is because we can't simply use the position following the current value of *maxN*, because a note may have been deleted somewhere in the middle of the tune. If one has, the new note must be put in the leftmost empty position—that is, the position of the deleted note. (If you don't want the new note put in the position of the deleted note, the simplest thing to do is start your melody over.) The FOR...NEXT loop determines the first empty position, which is a position with a value of −1 in the *noteN* array. The variable *seqNum* is set to this number. The number is then used to calculate the x coordinate for the note image, after which the note can be PUT on the staff. If the note needs a ledger line, Ledger is called to draw it.

AddNote [SR 5] is then called to add the note to the stored melody so that it can eventually be played. AddNote updates the element of the *position* array for the note's staff position (8 is added before dividing so that the coordinate can be "rounded" to the nearest region). The note-type number is then put in the position in the *noteN* array corresponding to the note's staff position. Thus *position* now contains the note's note region (from which its pitch will be obtained), and *noteN* contains its type (which will determine its duration if it's a tone or rest, or special processing if it's an accidental). *maxN* is also increased by 1 to account for one more note in the current melody if it's not a replacement for a deleted note.

Then, if the currently placed symbol is a sharp or a flat, it does not represent a note itself but affects the previous note. Therefore the note position is only equal to the current sequence position if the current note is less than 7. Finally, AddNote calls PlayNote [SR 6] to play the note.

In PlayNote, if the current note position does not contain a note, or if the symbol at that position is a sharp or flat, no note is sounded and the subroutine returns. Otherwise, depending on the kind of note symbol at the current position, that is, the value of *noteN(notePos)*, control jumps to a routine which either plays a tone, or just waits for the length of the appropriate rest.

If the note type is between 1 and 4 inclusive, it is a regular note or tone. If the symbol at the next position is a sharp or a flat, then *freqAdj* is set to a value which, when multiplied with the frequency of the base note, will raise or lower it by one half-note, or semitone. Then the routine SOUNDs the note by specifying its frequency (from the *freq* array) and its duration (determined by its note type referencing the *duration* array).

If the note type is 5 or 6, the note symbol is a rest. The routine at the label Rest works much like that for playing a tone, with the exception that the frequency played is zero cycles per second, producing a silent pause rather than an audible tone.

This completes the processing of a newly added note or symbol. PlayNote and then AddNote return, and control goes back to the top of the work loop through HandleNote. The work loop continues until a button or menu event is encountered.

Button and menu events

Clicking on one of the two buttons causes control to go to ButtonID [BE 0]—the button handler. If a button was indeed pushed, the button number is obtained from DIALOG(1) and the appropriate subroutine is called.

The Play button is handled by Play [BE 1]. This subroutine uses a FOR...NEXT loop to call PlayNote to play each note. Accidentals will be processed as encountered, and the frequency of the corresponding note will be adjusted if needed.

The Start button is handled by Start [BE 2]. This simply sets the *newTune* flag to *true* so that control will fall out of the inner work loop and return to the outer main loop [Main]. A new tune will be initialized before the next notes are added.

Menu events are handlled by MenuEvent [ME 0]. Quit to BASIC [ME 2] and Quit to Desktop [ME 3] are standard and need not be discussed in detail. Note, however, that Instructions [ME 1] calls DrawScreen to redraw the work screen with any existing staff contents when the user is

done with the instructions. It is important to remember that if you enable a menu option like Instructions that you want available while the user works with the program, you have to make sure you can restore whatever was going on when the program was interrupted.

Suggestions for MacCompose

One obvious addition to the program would be an option to save the current melody to disk or restore it from there. You could also expand MacCompose (especially if you have a Fat Mac) to allow several staves' worth of notes to be handled. There is nothing inherently difficult in doing this, but you *would* have to check for staff boundaries and redraw the staves as needed. You could also add sixteenth and thirty-second notes and longer rests as well.

Another improvement would be to allow the user to set the key signature (the group of sharps or flats often found just following the clef) so you could then just enter notes without remembering to put the appropriate accidental after each note of a given pitch encountered.

MacCompose program listing

```
'* * * *
```

```
        note = INT((crntX + 15) / 50)                          'note selected
        IF note >= 1 AND note <= 8 THEN GOSUB HandleNote

Ignore:
    WEND
  WEND

'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * MENU EVENTS
ME 0  MenuEvent:                                'on menu event, branch to appropriate subroutine
  MENU 6, 0, 0
  item = MENU(1)
  ON item GOSUB Instructions, , BasQuit, DeskQuit
  MENU 6, 0, 1
  RETURN

ME 1  Instructions:              '_____________________________ display instructions
  WINDOW 2, , (16,55) - (495,325), 2
  PRINT
  PRINT "                          Instructions for MacCompose"
  PRINT
  PRINT "    With MacCompose you can enter sheet music into your Macintosh and play"
  PRINT "it.  Do this by 'picking up' the note you want to use with the mouse pointer"
  PRINT "and dragging it to the proper vertical location on the staff.  When you"
  PRINT "release the button the note will be placed in the next empty place on the"
  PRINT " staff. Delete notes by moving the pointer over the note you wish to delete"
  PRINT " and clicking: The next note you add will be put into the empty space."
  PRINT
  PRINT "    The notes as seen across the screen are: Whole, Half, Quarter, Eighth,"
  PRINT "Quarter rest, Eighth rest, Sharp, and Flat.  The Sharp and Flat symbols"
  PRINT "raise or lower the frequency of the notes they are placed after by a "
  PRINT "semitone."
  PRINT
  CALL INITCURSOR
  BUTTON 1, 1, "Continue", (190,240) - (280,260)
  WHILE DIALOG(0) <> 1 : WEND
  BUTTON CLOSE 1 : WINDOW CLOSE 2
  GOSUB DrawScreen
  RETURN

ME 2  BasQuit:                   '_____________________________ quit to BASIC
  MENU RESET
  BUTTON CLOSE 1 : BUTTON CLOSE 2
  WINDOW CLOSE 1
  END

ME 3  DeskQuit:                  '_____________________________ quit to Mac Desktop
  MENU RESET
  SYSTEM
```

```
'********************************************** BUTTON EVENTS
ButtonID:                                  'called when any dialog event occurs
  IF DIALOG(0) <> 1 THEN NotButton                'no, ignore this event
  btn = DIALOG(1)
  ON btn GOSUB Play, Start
NotButton:
  RETURN

Play:              '_____________________________________ play stored tune
  FOR notePos = 1 TO maxN - 1
    GOSUB PlayNote
  NEXT
  RETURN

Start:             '_____________________________________ start over again
  newTune = true
  RETURN

'********************************************** SUBROUTINES
InitTune:          '_____________________________ initialize to write new tune
  maxN = 1                          'number of notes stored in memory + 1
  FOR notePos = 1 TO 30                  'initialize info for each note to -1
    noteN(notePos) = -1
    position(notePos) = -1
  NEXT
  GOSUB DrawScreen
  RESTORE Frequencies                'set frequencies from DATA statements
  FOR n  = 1 TO 13 : READ freq(n) : NEXT          'set up array with 13 notes
  RETURN

DrawScreen:        '_____________________ draw screen including any melody
  GOSUB DrawClef
  GOSUB DrawStaff
  FOR n = 1 TO 8                          'draw 8 symbols at bottom of screen
    PUT(50 * n, 175), notePic(1,n)
  NEXT
  FOR n = 1 TO maxN - 1                    'place any melody present on staff
    crntX = n * 20 + 40
    crntY = position(n) * 10
    IF noteN(n) <> -1 THEN PUT (crntX,crntY), notePic(1, noteN(n)), OR
    IF crntY = 130 OR crntY = 10 THEN GOSUB Ledger
  NEXT n
  RETURN

HandleNote:        '_____________ a legal note has been chosen, place and act on it
  CALL HIDECURSOR
  WHILE MOUSE(0) = -1                     'move note while button down
    PUT(MOUSE(1),MOUSE(2)),notePic(1,note)          'show note
    PUT(MOUSE(1),MOUSE(2)),notePic(1,note)          'hide note
  WEND
```

BE 0

BE 1

BE 2

SR 1

SR 2

SR 3

```
    crntY = MOUSE(2)
    IF crntY > 131 OR crntY < 5 THEN OutOfRange
    crntY = INT((crntY-35) / 10) * 10 + 40
    FOR X = 1 TO maxN
      IF noteN(X) = -1 THEN seqPos = X : X = maxN                    'find first sequence posit.
    NEXT X

    IF note < 7 THEN GOTO PutNote
    IF seqPos = 1 AND note > 6 THEN OutOfRange
    IF note > 6 AND noteN(seqPos - 1) > 4 THEN OutOfRange
PutNote:
    crntX = seqPos * 20 + 40
    PUT(crntX,crntY), notePic(1,note), OR                                'place note on screen
                                        'if this is one line above or below staff, draw line
    IF crntY = 130 OR crntY = 10 THEN GOSUB Ledger
    GOSUB AddNote
OutOfRange:
    CALL SHOWCURSOR
    RETURN

SR 4
CheckDelete:              '_____________________________ user wants to delete note
    note = INT((crntX - 40) / 20)                                    'find note position on staff
    IF note < 1 THEN WrongNote
    IF noteN(note) = -1 THEN WrongNote
    crntX = note * 20 + 40                                           'recalculate note location
    crntY = position(note) * 10                                        'and position on staff
    PUT (crntX,crntY), notePic(1,noteN(note)), XOR                          'erase note
    noteN(note) = -1 : position(note) = -1
    PUT (note * 20 + 40, 30), staffPiece, OR
                                        'if this is above or below staff, then erase ledger
    IF crntY = 130 OR crntY = 10 THEN GOSUB EraLedger
WrongNote:
    RETURN

SR 5
AddNote:                  '_____________________________ add given note to melody at seqPos
    position(seqPos) = INT((crntY + 8) / 10)
    noteN(seqPos) = note
    IF seqPos = maxN THEN maxN = maxN + 1
    IF note > 6 THEN notePos = seqPos - 1 ELSE notePos = seqPos
    GOSUB PlayNote
    RETURN

SR 6
PlayNote:                 '_____________________________________ play given note
    IF noteN(notePos) = -1 OR noteN(notePos) > 6 THEN RETURN
    ON noteN(notePos) GOTO Tone, Tone, Tone, Tone, Rest, Rest
Tone:
    freqAdj = 1
    IF noteN(notePos + 1) = 7 THEN freqAdj = z
    IF noteN(notePos + 1) = 8 THEN freqAdj = 1 / z
    SOUND freq(position(notePos)) * freqAdj, duration(noteN(notePos)), 255
    RETURN
```

```
Rest:
   SOUND 0, duration(noteN(notePos))                    'duration but no volume
   RETURN

Ledger:          '_____________________________ draw a LINE above OR below staff
   LINE (crntX - 3, crntY + 30) - (crntX + 19, crntY + 30)
   RETURN

EraLedger:       '_____________________________ erase line above or below
   LINE (crntX - 3, crntY + 30) - (crntX + 19, crntY + 30), 30
   RETURN

TitleScreen:
   GOSUB DrawClef
   GOSUB DrawStaff
   title$ = "MacCompose - Be a Mozart"
   CALL TEXTSIZE(24) : CALL TEXTFONT(0) : CALL TEXTMODE(1)
   RANDOMIZE TIMER
   CALL MOVETO(60,110)
   p = 5
   FOR i = 1 TO LEN(title$)
      j = INT(RND(1) * 3) - 1
      IF p < 1 THEN j = 1
      IF p > 8 THEN j = -1
      p = p + j
      CALL MOVE(0, j * 10) : PRINT MID$(title$, i, 1);
   NEXT i
   FOR t = 1 TO 8000 : NEXT
   RETURN

FormPics:        '_____________________________ form notes and put into array
   WINDOW 1, , (0,10) - (530,340), 2
   CIRCLE (20,200), 8, , , , .6                        ' whole note
   GET (12,170) - (28,205), notePic(1,1)

   CIRCLE (50,200), 8, , , , .6                        ' half note
   LINE (58,170) - (58,200)
   GET (42,170) - (58,205), notePic(1,2)

   FOR r = 0  TO 8                                     'quarter note
      CIRCLE (80,200), r, , , , .6
   NEXT r
   LINE (88,170) - (88,200)
   GET (72,170) - (92,205), notePic(1,3)

   FOR r = 0 TO 8                                      'eighth note
   CIRCLE (110,200), r, , , , .6
   NEXT r
   LINE (118,170) - (118,200)
   LINE (118,170) - (121,180)
   LINE (121,180) - (122,188)
   GET (102,170) - (122,205), notePic(1,4)
```

SR 7

SR 8

SR 9

SR 10

```
    LINE (135,170) - (142,175)                          'quarter rest
    LINE (142,175) - (135,180)
    LINE (135,180) - (145,190)
    LINE (145,190) - (135,200)
    LINE (135,200) - (134,203)
    GET (130,170) - (150,206), notePic(1,5)
    FOR r = 0 TO 2                                      'eighth rest
      CIRCLE(162,178), r
    NEXT
    LINE (160,180) - (166,183)
    LINE (166,183) - (172,180)
    LINE (172,180) - (166,200)
    GET (155,170) - (175,206), notePic(1,6)

    ofst = 8
    LINE (190,180 + ofst) - (190, 202 + ofst)           'sharp
    LINE (195,178 + ofst) - (195, 200 + ofst)
    LINE (185,190 + ofst) - (200, 186 + ofst)
    LINE (185,196 + ofst) - (200, 192 + ofst)
    GET (180,170) - (200,208), notePic(1,7)

    ofst = 5
    LINE (215, 178 + ofst) - (215, 202 + ofst)          'flat
    LINE (215, 192 + ofst) - (218, 189 + ofst)
    LINE (218, 189 + ofst) - (223, 189 + ofst)
    LINE (223, 189 + ofst) - (225, 194 + ofst)
    LINE (225, 194 + ofst) - (223, 198 + ofst)
    LINE (223, 198 + ofst) - (215, 202 + ofst)
    GET (210,170) - (230,208), notePic(1,8)
    RETURN

SR 11
DrawClef:                   '_____ clear screen, draw treble clef
    CLS
    RESTORE ClefPoints
    READ clefX, clefY
    PSET (clefX, clefY)
    FOR clef = 1 TO 20
      READ clefX, clefY
      LINE - (clefX, clefY)
    NEXT
    RETURN

SR 12
DrawStaff:                  '_____ draw staff
    FOR staff = 60 TO 140 STEP 20
      LINE(10,staff) - (500,staff)
    NEXT
    GET (80,30) - (100,165), staffPiece
    RETURN
```

```
Frequencies:                                        'note freqency values
   DATA 880, 784, 698.5, 659.3, 587.3
   DATA 523 .3, 493.9, 440, 392, 349.2
   DATA 329.6, 293.7, 261.6

ClefPoints:
   DATA 25, 160, 25, 50, 35 , 60, 35 , 70, 30, 80, 25, 90, 15, 100, 10, 110
   DATA 6, 120, 5, 130, 10, 140, 20, 148, 25, 150, 30, 148, 40, 140, 45, 130
   DATA 43,120, 39, 110, 25, 104, 18, 110, 14, 123
```

DAT 1

DAT 2

MacFinance

Although the admonition of Shakespeare's Polonius—"Neither a borrower nor a lender be"—is still prudent advice, it would be hard to take it literally today. We not only borrow for the occasional big purchase like a house or car, but most of us have charge accounts and credit cards as well. "Automatic" borrowing is built into the very mechanism of modern commerce.

"Very well," you might say. "I'll admit I borrow money in various guises, but I'm not really a lender. I've been avoiding my freeloading cousin Harry for years..." Well, think again. If you have a savings account, certificates of deposit (CDs), savings bonds, or similar kinds of financial paper, you're a lender: You're lending to the bank, Uncle Sam, or some other institution. A savings account is an open-ended loan with no fixed rate or time period, while CDs and bonds usually have fixed rates and specified periods, but they're all loans just the same.

If you are a borrower or a lender—and, as you can see, you're probably both—you need MacFinance. This easy-to-use program will lend you a hand when you want to answer questions like:

- If I take out a $2,500 loan with a two-year term, monthly payments, and an annual rate of 12.5%, how much will my payments be?
- How much am I actually going to pay the bank in interest on a $2,500 loan?
- If I take out a $5,000 CD with a one-year term and a rate of 10.5%, compounded daily, what will its future value (principal plus total interest over term) be?

After you've tried MacFinance and studied how it works, you'll be able to expand its capabilities by adding routines to answer other money questions you might ask frequently. The program is also an excellent example of how to integrate menus and dialog boxes in BASIC programs, and also demonstrate advanced window-management techniques.

How to use MacFinance

When MacFinance is run, the title screen shown in Figure 1 appears, including the MacFinance menu. The menu contains these five options:

The Borrowing option allows you to calculate how much your payments will be for a loan with specified terms, and Investing shows you how much an investment will be worth at the end of its term. There are also our standard options: Instructions, Quit to BASIC, and Quit to Desktop.

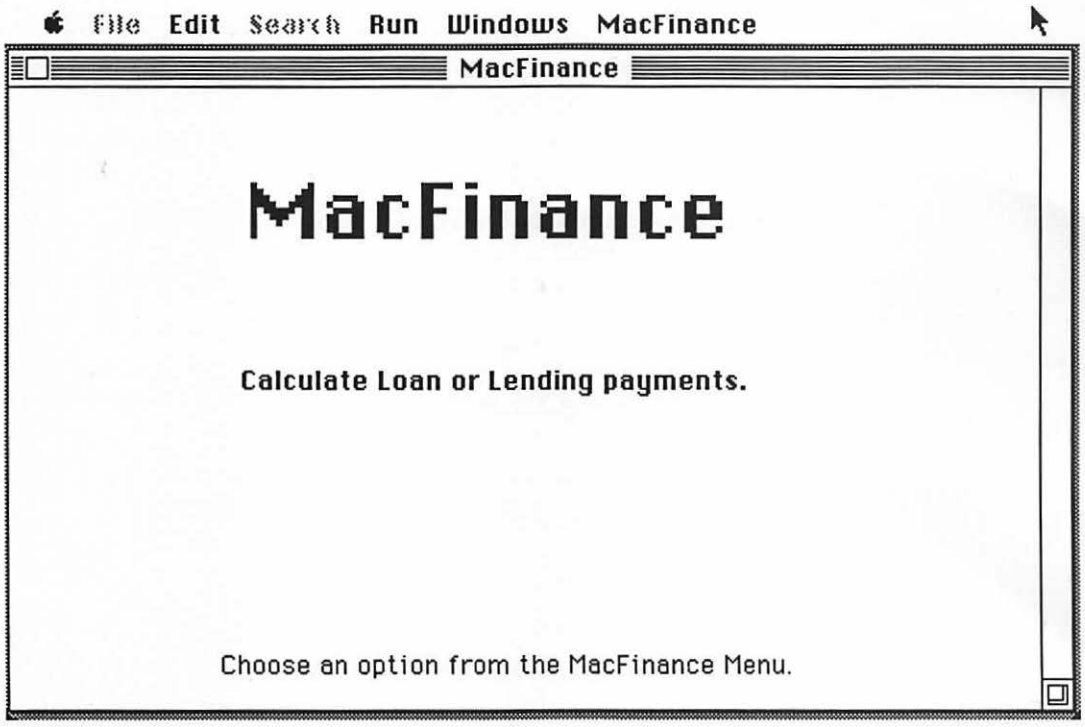


FIGURE 1. *The MacFinance title screen*

The first time you choose either the Borrowing or Investing option, a window is set up for that calculation, ready for you to enter the necessary information. Once the window is activated, you can move it around the screen and resize it just like the Macintosh Finder's and Microsoft BASIC's windows. You can click the window's close box to make it go away, and when you again choose the same option on the menu the window will reappear with its contents preserved from the last time you used it. You can have both the Borrowing and Investment windows open at once, but only one can be active at a time.

To get a better idea of what MacFinance does after you choose a menu option, picture this little scene. You've just learned that your local computer dealer is having a sale on Macintosh goodies like hard disks and lots of new software. You look over the ad, tote up the prices on your Mac's built-in calculator, and figure in the tax. You note that your dealer, in connection with a local bank, is offering two-year loans at 18.5% to finance purchases over $2,000, and it happens that your purchases (with tax) add up to $2,433.35.

So you go to the dealer and ask him how much the monthly payments will be. He rolls his eyes and groans in anguish as he scrabbles

in a desk drawer for a calculator. He finds it and begins entering figures, muttering as he tries to recall the formula for calculating compound interest. "Uh...just a minute, I think I can lend you a hand," you tell him.

At this point you pull your MacFinance disk out of your pocket, slip it into the dealer's Mac before his startled eyes, run MacFinance and choose Borrowing from the MacFinance menu. A window titled Borrowing appears at the left side of the screen, as shown in Figure 2, ready for you to enter the relevant figures. The little rectangles are standard edit fields like those used for dialog windows and for editing icon names in the Finder. Just click the mouse pointer in a field to put the insertion point there, then start typing. Hitting the Return or Tab key moves you to the next item, and you can also use the standard Cut, Paste, and Copy options. After you fill in the boxes, you simply click the Calculate button and the program computes and displays both the monthly payment amount and the total cost of the loan.

It might happen that you have the cash, but you're considering investing it rather than blowing it on computers. MacFinance can help you here, too. The Investing window in Figure 2 shows you what a CD costing about as much as the loan in the left window would yield. At the respective rates given here, it will cost about $500 to borrow the $2,433.35 for

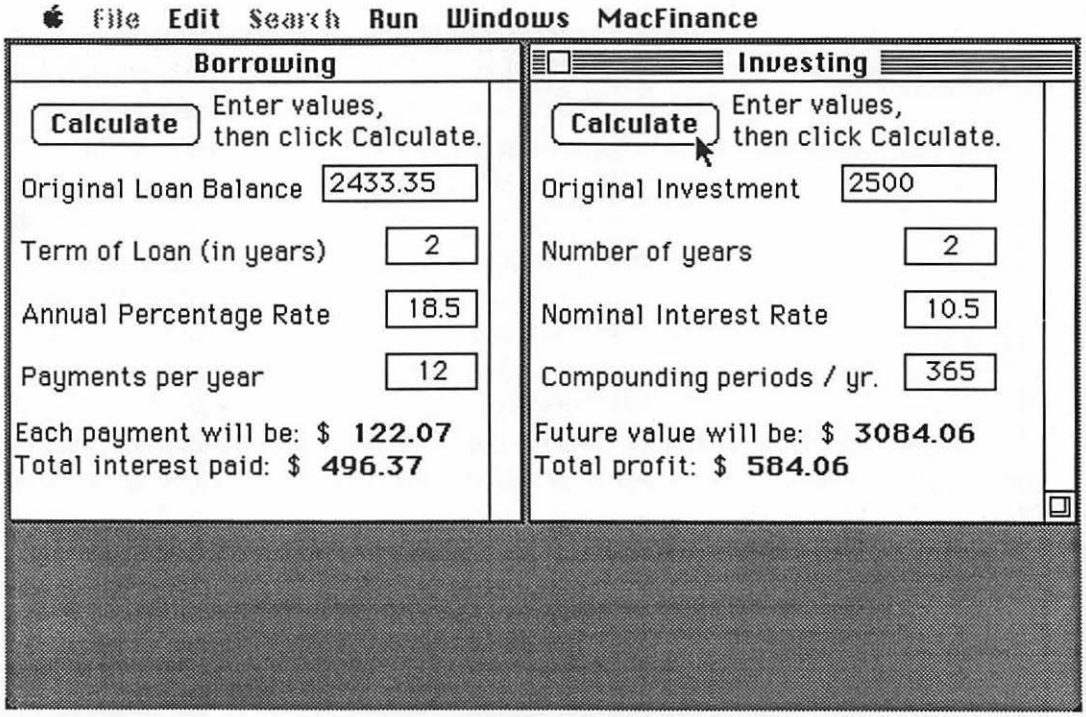


FIGURE 2. *The MacFinance work windows*

two years, whereas you could make almost $600 on the investment. Thus it might make more sense to invest the money and finance the computer purchase than to pay cash. To be sure, it's marginal, and other factors might push the argument either way. Since we're here to advise you on BASIC programming, not on managing your money, we'll let it go at that.

Although MacFinance is somewhat limited as a financial planning tool, it is expandable, and studying it closely will reward you with a real mastery of interactive programming on the Macintosh, not to mention window-refreshing techniques.

How MacFinance works

This program configures and enables two windows, one for borrowing and one for lending. Choosing the appropriate menu item opens the window. Once open, windows can be sized, moved, or closed. Only one window is active at a time, but the contents of each window are preserved until the window's close box is clicked.

These windows should be distinguished from the dialog boxes used for many functions in our programs. MacFinance's windows are dynamic, which means that the program must keep track of their status, manage their edit fields, and refresh their contents when they move on and off each other or a dialog box covers them up. These operations are handled by checking for the appropriate dialog event and examining the window's current status, as shown in the program outline in Figure 3.

Initialization	
dimension arrays for edit fields and prompts	**Init 1**
define functions	
initialize arrays for edit fields (**InitFields**)	**Init 2** (SR 6)
install MacFinance menu	
enable menu and dialog event-trapping	
open title window	
Main Program	
create endless loop interrupted by menu and dialog events	**Main**
Menu Events	
MenuEvent:	**ME 0**
suspend dialog event trapping	
disable menu	
branch to appropriate subroutine	
enable menu and resume dialog event-trapping	

(continued)

FIGURE 3. *Program outline*

OpenWind: open window for borrowing or investing — **ME 1**
create Calculate button

Instructions: display instructions — **ME 2**
open window 3
print instructions
create button, wait for button click
close window

BasQuit: quit to BASIC — **ME 3**

DeskQuit: quit to Mac Desktop — **ME 4**

Dialog Events

DialogEvent: — **DE 0**
suspend menu event trapping
branch to appropriate subroutine
resume menu event trapping

Btn: button clicked in current window — **DE 1**
if button clicked, perform calculation (**Calculate**) — SR 2

NField: move to a new edit field — **DE 2**
save contents of all edit fields (**GetEditFields**) — SR4

NewWindow: make a new window active — **DE 3**

GoAway: click in close box of current window — **DE 4**
if title window, just allow closing
close Calculate button
reactivate pertinent menu item
set new window flag

Refresh: refresh part of a window — **DE 5**
get window number
save last window number
set output to new window
if title window, redraw title screen (**TitleScreen**) — SR 7
if not, redraw pertinent window (**DrawWindow**) — SR 1
reset output to last window
switch to active edit field for that window

Key: Return to Tab key pressed — **DE 6**
save contents of edit fields (**GetEditFields**) — SR 4
increment to next field
move to that field

Subroutines

DrawWindow: — **SR 1**
display message
activate edit fields in current window (**FieldActivate**) — SP 1
set current edit field
if calc. flag set for current window (**Calculate**) — SR 2

(continued)

Figure 3. Program outline (continued)

```
Calculate:                                                    SR 2
   get values from edit fields (GetEditFields)                SR 4
   assign values to variables
   enable error trapping (ErrorHandler)                       SR 3
   do investment or loan calculation
   display formatted result
   disable error trapping

ErrorHandler: handle case of division by zero in calculation  SR 3

GetEditFields: get contents of edit fields in current window  SR 4

CleanUp: close all windows and edit fields, reset menu        SR 5

Initialize:                                                   SR 6
   initialize edit field contents, window and field flags
   read contents of edit field prompts

TitleScreen: display contents of title screen                 SR 7

Subprogram
FieldActivate:                                                SP 1
   find location and justification parameter of specified field
   display field label
   create edit field with current contents
```

Figure 3. Program outline (continued)

Initialization

Several arrays need to be established for maintaining the edit fields. *editField$* will contain the numbers the user types into the eight edit fields (four per window). *editName$* contains the descriptive labels, or prompts, that will be printed in front of the edit fields, and also the description of the totals. *wCalc* is an array of two flags that will indicate whether a calculation has been done in a given window. We need to keep track of this so that the program will know whether a calculation has to be redone when a window is refreshed after being covered. Finally, the array *fieldID* holds the edit field ID of the current edit field in each window.

Since anything that is typed into an edit field is treated as a string, numbers in edit fields must be converted to their numeric values before any calculations can be performed with them. The function DollarVal is therefore defined to convert an edit-field string to its dollar value, removing the dollar sign if it's present. If you sort out the parentheses, you'll see that the value of the expression *(LEFT$(d$,1) = "$")* is being added to the length of *d$*, and the RIGHT$ function is being used to extract that many characters starting from the right. The trick is that if the first character

in *d$* is a dollar sign, the expression is true and thus has a numeric value of −1. This means that 1 is subtracted from the length of the string, so RIGHT$ will extract everything except the dollar sign. If there is no dollar sign, the expression is false (0), so the full length of the string is extracted. Finally, the VAL (numeric value) of the string is taken.

Next, the TwoDec function is defined, which formats the display of dollar amounts calculated by the program, and the WINDOW CLOSE statement ensures that any remaining window is closed. This is always a good idea, because a program might run out of memory if the environment it happens to run in has a lot of memory tied up in windows and associated edit fields and buttons.

InitFields [SR 6] is then called to set up the conditions for the starting environment. This involves establishing the contents of the arrays just described, which will provide the window contents when the windows are created. The first pair of nested FOR...NEXT loops in this subroutine puts a dollar sign as the default string in the first edit field for each of the two windows. This will remind the user that the first item in each window is a dollar amount. The inner loop in the pair sets the remaining three edit fields in each window to null or nothing (""). The first edit field in each window is made the current edit field. The "calculation has been done" flag for each window is initialized to *false,* and the "newly entered window" flag is set to *true.* (The latter is logical because whichever window is first used is by definition "new.") Finally, the second FOR...NEXT pair reads in the edit-field names from the DATA statements in FieldNames [Dat]. Putting these strings in DATA statements makes it very easy to change them if you want to.

Control now returns to [Init 2]. The MacFinance menu is set up, and menu event-trapping is enabled. Menu events are handled by Menu Event [ME 0]. Dialog events (in this program, these are activities affecting windows and edit fields) are also enabled: They will be handled by DialogEvent [DE 0].

The MacFinance title window is now created, in what proves to be a rather arcane fashion. TitleScreen [SR 7] displays the window straightforwardly enough. The mystery is in how this subroutine gets called. Somehow it has been executed before we get to the main program loop [Main], since the title window appears when the program starts even though no obvious call to TitleScreen has appeared.

Doing a little detective work, we find that the only mention of TitleScreen (other than the subroutine label itself) is in Refresh [DE 5].

It happens that when a window needs to be refreshed, DIALOG(0) returns the value 5. This event also triggers the dialog trap, which sends control to DialogEvent [DE 0]. The ON DIALOG(0) GOSUB here passes the baton to Refresh. Looking at the code in Refresh, we see that TitleScreen is called if the title window (Window 4) needs refreshing. When the window is first created, the window immediately needs to be refreshed, and its contents are displayed. Got all that? Wow!

Processing menu events

As previously mentioned, menu events are processed by MenuEvent [ME 0]. The first thing this subroutine does is *suspend* dialog event-trapping with the DIALOG STOP statement. Note carefully the distinction between *suspending* dialog event-trapping with DIALOG STOP and *disabling* it with DIALOG OFF. Suspending dialog event-trapping allows BASIC to continue to record all dialog events but defers dialog event-trapping until DIALOG is turned back ON. At that point, DIALOG(0) will return the latest dialog event in the queue, another DIALOG(0) will return the next most recent event, and so on until all unprocessed events have been obtained. It's like handing each customer a numbered ticket rather than closing the shop each time we wait on someone.

MenuEvent next checks the MENU(0) function to get the number of the menu from which the choice was made. As the program is currently set up, the MacFinance menu (number 6, since menus are numbered starting from 0 at the left) is the only menu that would be in use. However, using MENU(0) rather than just assuming Menu 6 makes it easier to install additional menus if you wish.

The menu selected is then disabled, the item number of the selection (*item*) is obtained from the MENU(1) function, and the variable *windID* (window ID) is set to the item number. Since the menu is arranged so that Borrowing is item 1 and Investing item 2, the item number corresponds to the ID of the window that will be used for the selected option. This allows us to use general-purpose routines to manage windows based on their IDs. (The Instructions and the two quit menu operations receive window IDs 3 through 6, but these are not further used, since Instructions uses a fixed window and the quit options don't involve windows at all.)

Let's look now at the way the two major options, Borrowing and Investing, are processed. In both cases, control goes to OpenWind [ME 1]. This subroutine opens the appropriate window as specified by the value of *windID*. Note the coordinates that put Window 1, titled "Borrowing," in the left half of the screen and Window 2, titled "Investing," in the right

half. Also note that the last number in the WINDOW statements indicates the window is type 1, a "document window," which is movable and includes a size box and a title bar. Compare this with the window created in Instructions [ME 2], which is type 2—a fixed dialog box.

After the selected window is opened, the corresponding menu item is disabled (dimmed) and the Calculate button is created. You might wonder how one set of coordinates can specify a button that can go in either of two windows. The answer is that the coordinates for the rectangle specified in the BUTTON statement are always *relative* to the current Output window, so the button automatically goes in the appropriate position in whichever window is being created.

That's all the processing that the program does here. BASIC records all the user activities of entering data and requesting calculation, as well as manipulating windows once they exist, as *dialog* events, which will be processed by DialogEvent [DE 0]. We will note in passing that the Instructions [ME 2] and the two quit menu events [ME 3] and [ME 4] are set up as usual for programs in this book, except that the quit options call an additional subroutine, CleanUp (SR 5) for their janitorial service. Now let's go on to explore the many dialog events involved in MacFinance.

Dialog events

DialogEvent [DE 0] first suspends menu event-trapping, for the same reasons MenuEvent suspends dialog event-trapping. The current window ID is obtained from WINDOW(0); this function returns the ID of the window that is currently active. A window is active when it is first opened, and again later if the user clicks in it to make it active. The BUTTON and EDIT FIELD statements and functions are always related to the active window.

The function DIALOG(0) returns the number associated with the dialog event encountered. The ON...GOSUB statement then transfers control to the appropriate subroutine.

Now let's look at the events that must be handled. Rather than take them in the order they appear in the code (which is determined by the numbers BASIC assigns to the corresponding dialog events), we'll break them down into these two categories: window manipulation, and data entry and calculation.

Window manipulation

If the user activates a window by clicking in it, NewWindow [DE 3] is called. This subroutine gets the window ID from DIALOG(3), which

has been defined so it will return the window ID of the newly activated window. A WINDOW statement then makes this window the current Output window so that any text that will be displayed during subsequent processing (such as the result of a calculation) will be displayed in this window. Both calculation windows can be on the screen (along with things like the Macintosh calculator and other desk accessories), but only one window will be active and be the current Output window. Field editing and dialog functions will all relate to this window.

If the user clicks the close box to remove a window, GoAway [DE 4] is called. DIALOG(4) contains the ID of the window clicked on. Since the title window has no buttons and is not connected with any menu item, we simply return if that was the window closed. Otherwise, the Calculate button in the current window is removed, the corresponding menu item is reactivated so the user can create this window again later, and the corresponding flag in the *newWind* array is set to *true,* indicating that this is a "new" window—which it will be if it's requested and set up again later and we need to restore its contents. (We'll see later why we need to keep track of this "new" window.)

The Macintosh takes care of moving and changing the size of windows, but the programmer is responsible for restoring windows' contents that may have been overwritten, such as by other windows being moved over them. When MacFinance needs to refresh a window, it calls Refresh [DE 5]. In this subroutine, DIALOG(5) returns the ID of the window in question. The variable *crntWind* is used to save the ID of the current window (which may not be the same as the one that needs refreshing), obtaining it from the WINDOW(1) function. The WINDOW OUTPUT statement then directs output to the window to be refreshed. If the window ID indicates that it is the title window, TitleScreen [SR 7] is called to redraw this window (you may remember that this is how the title window is drawn in the first place).

If the window to be refreshed is not the title screen, DrawWindow [SR 1] will be used to redraw the window. This subroutine first prints the "generic" instructions in the window (again, the coordinates used are relative to the current Output window, so they work in either window). Then a FOR...NEXT loop calls the FieldActivate subprogram [SP 1] four times to activate the four edit fields.

Note that FieldActivate is a subprogram, not a subroutine. This allows us to give it (via the SHARED statement) just the global variables it needs, so we don't have conflict between variables in the subprogram and the main program. The STATIC attribute preserves the values of the

specified variables between calls to the subprogram. The shared data accessed by the subprogram consists of the *editName$* and *editField$* string arrays, which, you may recall, contain the prompts and the default contents respectively of the four edit fields in each of the two windows. The other variables accessed are the *newWind* flag array and *fieldBase* (set in InitFields), which holds the y coordinate of the first edit field.

The y coordinate for the base of the edit field is offset by multiplying the field ID (which will be incremented in turn by the FOR...NEXT loop in the calling routine, DrawWindow) by 30 to get the desired spacing between fields. The variable *left* is set to the coordinate for the left boundary of the edit field; the IF statement is needed because the first field is much wider than the others and thus needs to start farther to the left than the others. The variable *just* is also set; it is used to justify the contents of the field boxes: The first edit field will be left justified, and the rest will be center justified.

The appropriate prompt or label is first printed near the left boundary of the window. The string to be displayed in the window is then obtained. Finally, if the *newWind* flag for the current window ID indicates that it's a "new" window (one just activated or one that was closed and then requested again from the menu), the EDIT FIELD statement is used to establish the edit field with the specified ID, default contents, rectangle coordinates, type, and justification, which uses the value stored in *just*. (If you're not familiar with the options that can be specified in the EDIT FIELD statement and how they determine the appearance and behavior of the edit field, please see the detailed discussion of edit fields in the MacGraph chapter.)

After the edit fields have been established or reactivated and we've returned from the subprogram, DrawWindow uses one more EDIT FIELD statement to make the edit field whose ID is stored in *fieldID* for the currently active window the current edit field. This means that the user can pick up where he or she left off when reactivating a window. DrawWindow then sets the appropriate *newWind* flag to *false*. If a calculation result had been obtained since the window was activated (as indicated by the flag in the *wCalc* array), DrawWindow calls Calculate [SR 2] to perform the calculation again and put the result in the "total" area of the window. (We'll talk more about Calculate a little later, when we discuss what happens when the user clicks the Calculate button.)

Upon return to Refresh, the output is reset to the current window (whose ID we saved in *crntWind*)—which, as we have noted, may not be the same as the window that was refreshed. Also, if the ID indicates that

the window is one of the calculation windows, an EDIT FIELD statement is used to reestablish the current edit field. Again, we must do this because the refreshed window in which we set the current edit field may not be the current Output window, which has the edit field we *really* want to be current, since this is the window where the user is acting.

Now that we've covered how the user's movement between windows and other window manipulation dialog events are handled, we're ready to get to the actual work done by the program: getting data and performing calculations. It is often said that modern software uses more code to support the user's interaction (to be "friendly") than to actually perform the tasks the program was written for. This recognition of the importance of the human element in computer use is integral to the Macintosh, so it's not surprising that many Macintosh programs that do relatively little actual data processing (like this one, for example) have a large proportion of "support" code.

Data entry and calculations

Only one edit field in the current window is active at any one time. The user may type a number in, erase with the Backspace key, select the field, and cut, paste, and copy it with the standard Macintosh editing facilities. These activities are handled automatically by BASIC. However, when the user wants to move to a new edit field by either clicking the pointer in it, or pressing the Tab or Return key, the program must take several actions to keep track of things.

NField [DE 2] is called when the program detects a dialog event indicating that the user clicked in a new edit field. This subroutine calls GetEditFields [SR 4], which uses a FOR...NEXT loop to assign the current contents of the edit fields in the active window to the *editField$* array. You will recall that this array is initialized to default strings (the dollar sign for the first field, nothing for the others), but when the user has moved to a new field one or more fields probably have data in them. The data is found via BASIC's EDIT$ function, which then returns the contents of the specified edit field.

After returning from this subroutine, NField makes the new edit field (whose ID is returned by DIALOG(2)) the new current edit field. It also sets the corresponding current field indicator in *fieldID* for future use.

The other two ways the user can get into a new edit field are by pressing the Return or the Tab key. These keys also generate dialog events, both of which take us to Key [DE 6]. This processing, like that in NField, calls GetEditFields. Next, the new field ID must be obtained. It can't be

gotten from a dialog function, as it was with the mouse click, but we know it should be the next ID (or 1, if the user moved from field 4). Thus the current field ID is simply MODded with 4 to get the new ID, our current field ID is updated, and the new field is edited with an EDIT FIELD statement.

After entering data, the user will eventually click on the Calculate button to get a total. The "button click" dialog event sends control to Btn [DE 1], which checks DIALOG(1) to find which button was pressed. If it is the Calculate button, Calculate [SR 2] is called.

This subroutine first calls GetEditFields to ensure that it has the latest data from the edit fields. Then the DollarVal function discussed earlier is used to get the numeric values from the edit fields into the appropriate variables. Because both the loan and the investment calculations use the same variables for principal, number of years, interest rate, and periods per year, the same variables can reasonably be used in the program code for either calculation.

Before the subroutine performs the appropriate calculation, an ON ERROR GOTO statement traps the possible error of division by zero. This statement will call ErrorHandler [SR 3] if an error is detected. If the error is other than division by zero, the ERROR statement in ErrorHandler prints the error number. If the error is division by zero (by far the most likely error here), the total is set to zero and the routine returns to Calculate. (Of course, you could add an error message to make the problem more explicit to the user if you wish.)

Either the loan or the investment calculation is now performed, depending on which window is current. The formulas are too complex to explain here, but we will say that they're based on the standard compound interest formula used by banks and loan companies.

Finally, the appropriate flag in *wCalc* is set to indicate that a calculation has been performed in the current window (which may have to be refreshed later). The appropriate label and value are then printed. Note that the value is rounded to two decimal places using the TwoDec function defined in [Init 1]. If you don't like occasionally getting an answer like $345.2 (instead of $345.20), you could add the appropriate code to include the trailing zero(es).

Suggestions for MacFinance

Unlike traditional programs, which have paths through them rigidly laid out, Macintosh programs that take advantage of the user interface tend to have the kind of "woven" structure we observed in MacFinance, where

the flow of control depends on both menu and dialog events. This structure (or seeming lack of it) may take a little getting used to. However, when you understand how the menu and dialog events interact, you will be rewarded with the ability to use the full potential of that user interface.

It would be fairly easy to add more windows to MacFinance for additional financial calculations. If a new calculation is a variant of the existing ones and also uses four variables, you would only have to add the necessary elements to the arrays and handle the new menu selection. If your calculation is substantially different from ours, you would probably want to generalize the subroutines involving field editing and window refreshing so that you could handle a varying number of edit fields.

MacFinance program listing

```
'*************************************************************
'                          MacFinance
'                       Financial Package
'*************************************************************

'*********************************************** INITIALIZE
INIT 1  CLEAR ,12000                          'permits smoother run on Slim Mac
        false = 0 : true = NOT false
        OPTION BASE 1
        DIM editField$(2,4), editName$(2,6), wCalc(2), fieldID(2)
                          'DollarVal returns dollar value of string, ignoring leading $
        DEF FN DollarVal(d$) = VAL(RIGHT$(d$, LEN(d$) + (LEFT$(d$,1) = "$")))
        DEF FN TwoDec(z) = INT(z * 100 + .5) / 100          'round to two decimal places

INIT 2  WINDOW CLOSE 1                                      'start with blank screen
        GOSUB InitFields

        MENU 6, 0, 1, "MacFinance"                          'install MacFinance menu
        MENU 6, 1, 1, "Borrowing"
        MENU 6, 2, 1, "Investing"
        MENU 6, 3, 1, "Instructions"
        MENU 6, 4, 0 , "-"
        MENU 6, 5, 1, "Quit to BASIC"
        MENU 6, 6, 1, "Quit to Desktop"
        ON MENU GOSUB MenuEvent : MENU ON
        ON DIALOG GOSUB DialogEvent : DIALOG ON

        WINDOW 4, "MacFinance", (2,40) - (508,337), 1       'open title window

'*********************************************** MAIN PROGRAM
MAIN    WHILE true : WEND                   'endless loop; wait for any event trapping

'*********************************************** MENU EVENTS
ME 0    MenuEvent:
          DIALOG STOP
          menuBar = MENU(0)
          MENU menuBar, 0, 0                                'disable menu
          item = MENU(1) : windID = item                    'window 1 is item 1, etc...
          ON item GOSUB OpenWind, OpenWind, Instructions, , BasQuit, DeskQuit
          MENU menuBar,0,1                                  're-enable menu
          DIALOG ON
          RETURN

ME 1    OpenWind:           '_____ open and form window indicated by windID
          IF windID = 1 THEN WINDOW 1, "Borrowing", (3,40) - (245,250), 1
          IF windID = 2 THEN WINDOW 2, "Investing", (250,40) - (509,250), 1
          CALL TEXTMODE(1)
          MENU 6, windID, 0
          BUTTON 1, 1, "Calculate", (10,10) - (90,30), 1
          RETURN
```

```
Instructions:           '_____ show user some instructions
   WINDOW 3, , (16,55) - (495,325), 2
   PRINT
   PRINT "                    Instructions for MacFinance"
   PRINT
   PRINT "     This program allows you to calculate both sides of the lending"
   PRINT " game.  You can see both what your payments would be if you borrowed"
   PRINT " money, and how much you would make if you lent it."
   PRINT
   PRINT "     Choose either Borrowing or Investing from the MacFinance menu."
   PRINT " For either one, enter the values you wish to try.  Then click the Calculate"
   PRINT " button in the respective window to see what the result will be."
   PRINT
   PRINT "     While entering numbers, pressing either the Tab or Return key can be"
   PRINT " used to move to the next edit box."
   PRINT
   CALL INITCURSOR
   BUTTON 1, 1, "Continue", (190,240) - (280,260)
   WHILE DIALOG(0) <> 1 : WEND
   BUTTON CLOSE 1 : WINDOW CLOSE 3
   RETURN

BasQuit:                '_____ quit to BASIC
   GOSUB CleanUp
   END

DeskQuit:               '_____ quit to Mac Desktop
   GOSUB CleanUp
   SYSTEM

'********************************************** DIALOG EVENTS
DialogEvent:
   MENU STOP
   windID = WINDOW(0)                  ' Set current window, and act on dialog event.
   ON DIALOG(0) GOSUB Btn, NField, NewWindow, GoAway, Refresh, Key, Key
   MENU ON
   RETURN

Btn:                    '_____ button clicked in current window
   buttonID = DIALOG(1)                                    'which button?
   IF buttonID = 1 THEN  GOSUB Calculate
   RETURN

NField:                 '_____ move to a new edit field
   GOSUB GetEditFields
   EDIT FIELD DIALOG(2)
   fieldID(windID) = DIALOG(2)
   RETURN
```

ME 2

ME 3

ME 4

DE 0

DE 1

DE 2

DE 3
```
NewWindow:                    '_____ click in a new window
  WINDOW DIALOG(3)
  RETURN
```

DE 4
```
GoAway:                       '_____ close box clicked in current window
  IF DIALOG(4) = 4 THEN RETURN                    'don't worry about title window
  BUTTON CLOSE 1
  MENU 6, DIALOG(4), 1                            'reactivate menu item
  newWind(DIALOG(4)) = true                       'set new window flag
  RETURN
```

DE 5
```
Refresh:                      '_____ refresh indicated window
  windID = DIALOG(5)                              'get window number
  crntWind = WINDOW(1)                            'save current window number
  WINDOW OUTPUT(windID)                           'set output to window to refresh
  IF windID = 4 THEN GOSUB TitleScreen ELSE GOSUB DrawWindow
  WINDOW OUTPUT(crntWind)                         'reset output to first window
  IF crntWind = 1 OR crntWind = 2 THEN EDIT FIELD fieldID(crntWind)
  RETURN
```

DE 6
```
Key:                          '_____ Return or Tab key pressed; move to next field
  GOSUB GetEditFields
  fieldID(windID) = (fieldID(windID) MOD 4) + 1
  EDIT FIELD fieldID(windID)
  RETURN
```

```
'* * * *
```

```
    IF windID <> 1 THEN Investing
    growthRate = rate / (100 * period)
    amt = prin * growthRate / (1 - 1 / (1 + growthRate) ^ (period * years))
    GOTO PrintTotal
Investing:                                                    'investment value
    growthRate = 1 + rate / (100 * period)                    'convert decimal to percent
    amt = prin * growthRate ^ (period * years)                'calculate investment amount

PrintTotal:
    ON ERROR GOTO 0                                           'disable error trapping
    wCalc(windID) = true                                      'flag calculation for this window

    CALL TEXTMODE(0)
    LOCATE 11,1 : PRINT editName$(windID,5);
    CALL TEXTFACE(1) : PRINT FN TwoDec(amt) : CALL TEXTFACE(0)
    PRINT editName$(windID,6);
    CALL TEXTFACE(1)
    IF windID = 1 THEN PRINT FN TwoDec(amt * period * years - prin)
    IF windID = 2 THEN PRINT FN TwoDec(amt - prin)
    CALL TEXTMODE(1) : CALL TEXTFACE(0)
    RETURN

ErrorHandler:          '_____ handle Division by Zero error
    IF ERR <> 11 THEN ERROR ERR
    t = 0
    RESUME NEXT

GetEditFields:         '_____ get active edit fields and save them
    FOR n = 1 TO 4
      editField$(windID,n) = EDIT$(n)
    NEXT
    RETURN

CleanUp:               '_____ clean up before quitting
    FOR n = 1 TO 4
      WINDOW CLOSE n
      EDIT FIELD CLOSE n
    NEXT
    MENU RESET
    RETURN

InitFields:            '_____ set up startup configuration
    fieldBase = 55                                            'first field starts at this y coord
    FOR windID = 1 TO 2                                       'for both windows, initialize with
      editField$(windID,1) = "$"                              'default edit field strings
      FOR fieldID = 2 TO 4
        editField$(windID,fieldID) = ""
      NEXT
```

SR 3

SR 4

SR 5

SR 6

```
    fieldID(windID) = 1                          'current edit field number
    wCalc(windID) = false                        'true if there has been a calculation.
    newWind(windID) = true                       'true if a new window
  NEXT windID

  RESTORE FieldNames                             'initialize edit field names from DATA
  FOR n = 1 TO 2
    FOR m = 1 TO 6
      READ editName$(n,m)
    NEXT m
  NEXT n
  RETURN
```

SR 7

```
TitleScreen:                    '_____ display title screen
  CALL TEXTFONT(0) : CALL TEXTSIZE(36) : CALL TEXTMODE(1)
  CALL MOVETO(112,72) : PRINT "MacFinance"
  CALL TEXTSIZE(12)
  CALL MOVETO(110,144) : PRINT "Calculate Loan or Lending payments."
  CALL TEXTFONT(1)
  CALL MOVETO(100,280)
  PRINT "Choose an option from the MacFinance Menu.";
  RETURN
```

SP 1

```
SUB FieldActivate(win,fieldID) STATIC          '_____ activate an edit field
  SHARED editName$(), editField$(), newWind(), fieldBase
  b = fieldBase + (fieldID - 1) * 30                                'y baseline
  IF fieldID = 1 THEN left = 150 : just = 1 ELSE left = 180 : just = 2
  CALL MOVETO(5,b)
  PRINT editName$(win,fieldID);
  f$ = editField$(win,fieldID)                                      'field default value
  IF newWind(win) THEN EDIT FIELD fieldID, f$, (left, b - 15) - (220,b), 1, just
  END SUB

FieldNames:                     '_____ names for each edit field for both windows
  DATA "Original Loan Balance", "Term of Loan (in years)"
  DATA "Annual Percentage Rate", "Payments per year"
  DATA "Each payment will be: $", "Total interest paid: $"
  DATA "Original Investment", "Number of years"
  DATA "Nominal Interest Rate", "Compounding periods / yr."
  DATA "Future value will be: $", "Total profit: $"
```

MacMeasure

Most of us have trouble figuring out how far it really is from point A to point B on a map. It's true that maps have scales that show how many actual units (usually miles or kilometers) are represented by a given distance on the map. We can then span the scale with our fingers and try to see approximately how many finger spans cover the map distance between the two points

of interest. If we want to be more precise in our calculations, we can measure both the scale and the map distance with a ruler, then use the formula (expressed here in miles):

$$\text{real dist. (miles)} = \text{map dist. (inches)} \times \frac{\text{scale dist. (miles)}}{\text{scale length (inches)}}$$

Thus, if the scale shows that 100 miles is equal to 3 inches and it's approximately 5 inches on the map from Mud Flats to Rambunctious Junction, we could figure that the actual distance between these points is $5 \times 100/3$, or about 167 miles.

Well, it happens that the Macintosh comes equipped with a built-in measuring device—the mouse. In order for the mouse to be the precise pointer it is, the Macintosh must convert the distance covered by the mouse to a proportional distance on the screen, measured in screen coordinates. MacMeasure takes advantage of this fact to create an automatic distance-measuring tool that enables you to quickly and easily determine the distances between points on a map.

How to use MacMeasure

When you run MacMeasure, you'll see the title screen shown in Figure 1. The MacMeasure menu contains two major options, Calibrate and Measure Trip, as well as the two standard quit options.

Calibrating the scale

Before you can measure distances on a map, you must tell MacMeasure the length of the map's scale and the distance the scale length represents. With your chosen map handy, pull down the MacMeasure menu and choose Calibrate. You'll see the screen of instructions shown in Figure 2.

The calibration process is simple. Move the mouse so that the pointer is on the left side of the screen. Put your map on a hard, flat surface and smooth out the wrinkles if there are any, then locate the map scale (usually near the bottom of the map or inset in a little box). Place the mouse so its left edge is lined up with the beginning of the scale. Now hold down the mouse button and slide the mouse along the scale. As you slide the mouse, a line is drawn on the screen (as shown in Figure 2) corresponding to the path of the mouse. This is a "rubber band" line—it stretches out behind the pointer and bends from side to side if the path you're tracing isn't quite straight. If the line isn't straight, simply adjust the mouse position until the line on the screen is straight. This will improve the accuracy

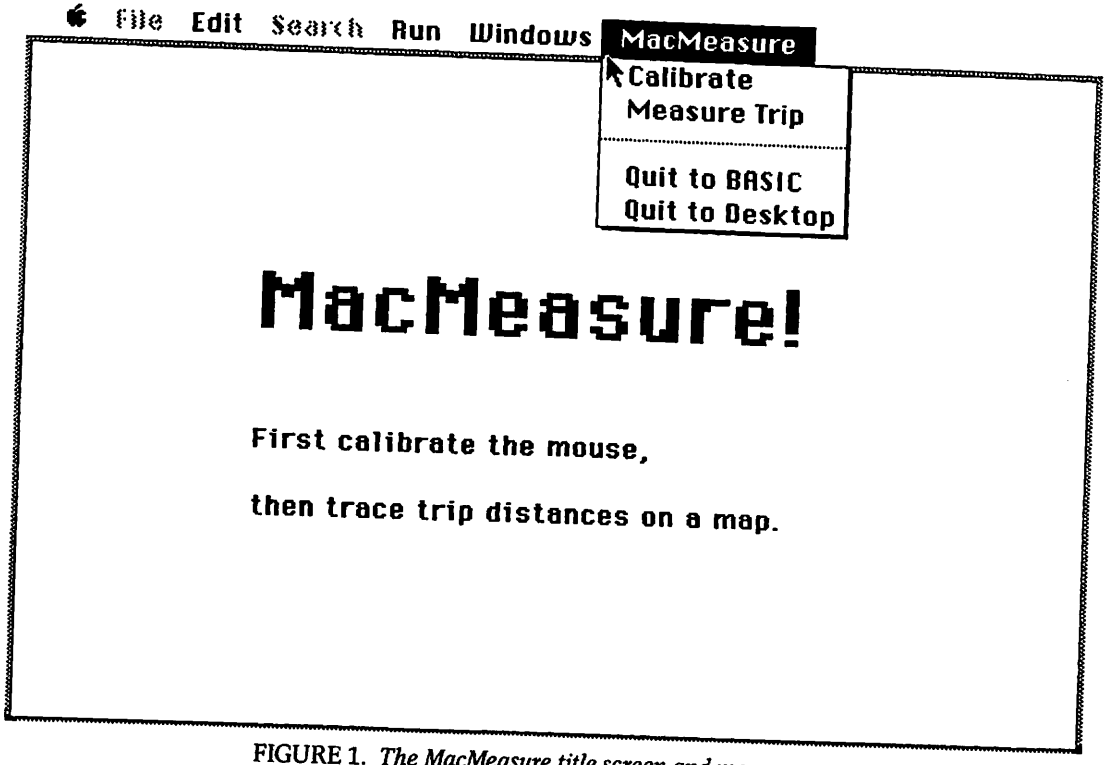


FIGURE 1. *The MacMeasure title screen and menu*

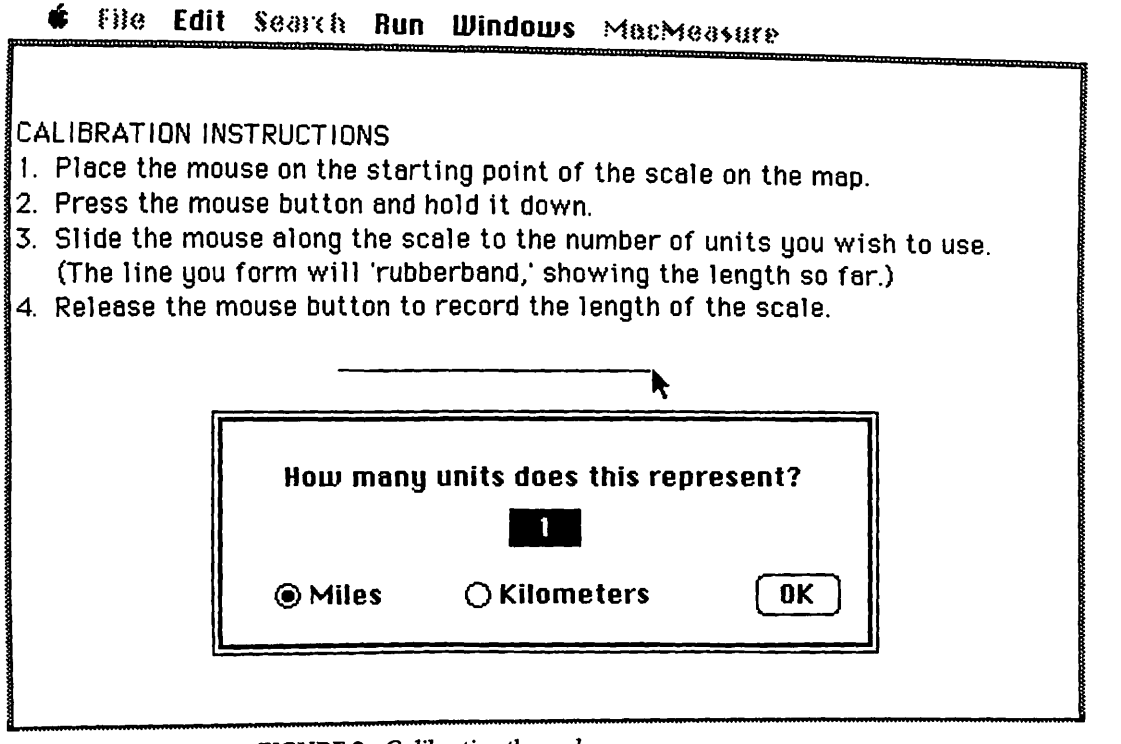
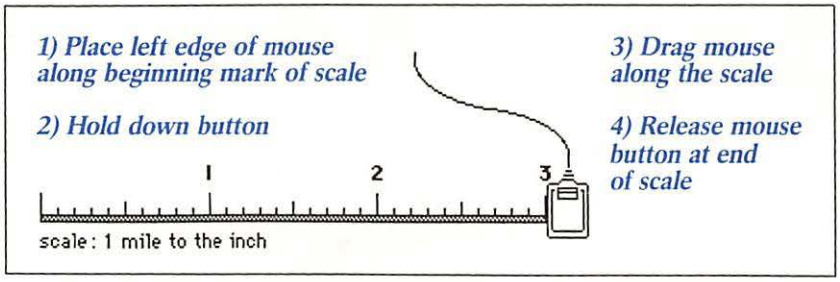


FIGURE 2. *Calibrating the scale*

of your calibration. If you happen to release the mouse button *without* moving the mouse, an error box appears and informs you that you have attempted to calibrate with a scale of "no length." If this happens, simply click the OK button in the box and start over.

Here's a drawing that illustrates how the four steps of the instructions would be carried out in practice:



When the left edge of the mouse reaches the end of the scale (or the end of the part you wish to use), release the mouse button. The dialog box shown in Figure 2 appears, asking what real distance (in miles or kilometers) is represented by the scale distance you traced. This is the number marked on the map scale at the point where you released the mouse button when calibrating. A default of 1 mile is shown, and you can edit the number using all the standard editing functions.

Two small "radio" buttons, marked Miles and Kilometers, appear near the bottom of the box. The default is miles; if you want to use kilometers, click on the Kilometers button. Select the unit corresponding to where you stopped calibrating. For example, if your map scale has both miles and kilometers and you released the button at the point indicating 500 miles, you would enter 500 for the number of units and leave the default button for Miles selected.

Clicking the OK button completes the calibration process and leaves you ready to measure distances on the map. Note that if you quit the program and restart, or decide to use a different map, you will have to repeat the calibration procedure.

Measuring trip distances

To measure a distance on your map, you need a reference point or mark on the mouse that you can use to make sure that you're tracing precisely between the two points in question. When you calibrate along the map scale, it isn't too hard to trace a straight line using the edge of the mouse, and the

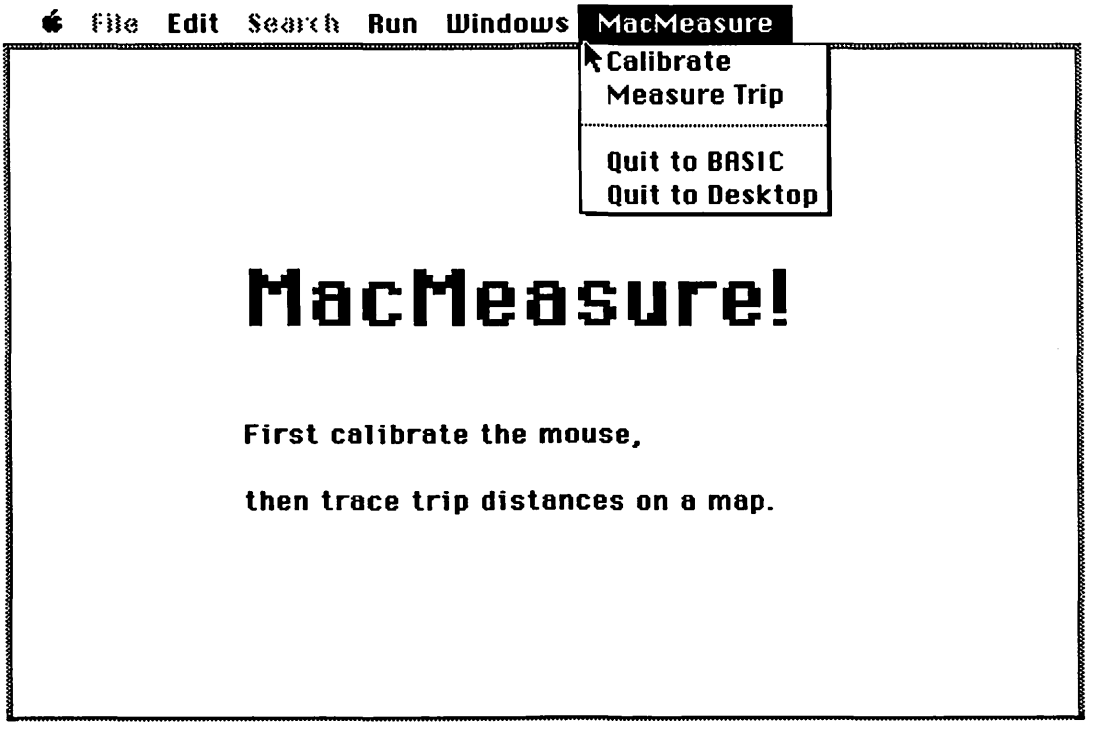


FIGURE 1. *The MacMeasure title screen and menu*

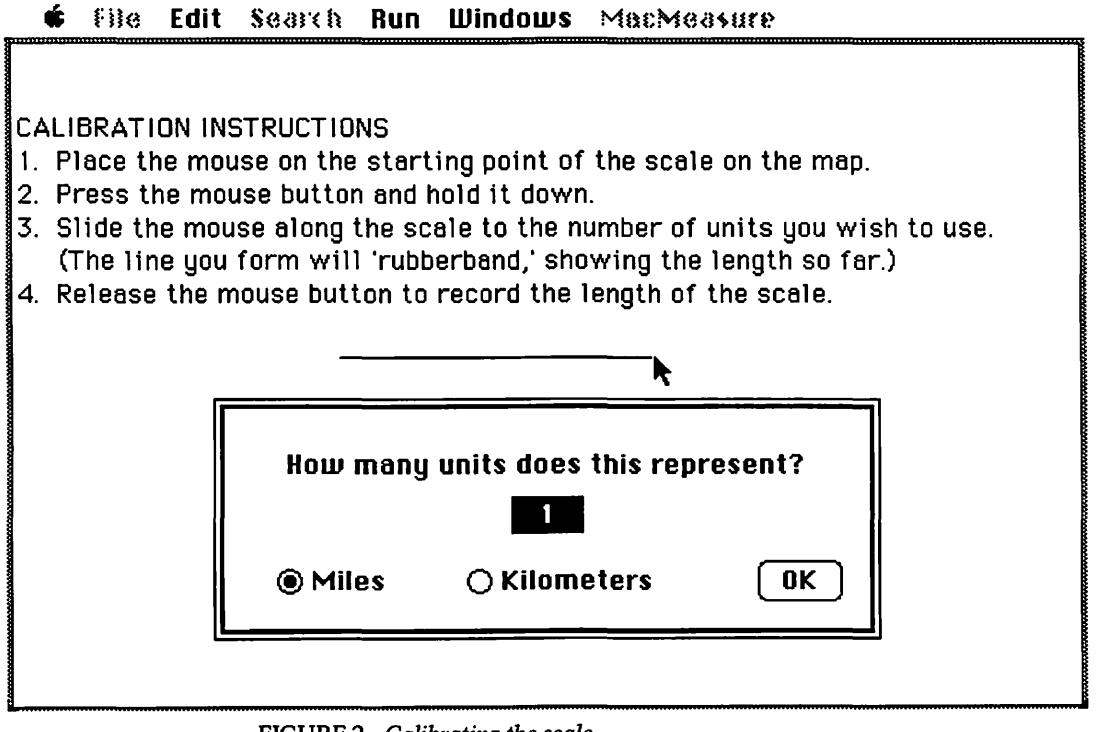
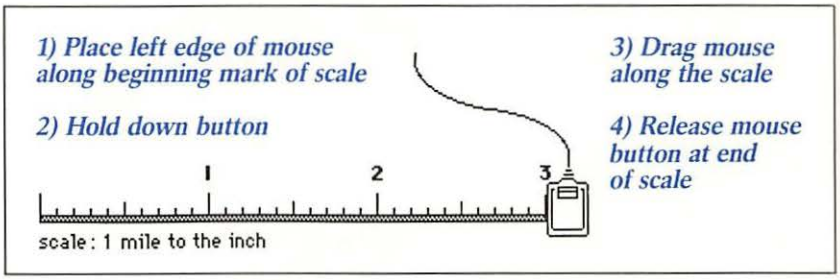


FIGURE 2. *Calibrating the scale*

of your calibration. If you happen to release the mouse button *without* moving the mouse, an error box appears and informs you that you have attempted to calibrate with a scale of "no length." If this happens, simply click the OK button in the box and start over.

Here's a drawing that illustrates how the four steps of the instructions would be carried out in practice:



When the left edge of the mouse reaches the end of the scale (or the end of the part you wish to use), release the mouse button. The dialog box shown in Figure 2 appears, asking what real distance (in miles or kilometers) is represented by the scale distance you traced. This is the number marked on the map scale at the point where you released the mouse button when calibrating. A default of 1 mile is shown, and you can edit the number using all the standard editing functions.

Two small "radio" buttons, marked Miles and Kilometers, appear near the bottom of the box. The default is miles; if you want to use kilometers, click on the Kilometers button. Select the unit corresponding to where you stopped calibrating. For example, if your map scale has both miles and kilometers and you released the button at the point indicating 500 miles, you would enter 500 for the number of units and leave the default button for Miles selected.

Clicking the OK button completes the calibration process and leaves you ready to measure distances on the map. Note that if you quit the program and restart, or decide to use a different map, you will have to repeat the calibration procedure.

Measuring trip distances

To measure a distance on your map, you need a reference point or mark on the mouse that you can use to make sure that you're tracing precisely between the two points in question. When you calibrate along the map scale, it isn't too hard to trace a straight line using the edge of the mouse, and the

"rubber band" indicates when the line is deviating. On a map, however, points may be at all sorts of angles to each other, since you'll probably want to trace along highway routes or other lines that have bends in them.

The best solution is to attach a pointer of some sort to the mouse. One quick and easy way of doing this is to find a round toothpick and break it in half. Take one half and wedge it in the outermost groove in the mouse cord's strain relief so that the point of the toothpick is suspended about a sixteenth of an inch above the surface of the map (see Figure 3). You can put the toothpick, or similar doodad, on either side of the strain relief depending on whether you're more comfortable with your left or right hand on the mouse. Then you're ready to start tracing complicated paths on the map. One warning though: Since the tracing pointer is a short distance away from the roller ball on the bottom of the mouse, you must make sure to keep the mouse square with respect to the sides and bottom of the map. In other words, try not to rotate the mouse when tracing.

Once you've established a reference point on the mouse, choose Measure Trip from the MacMeasure menu to open the window shown in Figure 4. A representation of the scale you have calibrated is displayed at the top of the window, along with some instructions. As the instructions indicate, you simply position the mouse reference point over the starting point on the map and click once to indicate that this is where measurement is to begin. You will hear a beep, and the trip-counter total will appear at the top of the screen. Initially it will show a trip of 0 miles (or kilometers, as appropriate). As you trace a path on the map, a dotted line appears behind the mouse pointer on the screen, and the trip counter is updated with the distance in your chosen units represented by the map distance you've

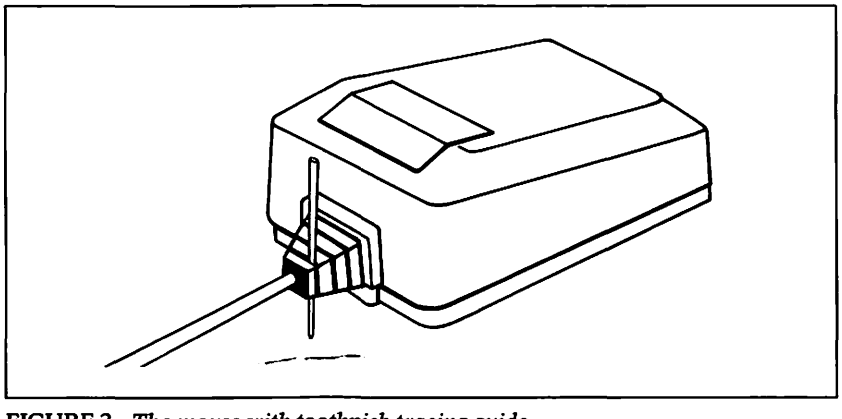


FIGURE 3. *The mouse with toothpick tracing guide*

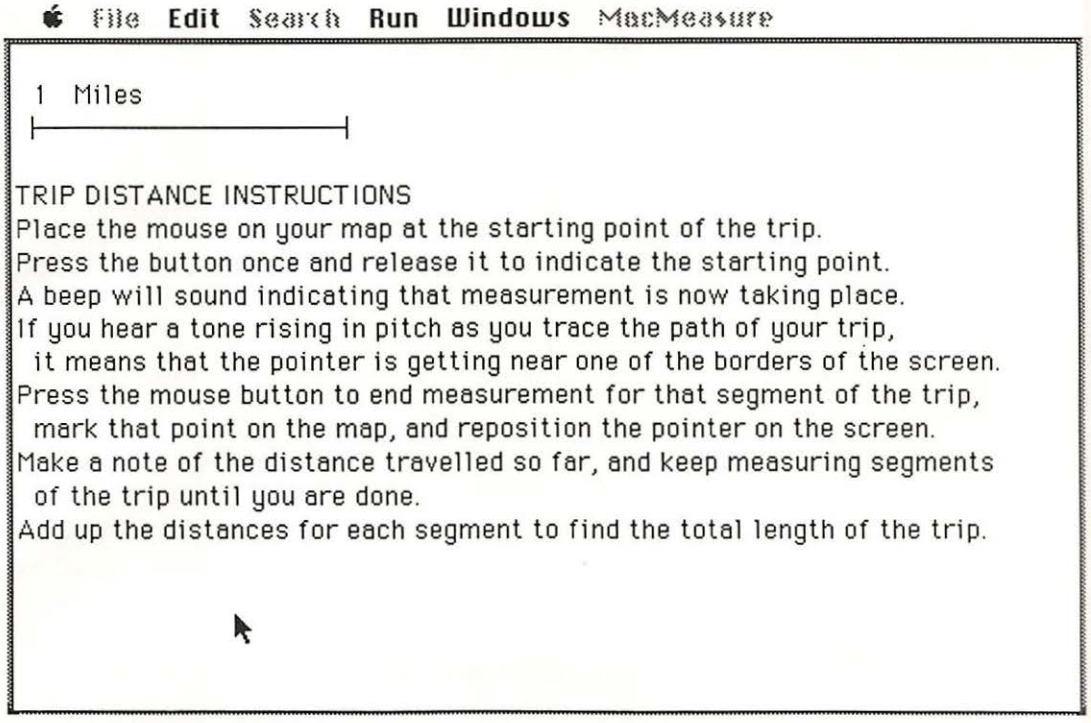
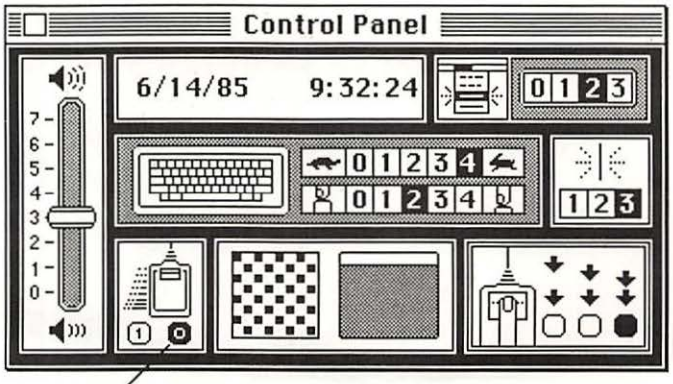


FIGURE 4. *The Measure Trip instruction window*

covered so far. When you've reached your destination on the map, click the mouse button once more to stop measurement.

At some point before you actually begin tracing your route on the map you must make sure that *mouse tracking* is set to 0. To do this, choose Control Panel from the Apple menu to open this window:



Set mouse tracking to 0 before tracing map

The two buttons labeled 0 and 1 in the mouse-tracking box affect the relationship between the movement of the mouse on a tabletop and the corresponding distance the mouse pointer travels on the screen. If the 1 button is selected, a "velocity component" of mouse movement is added to the actual distance traveled by the mouse. The effect is that faster movements of the mouse result in larger movements of the pointer on the screen, which will throw off the trip counter. Clicking the 0 button, however, establishes a one-to-one correspondence between mouse and pointer movements, resulting in greater accuracy when tracing routes on the map.

You may occasionally find that the mouse pointer reaches the edge of the screen before you've traced the full distance on the map. (It may help to know that the working area of the mouse on the tabletop is about the size of a postcard). Since you're likely to be looking at the map rather than at the screen, MacMeasure provides an audible warning for this situation: As the mouse pointer gets near a screen edge, you'll hear a "chut-chut" tone that will rise in pitch as you get closer to the edge. When you hear this tone, there are two things you can do.

If the map is small enough to turn easily, you can lift the mouse with one hand and rotate the map under it 180 degrees so that the destination is facing back the way you came. You can then continue tracing in that direction, and measurement will continue. Since the trip counter records only distance, not direction, the final total will be the same as if you had traced the whole distance in the same direction.

If the map is rather bulky, an alternative and altogether more workable approach is to mark the point on the map that you've reached, release the mouse button to stop measurement, and note the total on the trip counter. You can then move the mouse pointer to the left or the top of the screen (depending on the direction you're tracing) and measure the rest of the distance. When you're done, simply add the two distances together. In fact, you can use the built-in Macintosh calculator to record and add a series of distances in this fashion.

Unless you have a fairly large map, many repeated measurements or map rotations usually won't be necessary if you start your tracing with the arrow at the left side of the screen (if you're tracing distance in a west-east direction) or at the top of the screen (if you're tracing north-south).

After you finish a measurement, simply choose Measure Trip again if you want to make a new measurement. The trip counter will be reset to 0 automatically. Don't forget to recalibrate if you change maps or want to use a different scale or unit of measurement.

A little more about maps

Maps differ in both scale and projection. Scale is no problem, since MacMeasure can handle a small-scale map (for example, the whole state of California at 80 miles to the inch) just as easily as, say, a large-scale street map of your town, which might have a scale of only a half-mile to the inch. When the scale gets small enough, however (as on a map of the entire United States or the whole world), the problem of projection arises.

We won't go into the details of the way map projections are made. Let's just say that, in general, projection is an attempt to represent a round, three-dimensional object (the earth) on a flat piece of paper. In a small area the curvature of the earth doesn't make much difference, but over longer distances distortion occurs. For example, the most common world maps use the Mercator projection, which tends to make bodies of land near the poles much larger than they are in reality: Greenland is a good example. Other methods of projection represent areas accurately but introduce other types of distortion.

The main reason we mention this is to warn you that MacMeasure will not be as accurate on world maps as it is on maps of the United States or smaller areas. World maps often qualify their scale with a phrase like "along equator" or "along meridian." In the former case, MacMeasure will measure areas near the equator more accurately than those nearer the poles; north-south distances will be measured more accurately than east-west ones on maps scaled along the meridian.

If you're really interested in accuracy on small-scale maps, you can find formulas in books of navigation or cartography that provide for adjusting the scale of a map with a given type of projection according to the latitude or longitude at which you are measuring. You could modify MacMeasure's trip totals using the appropriate formula, or modify the program so it will ask you the latitude and/or longitude and apply the formula to calculate the result automatically.

How MacMeasure works

This program has a very simple structure. There are two main menu events—Calibrate and Measure Trip—and the two Quit options. An endless main loop waits for menu selections. The most interesting feature in the program is the way it uses the mouse as a measuring device. A program outline for MacMeasure is shown in Figure 5.

Initialization

initialize variables	**Init 1**
create window	**Init 2**
install MacMeasure menu, enable menu event-trapping	
display title screen	**Init 3**

Main Program

run in idle loop; wait for menu event	**Main**

Menu Events

MenuEvent: branch to appropriate subroutine	**ME 0**
Calibrate: calibrate mouse movement with map distance	**ME 1**
show instructions	**ME 1a**
WHILE a valid distance not entered	**ME 1b**
wait for a button press	
save start and end points of mouse drag (**GetMouse**)	SR 3
WHILE waiting for end of drag	
update line on screen (**GetMouse**, **DrawLine**)	SR 3, 4
WEND	
if distance covered at end of drag is zero,	
display error message (**ErrorMessage**)	SR 1
WEND	
create dialog box	**ME 1c**
ask user for equivalent map distance	
calculate scale from screen distance and map distance	
close dialog box	
Trip: measure a trip distance on the map	**ME 2**
display scale and unit of measurement	**ME 2a**
show instructions	
wait for first button press and release	**ME 2b**
WHILE mouse button not down	ME 2c
draw a dot at current pointer location	
get next pointer position	
if pointer in boundary area, sound alarm (**Warning**)	SP 1
find relative movement of pointer in pixels	
add distance to cumulative total distance in pixels	
convert distance to equivalent map distance	
set starting point for next movement of pointer	
WEND	
BasQuit: quit to BASIC	**ME 3**
DeskQuit: quit to Mac Desktop	**ME 4**

Subroutines

ErrorMessage:	**SR 1**
create dialog box (**SetupWindow**)	SR 2
display error message	
wait for button click, close box	
SetupWindow: create dialog box and OK button	**SR 2**
GetMouse: get coordinates of start and end of drag	**SR 3**
DrawLine: draw given line	**SR 4**

FIGURE 5. *Program outline*

Initialization

In [Init 1] the dimensions of the calibration dialog box are set, and the coordinates of the alarm positions (the left, right, top, and bottom boundaries at which we want to warn that the mouse is too close to the edge of the screen) are also established. The default unit type is set to "miles" (we're old-fashioned). The MacMeasure window is then set up.

The MacMeasure menu is set up in the [Init 2] subroutine and menu event-handling is enabled. [Init 3] draws the title screen (which is so simple that it doesn't need a separate subroutine).

The main program loop [Main] is an endless loop that waits for menu events. Menu events are handled by MenuEvent [ME 0]. The two Quit options [ME 3, ME 4] are standard and need no explanation. Now, with these preliminaries out of the way, let's look at MacMeasure's two main operations: the calibration of the mouse to a map scale and the measurement of distances on a map.

Calibration

The calibration procedure, logically enough, is handled by Calibrate [ME 1a-c]. It starts by clearing the screen and displaying the necessary instructions. In [ME 1b] the distance in pixels the mouse pointer will be moved is stored in the variable *distance,* which is initialized of course as 0. The calibration procedure is framed with an outer WHILE...WEND loop that will repeat until a valid distance is obtained—that is, until the mouse is clicked, dragged some distance, and released.

The first of two inner WHILE...WEND loops waits for the mouse button to be pressed. (Values of MOUSE(0) greater than −1 mean that the mouse is either not active at all or not currently down.) Once the mouse button is detected as being down, GetMouse [SR 3] is called. This subroutine gets two sets of coordinates: The point at which the mouse drag began (x1,y1) is obtained with MOUSE(3) and the point the mouse had reached at the time MOUSE(0) was last called (x2,y2) is obtained with MOUSE(6). If the drag has ended, the second point will be the location where the drag ended. The first time this subroutine is called, the mouse will have barely moved, but the distance will increase as the mouse is being dragged, so longer lines will be drawn.

Upon return from GetMouse, the mouse's starting coordinates are stored in the variables *startX* and *startY.* The PENMODE is then set to 10, or XOR. This lets us draw a line and then erase it by drawing the same line again, since XOR reverses any pixel that is already black when you

draw over it. DrawLine [SR 4] is now called to draw the first line. DrawLine uses the QuickDraw MOVETO routine to position the pen at the starting coordinates and then uses the QuickDraw LINETO routine to draw a line to the current mouse-pointer location.

A WHILE...WEND loop is then used to repeat this process as long as the mouse continues to be dragged. The first call to DrawLine in each pass has the effect of erasing the current line, due to the effect of XOR just described. GetMouse then gets new coordinates for the mouse, and another call to DrawLine draws a line to the new mouse position. Since this all happens rather quickly, the drawing and redrawing of the line and its following the mouse pointer from side to side if the mouse moves a bit up or down gives a stretching, or "rubber-band" effect.

When the mouse is no longer being dragged, the loop is exited. PENMODE is then set back to the default Copy mode, which draws a black line regardless of the contents of the existing screen, and DrawLine is called one more time to draw the final line representing the length of the scale on the map.

The scale distance is now converted to a unit distance. You may recall from your study of analytic geometry in your school days that the distance between two points, (x1,y1) and (x2,y2), is equal to the square root of the sum of the squares of the changes in the x and y coordinates of the points. In our case we have (*startX*,*startY*) as the starting point and (*x2*,*y2*) as the ending point. Thus the change in the x coordinate is $x2 - startX$ and the change in the y coordinate is $y2 - startY$. Each quantity is then squared, the two quantities are added together, and the square root of the whole shooting match is taken.

The program then checks to see whether the distance is zero: That is, the mouse hasn't been moved at all during the mouse drag. If this is the case, ErrorMessage [SR 1] is called. This in turn calls SetupWindow [SR 2], which creates a dialog box with an OK button. (Having this box set up by a separate subroutine is handy because we will need it more than once during the program.) After control returns to ErrorMessage, a message is displayed to the effect that the user has created a scale of zero length (which isn't very useful). ErrorMessage then waits for the OK button to be clicked, after which it closes the dialog box and returns control to Calibrate [ME 1a].

If the distance was 0, control goes back to the top of the loop in Calibrate [ME 1b] so that another attempt at calibration can be made (the user probably accidentally released the mouse button after the initial button press). If a valid distance was obtained, SetupWindow is called to set

up our multipurpose dialog box again. The dialog box then asks the user what the distance the mouse was dragged is supposed to represent. The user will have an opportunity to specify the type of unit when the Miles and Kilometers buttons are set up.

After the *How many units?* prompt is displayed, the EDIT FIELD statement is used to allow the user to enter the requested data. We discuss the use of edit fields extensively in the MacGraph and MacAnimate chapters, so you might refer to them if you're not familiar with edit fields—they are discussed in even more detail in *Microsoft Macinations* (Microsoft Press, 1985). Here we have only one field to edit, so we don't have to worry about managing or moving between multiple edit fields.

The default value of one unit is displayed (it is the 1 in quotes that appears as a parameter in the EDIT FIELD statement). The user can use the usual edit functions (cut, paste, backspace, and so on) to change the unit to the desired value. Next, two buttons marked Miles and Kilometers are created. (Note that they are button numbers 2 and 3; button number 1 is the OK button provided by SetupWindow.) The last parameter in the BUTTON statements (3) makes them small "radio" buttons. The second 2 in the statement for button 2 displays the Miles button as preselected (filled in with a circle), indicating that miles is the default unit of measurement. *unitType$* is set to this default, and the flag *pressed* is set to 0.

A WHILE...WEND loop then waits for button presses. If either button 2 or 3 is pressed, the unit type is then set to the appropriate unit. When button 1 (OK) is pressed, the loop is exited.

Finally, the results of the calibration are used to determine the scale for future use at the end of [ME 1c]. The value the user entered for the number of units in the scale is returned by the EDIT$ function (1 is the edit-field number; there's only one). Then the BASIC VAL function converts this to a numeric value. The length of the scale was the distance the mouse traveled in pixels, obtained earlier. Dividing the number of units by the length of the scale gives the amount of mouse distance corresponding to one "real-world" unit. This value is stored in the variable *scale* and will be used in converting the distance the mouse travels during trip measurement to the actual measured trip distance.

Measuring a trip

When the Measure Trip menu option is chosen, Trip [ME 2a] is used to calculate the distance between two points on the map. For this to work, the user must have calibrated the mouse for the current map as described in the previous section.

Trip first clears the screen and then displays the unit of measurement in the current calibrated scale. A series of calls to the QuickDraw LINE and MOVE routines is used to show a line the length of the current scale. The instructions for measuring trip distance are then displayed.

The variable *distance* in [ME 2b], which will be used to keep track of the accumulating trip length, is set to 0. The "dummy" statement that follows, which simply gets any pending mouse event from MOUSE(0), is a useful precaution. No action is performed by this event; the purpose of the statement is to ensure that there isn't a leftover mouse click that would cause measurement to begin before the user is really ready.

A WHILE...WEND loop is now used to wait until the mouse button is pressed and then released. This loop uses the condition *WHILE MOUSE(0) < 1* to serve two purposes: (1) wait for the mouse button to go down, and (2) wait for the button to be released again. As long as the mouse button hasn't been touched at all, MOUSE(0) will be 0, which is less than 1. Once the button is down, MOUSE(0) will be less than 0 as long as it remains down. When the button is released, however, MOUSE(0) will return a value of 1 or greater (the actual values depend on whether single-, double-, or triple-clicking occurred—normally it would be a single click). When the release is detected, the loop is exited and a beep is sounded to let the user know that measurement of mouse movement will now begin.

In [ME 2c], the initial mouse x and y coordinates are obtained from MOUSE(1) and MOUSE(2), respectively. Control then drops into a WHILE...WEND loop that will handle the tracing of the trip and its measurement: The loop runs as long as the mouse button is not down, which, as you recall from the user instructions, is the signal to stop measuring.

A PSET statement is used to draw a point at the starting position (*posX,posY*). The mouse position is then checked again (it probably will have moved), and the values returned (the new mouse position) are assigned to (*newX,newY*).

Next, the program determines whether the user must be warned that the mouse is too close to an edge of the screen. Four IF...THEN statements check the boundaries in the four directions, and in each case the Warning subprogram [SP 1] is called if the boundary is exceeded (recall that the alarm boundaries were set back in [Init 1]). The boundaries are far enough back from the edges of the screen to provide enough warning for the user to stop tracing before hitting the actual screen edge.

The Warning subprogram is passed a value equal to the distance the mouse has gone past the warning boundary toward the edge of the

screen. If you examine the SOUND statement used in Warning, you can see that this has the effect of increasing both the pitch and the volume of the sound as the mouse gets farther from the boundary and moves closer to the edge of the screen.

After any necessary warning is given, the loop continues and the distance between the last reading of the mouse's position and its new position is calculated. The first time through the loop, this will be the distance from the position read just before entering the loop; on subsequent passes, the distance will be the difference between points reached in the preceding and the current pass. The calculation used here is similar to that used in Calibrate [ME 1a]: The square root of the sum of the squares of the distances is added to the previous total distance to get the new total distance.

Next, the program prints the current distance on the "trip counter" display in the upper left corner of the screen. First, the distance in screen (pixel) units is converted to the "real-world" distance by multiplying it by the scale established as a result of the earlier scale calibration. The result is expressed in the proper units up to two decimal places.

After the current trip total is displayed, the current mouse (x,y) coordinates are stored as the "old" coordinates (*posX,posY*), and the loop executes again if the mouse button has not been clicked. When the mouse button is clicked, the loop is exited. A beep signals that measurement is finished, for the mouse is presumably at its destination.

Suggestions for MacMeasure

MacMeasure is a useful tool for looking at historical maps. You can measure the progress of military campaigns, for example. While it may not look very impressive for General Lee to lead a tattered band of Confederate troops four-and-a-half map inches in three days, you might get a better feeling for the effort involved if MacMeasure informs you the distance marched was 102 miles.

You could write programs using routines like MacMeasure's for other measuring tasks. For example, you could write a program that would let you trace a dress pattern, show it on the screen, and print the various dimensions that would be obtained if you reduced or expanded it by so many sizes. You could also make a version of MacMeasure that measures areas and use it to calculate the areas of rectangular plots such as city lots or farm fields. You can be master of all your mouse surveys!

draw over it. DrawLine [SR 4] is now called to draw the first line. DrawLine uses the QuickDraw MOVETO routine to position the pen at the starting coordinates and then uses the QuickDraw LINETO routine to draw a line to the current mouse-pointer location.

A WHILE...WEND loop is then used to repeat this process as long as the mouse continues to be dragged. The first call to DrawLine in each pass has the effect of erasing the current line, due to the effect of XOR just described. GetMouse then gets new coordinates for the mouse, and another call to DrawLine draws a line to the new mouse position. Since this all happens rather quickly, the drawing and redrawing of the line and its following the mouse pointer from side to side if the mouse moves a bit up or down gives a stretching, or "rubber-band" effect.

When the mouse is no longer being dragged, the loop is exited. PENMODE is then set back to the default Copy mode, which draws a black line regardless of the contents of the existing screen, and DrawLine is called one more time to draw the final line representing the length of the scale on the map.

The scale distance is now converted to a unit distance. You may recall from your study of analytic geometry in your school days that the distance between two points, (x1,y1) and (x2,y2), is equal to the square root of the sum of the squares of the changes in the x and y coordinates of the points. In our case we have (*startX*,*startY*) as the starting point and (*x2*,*y2*) as the ending point. Thus the change in the x coordinate is $x2 - startX$ and the change in the y coordinate is $y2 - startY$. Each quantity is then squared, the two quantities are added together, and the square root of the whole shooting match is taken.

The program then checks to see whether the distance is zero: That is, the mouse hasn't been moved at all during the mouse drag. If this is the case, ErrorMessage [SR 1] is called. This in turn calls SetupWindow [SR 2], which creates a dialog box with an OK button. (Having this box set up by a separate subroutine is handy because we will need it more than once during the program.) After control returns to ErrorMessage, a message is displayed to the effect that the user has created a scale of zero length (which isn't very useful). ErrorMessage then waits for the OK button to be clicked, after which it closes the dialog box and returns control to Calibrate [ME 1a].

If the distance was 0, control goes back to the top of the loop in Calibrate [ME 1b] so that another attempt at calibration can be made (the user probably accidentally released the mouse button after the initial button press). If a valid distance was obtained, SetupWindow is called to set

up our multipurpose dialog box again. The dialog box then asks the user what the distance the mouse was dragged is supposed to represent. The user will have an opportunity to specify the type of unit when the Miles and Kilometers buttons are set up.

After the *How many units?* prompt is displayed, the EDIT FIELD statement is used to allow the user to enter the requested data. We discuss the use of edit fields extensively in the MacGraph and MacAnimate chapters, so you might refer to them if you're not familiar with edit fields—they are discussed in even more detail in *Microsoft Macinations* (Microsoft Press, 1985). Here we have only one field to edit, so we don't have to worry about managing or moving between multiple edit fields.

The default value of one unit is displayed (it is the 1 in quotes that appears as a parameter in the EDIT FIELD statement). The user can use the usual edit functions (cut, paste, backspace, and so on) to change the unit to the desired value. Next, two buttons marked Miles and Kilometers are created. (Note that they are button numbers 2 and 3; button number 1 is the OK button provided by SetupWindow.) The last parameter in the BUTTON statements (3) makes them small "radio" buttons. The second 2 in the statement for button 2 displays the Miles button as preselected (filled in with a circle), indicating that miles is the default unit of measurement. *unitType$* is set to this default, and the flag *pressed* is set to 0.

A WHILE...WEND loop then waits for button presses. If either button 2 or 3 is pressed, the unit type is then set to the appropriate unit. When button 1 (OK) is pressed, the loop is exited.

Finally, the results of the calibration are used to determine the scale for future use at the end of [ME 1c]. The value the user entered for the number of units in the scale is returned by the EDIT$ function (1 is the edit-field number; there's only one). Then the BASIC VAL function converts this to a numeric value. The length of the scale was the distance the mouse traveled in pixels, obtained earlier. Dividing the number of units by the length of the scale gives the amount of mouse distance corresponding to one "real-world" unit. This value is stored in the variable *scale* and will be used in converting the distance the mouse travels during trip measurement to the actual measured trip distance.

Measuring a trip

When the Measure Trip menu option is chosen, Trip [ME 2a] is used to calculate the distance between two points on the map. For this to work, the user must have calibrated the mouse for the current map as described in the previous section.

Trip first clears the screen and then displays the unit of measurement in the current calibrated scale. A series of calls to the QuickDraw LINE and MOVE routines is used to show a line the length of the current scale. The instructions for measuring trip distance are then displayed.

The variable *distance* in [ME 2b], which will be used to keep track of the accumulating trip length, is set to 0. The "dummy" statement that follows, which simply gets any pending mouse event from MOUSE(0), is a useful precaution. No action is performed by this event; the purpose of the statement is to ensure that there isn't a leftover mouse click that would cause measurement to begin before the user is really ready.

A WHILE...WEND loop is now used to wait until the mouse button is pressed and then released. This loop uses the condition *WHILE MOUSE(0) < 1* to serve two purposes: (1) wait for the mouse button to go down, and (2) wait for the button to be released again. As long as the mouse button hasn't been touched at all, MOUSE(0) will be 0, which is less than 1. Once the button is down, MOUSE(0) will be less than 0 as long as it remains down. When the button is released, however, MOUSE(0) will return a value of 1 or greater (the actual values depend on whether single-, double-, or triple-clicking occurred—normally it would be a single click). When the release is detected, the loop is exited and a beep is sounded to let the user know that measurement of mouse movement will now begin.

In [ME 2c], the initial mouse x and y coordinates are obtained from MOUSE(1) and MOUSE(2), respectively. Control then drops into a WHILE...WEND loop that will handle the tracing of the trip and its measurement: The loop runs as long as the mouse button is not down, which, as you recall from the user instructions, is the signal to stop measuring.

A PSET statement is used to draw a point at the starting position (*posX,posY*). The mouse position is then checked again (it probably will have moved), and the values returned (the new mouse position) are assigned to (*newX,newY*).

Next, the program determines whether the user must be warned that the mouse is too close to an edge of the screen. Four IF...THEN statements check the boundaries in the four directions, and in each case the Warning subprogram [SP 1] is called if the boundary is exceeded (recall that the alarm boundaries were set back in [Init 1]). The boundaries are far enough back from the edges of the screen to provide enough warning for the user to stop tracing before hitting the actual screen edge.

The Warning subprogram is passed a value equal to the distance the mouse has gone past the warning boundary toward the edge of the

screen. If you examine the SOUND statement used in Warning, you can see that this has the effect of increasing both the pitch and the volume of the sound as the mouse gets farther from the boundary and moves closer to the edge of the screen.

After any necessary warning is given, the loop continues and the distance between the last reading of the mouse's position and its new position is calculated. The first time through the loop, this will be the distance from the position read just before entering the loop; on subsequent passes, the distance will be the difference between points reached in the preceding and the current pass. The calculation used here is similar to that used in Calibrate [ME 1a]: The square root of the sum of the squares of the distances is added to the previous total distance to get the new total distance.

Next, the program prints the current distance on the "trip counter" display in the upper left corner of the screen. First, the distance in screen (pixel) units is converted to the "real-world" distance by multiplying it by the scale established as a result of the earlier scale calibration. The result is expressed in the proper units up to two decimal places.

After the current trip total is displayed, the current mouse (x,y) coordinates are stored as the "old" coordinates (*posX,posY*), and the loop executes again if the mouse button has not been clicked. When the mouse button is clicked, the loop is exited. A beep signals that measurement is finished, for the mouse is presumably at its destination.

Suggestions for MacMeasure

MacMeasure is a useful tool for looking at historical maps. You can measure the progress of military campaigns, for example. While it may not look very impressive for General Lee to lead a tattered band of Confederate troops four-and-a-half map inches in three days, you might get a better feeling for the effort involved if MacMeasure informs you the distance marched was 102 miles.

You could write programs using routines like MacMeasure's for other measuring tasks. For example, you could write a program that would let you trace a dress pattern, show it on the screen, and print the various dimensions that would be obtained if you reduced or expanded it by so many sizes. You could also make a version of MacMeasure that measures areas and use it to calculate the areas of rectangular plots such as city lots or farm fields. You can be master of all your mouse surveys!

MacMeasure program listing

```
'*****************************************************************.
'                          MacMeasure
'                Use the mouse to measure map distances.
'*****************************************************************

'********************************************************* INITIALIZE
false = 0 : true = NOT false
xCen = 256 : size = 150                              'size of dialog box
alarmL = 80 : alarmR = 420                 'left and right alarm trigger positions
alarmU = 100 : alarmD = 240                'up and down alarm trigger positions
unitType$ = "Miles"

WINDOW 1, "MacMeasure", (3,22) - (509,340), 3

MENU 6, 0, 1, "MacMeasure"                          'install  MacMeasure menu
MENU 6, 1, 1, "Calibrate"
MENU 6, 2, 1, "Measure Trip"
MENU 6, 3, 0, "-"
MENU 6, 4, 1, "Quit to BASIC"
MENU 6, 5, 1, "Quit to Desktop"
ON MENU GOSUB MenuEvent : MENU ON

CLS : CALL TEXTFACE(1) : CALL TEXTSIZE(36)           'draw Title Screen
LOCATE 3,5 : PRINT "MacMeasure!"
CALL TEXTSIZE(12) : LOCATE 12,13
PRINT "First calibrate the mouse,"
LOCATE 14,13
PRINT "then trace trip distances on a map."
CALL TEXTFACE(0)

'******************************************************** MAIN PROGRAM
WHILE true : WEND                          'do nothing but wait for menu event

'******************************************************** MENU EVENTS
MenuEvent:
   MENU 6, 0, 0                                      'disable MacMeasure menu
   item = MENU(1)                                        'get item selected
   ON item GOSUB Calibrate, Trip, , BasQuit, DeskQuit
   MENU 6, 0, 1                                     're-enable MacMeasure menu
   RETURN

Calibrate:          '_____________________________ calibrate mouse
   CLS
   LOCATE 3,1
   PRINT "CALIBRATION INSTRUCTIONS"
   PRINT "1.  Place the mouse on the starting point of the scale on the map."
```

INIT 1

INIT 2

INIT 3

MAIN

ME 0

ME 1a

```
PRINT "2.  Press the mouse button and hold it down."
PRINT "3.  Slide the mouse along the scale to the number of units you wish to use."
PRINT "    (The line you form will 'rubberband,' showing the length so far.)"
PRINT "4.  Release the mouse button to record the length of the scale."
```

ME 1b

```
distance = 0                                        'set dummy distance to start loop
WHILE distance = 0                                  'loop until valid distance is entered
   WHILE MOUSE(0) > -1 : WEND                       'wait for button press and drag
   GOSUB GetMouse                                   'get coordinates
   startX = x1: startY = y1
   CALL PENMODE(10)                                 'set XOR penmode
   GOSUB DrawLine                                   'draw first line

   WHILE MOUSE(0) < 0                               'while dragging
      GOSUB DrawLine                                'erase last line
      GOSUB GetMouse                                'get new coordinates
      GOSUB DrawLine                                'draw new line
   WEND

   CALL PENMODE(8)                                  'set COPY penmode
   GOSUB DrawLine                                   'draw new line
   distance = SQR((x2 - startX) ^ 2 + (y2 - startY) ^ 2)
   IF distance = 0 THEN GOSUB ErrorMessage
WEND                                                'while distance = 0
```

ME 1c

```
GOSUB SetupWindow              '_____ create dialog box for setting scale
CALL TEXTFONT(0)
LOCATE 2, 4 : PRINT "How many units does this represent?"
EDIT FIELD 1, "1", (size - 15, 40) - (size + 15, 55), 2, 2
BUTTON 2, 2, "Miles", (20,70) - (100,90), 3
BUTTON 3, 1, "Kilometers", (110,70) - (210,90), 3
unitType$ = "Miles"

pressed = 0
WHILE pressed <> 1                                  'repeat until OK button pressed
   WHILE DIALOG(0) <> 1 : WEND                      'wait for button press
   pressed = DIALOG(1)
   IF pressed = 2 THEN BUTTON 2,2 : BUTTON 3,1 : unitType$ = "Miles"
   IF pressed = 3 THEN BUTTON 2,1 : BUTTON 3,2 : unitType$ = "Kilometers"
WEND

units = VAL(EDIT$(1))
unitLength = distance
scale = units / distance
WINDOW CLOSE 2                                      'close dialog box for setting scale
RETURN
```

ME 2a

```
Trip:                          '_____ measure trip
   CLS
   LOCATE 2,1 : PRINT units " " unitType$           'print calibrated units
```

```
    LOCATE 3,2                                          'and show line length
    CALL LINE(0,-10) : CALL MOVE(0,5)
    CALL LINE(unitLength,0)
    CALL MOVE(0,-5) : CALL LINE(0,10)
    LOCATE 5,1
    PRINT "TRIP DISTANCE INSTRUCTIONS"
    PRINT "Place the mouse on your map at the starting point of the trip."
    PRINT "Press the button once and release it to indicate the starting point."
    PRINT "A beep will sound indicating that measurement is now taking place."
    PRINT "If you hear a tone rising in pitch as you trace the path of your trip, "
    PRINT "  it means that the pointer is getting near one of the borders of the screen."
    PRINT "Press the mouse button to end measurement for that segment of the trip,"
    PRINT "  mark that point on the map, and reposition the pointer on the screen.
    PRINT "Make a note of the distance travelled so far, and keep measuring segments"
    PRINT "  of the trip until you are done.
    PRINT "Add up the distances for each segment to find the total length of the trip."

    '_____ trace mouse movement and measure distance it moves
    distance = 0                                        'initialize distance
    dummy = MOUSE(0)                                    'clear out any pending mouse events
    WHILE MOUSE(0) < 1 : WEND                           'wait until button is pressed, then released
    SOUND 1000,1 : CLS                                  'make sound and clear screen to see path traced

    '_____ set initial mouse coordinates
    posX = MOUSE(1) : posY = MOUSE(2)                   'set x and y start position

    WHILE MOUSE(0) = 0                                  'while button not down
      PSET (MOUSE(1), MOUSE(2))                         'draw mouse position
      newX = MOUSE(1) : newY = MOUSE(2)                 'new x and y

      IF newX < alarmL THEN CALL Warning(alarmL - newX) : GOTO PastWarn
      IF newX > alarmR THEN CALL Warning(newX - alarmR) : GOTO PastWarn
      IF newY + 40 < alarmU THEN CALL Warning(alarmU - (newY + 40)) : GOTO PastWarn
      IF newY > alarmD THEN CALL Warning(newY - alarmD)

PastWarn:
      dx = ABS(newX - posX)
      dy = ABS(newY - posY)
      distance = SQR(dx ^ 2 + dy ^ 2) + distance        'set cumulative distance
      Trip = INT(scale * distance * 100) / 100          'show distance
      LOCATE 1,1 :  PRINT "The trip is " Trip " " unitType$
      posX = newX : posY = newY
    WEND                                                'button not down yet
    SOUND 1000,1
    RETURN

BasQuit:                '_____ quit to BASIC
    MENU RESET
    END
```

ME 2b

ME 2c

ME 3

```
ME 4  DeskQuit:          '_____ quit to Mac DeskTop
        MENU RESET
        SYSTEM

      '********************************************** SUBROUTINES
SR 1  ErrorMessage:
        GOSUB SetupWindow
        CALL TEXTFONT(0) : PRINT
        PRINT "You have made an attempt to calibrate the"
        PRINT "planimeter with a scale of no length."
        LOCATE 5,8 : PRINT "Please try again."
        WHILE DIALOG(0) <> 1 : WEND
        CALL TEXTFONT(1)
        WINDOW CLOSE 2
        RETURN

SR 2  SetupWindow:
        WINDOW 2, , (xCen - size, 200) - (xCen + size, 300), -2
        BUTTON 1, 1, "OK", (2 * size - 50, 70) - (2 * size - 10, 90)
        RETURN

SR 3  GetMouse:          '_____ get new line coordinates
        x1 = MOUSE(3) : y1 = MOUSE(4)          'beginning of drag
        x2 = MOUSE(5) : y2 = MOUSE(6)          'end of drag
        RETURN

SR 4  DrawLine:          '_____ draw given line
        CALL MOVETO(x1,y1)
        CALL LINETO(x2,y2)
        RETURN

SP 1  SUB Warning(alarm) STATIC          'warn that mouse pointer is getting near edge
        SOUND 50 + alarm * 4, 1, 50 + alarm * 2
        END SUB
```

ABOUT THE AUTHORS

Mitchell Waite is president of The Waite Group, Inc., a computer-book publishing firm renowned for producing well-written books. Best-sellers from The Waite Group include *UNIX Primer Plus*, *C Primer Plus*, and *Assembly Language Primer for the IBM PC*. Fluent in a variety of computer languages, Mitchell has been involved in the personal computer industry since 1976, when he bought an Apple I computer from Steve Jobs.

Chuck Blanchard is a consultant and engineer with several years of programming experience. Chuck has worked extensively with BASIC, Pascal, FORTH, LISP, and many assembly languages, and is currently working on a project aimed at developing a visual programming language for the Macintosh.

Don Urquhart is an instructor in Electronics Technology at the College of Marin in Kentfield, California, where he conducts courses in analog and digital systems. Before becoming a teacher, Don spent 15 years as an aerospace engineer.

Dan Putterman took his first college computer course at the age of thirteen. An accomplished programmer, he now teaches and consults on the use of microcomputers. He is the author of the FrontEnd, a popular DOS utilities program for the IBM PC, and a co-founder of Innovative Techniques, a microcomputer-software company based in Marin County, California.

The manuscript for this book was prepared and submitted to Microsoft Press in electronic form. Text files were processed and formatted using Microsoft Word.

Cover design by Greg Hickman. Design executed on the DICOMED IMAGINATOR™ computer-graphics system at Pacific Color, Seattle, Washington.
Interior text design by Karen-Lynne de Robinson and Christopher Banks.
The high-resolution screen displays were created on the Apple Macintosh and printed on the Hewlett-Packard LaserJet.

Text composition by Microsoft Press in Rotation with display in Erbar Light Condensed, using the CCI composition system and the Mergenthaler Linotron 202 digital phototypesetter.

OTHER TITLES FROM MICROSOFT PRESS

THE APPLE ENVIRONMENT

The Apple Macintosh Book, Second Edition
by Cary Lu — $19.95

Excel in Business Number-Crunching Power on the Apple Macintosh
by Douglas Cobb and the Cobb Group — $22.95

The Printed Word Professional Word Processing with Microsoft Word on the Apple Macintosh
by David A. Kater and Richard L. Kater — $17.95

MacWork MacPlay Creative Ideas for Fun and Profit on Your Apple Macintosh
by Lon Poole — $18.95

Presentation Graphics on the Apple Macintosh How to use Microsoft Chart to Create Dazzling Graphics for Professional and Corporate Applications
by Steve Lambert — $18.95

Microsoft Macinations An Introduction to Microsoft BASIC for the Apple Macintosh
by The Waite Group, Mitchell Waite, Robert Lafore, and Ira Lansing — $19.95

Creative Programming in Microsoft BASIC for Optimal Macintosh Performance
by Steve Lambert — $18.95

Microsoft Multiplan: Of Mice and Menus Models for Managing Your Business with the Apple Macintosh
by The Waite Group, Bill Bono, and Ken Kalkis — $16.95

Command Performance: Multiplan on the Apple Macintosh The Microsoft Desktop Dictionary and Cross-Reference Guide
by Eddie Adamis — $19.95

Inside MacPaint Sailing Through the Sea of FatBits on a Single-Pixel Raft
by Jeffrey S. Young — $18.95

AppleWorks Boosting Your Business with Integrated Software
by Charles Rubin — $16.95

The Endless Apple How to Maintain State-of-the-Art Performance on Your Apple II and IIe
by Charles Rubin — $15.95

GENERAL

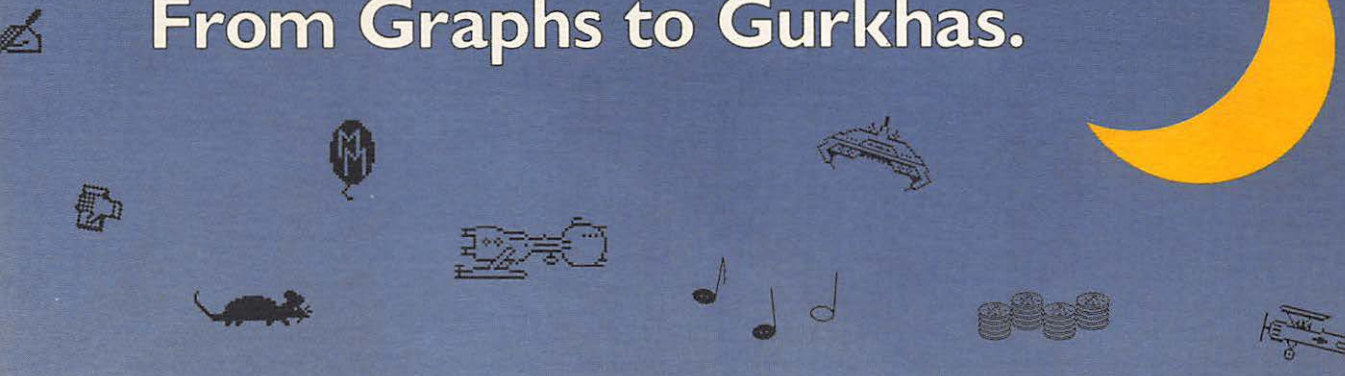
Online A Guide to America's Leading Information Services
by Steve Lambert — $19.95

Silicon Valley Guide to Financial Success in Software
by Daniel Remer, Paul Remer, and Robert Dunaway — $19.95

Out of the Inner Circle A Hacker's Guide to Computer Security
by "The Cracker" (Bill Landreth) — softcover $9.95, hardcover $19.95

A Much, Much Better World
by Eldon Dedini — $6.95

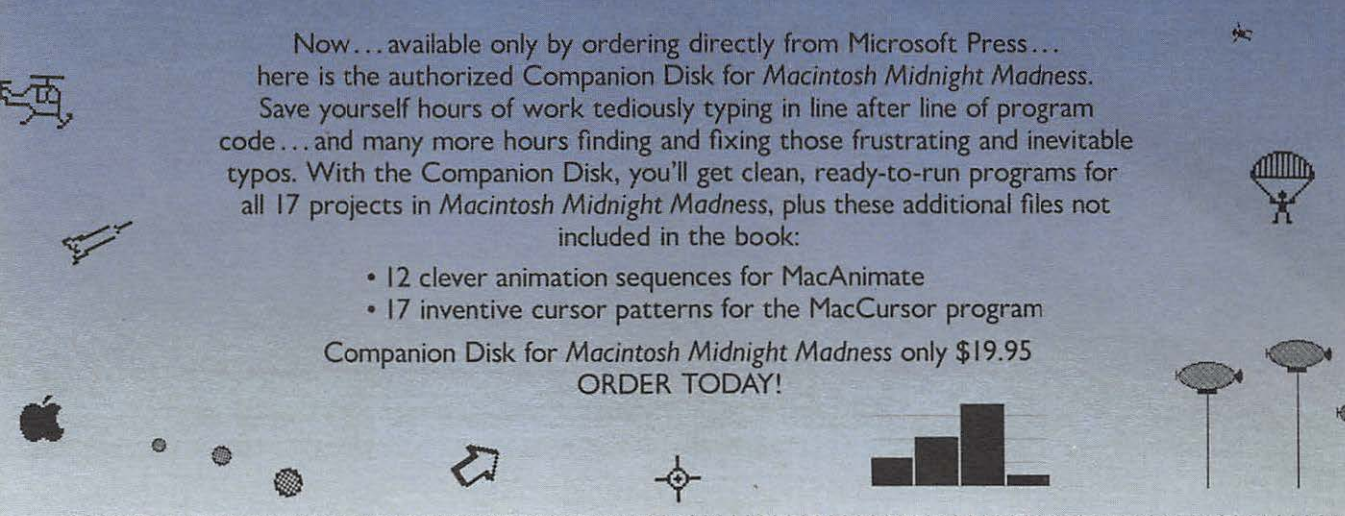
Instant Programs . . . Error-Free . From Graphs to Gurkhas.



Now . . . available only by ordering directly from Microsoft Press . . . here is the authorized Companion Disk for *Macintosh Midnight Madness*. Save yourself hours of work tediously typing in line after line of program code . . . and many more hours finding and fixing those frustrating and inevitable typos. With the Companion Disk, you'll get clean, ready-to-run programs for all 17 projects in *Macintosh Midnight Madness*, plus these additional files not included in the book:

- 12 clever animation sequences for MacAnimate
- 17 inventive cursor patterns for the MacCursor program

Companion Disk for *Macintosh Midnight Madness* only $19.95
ORDER TODAY!



ORDER CARD

YES . . . please send me _____ copies of the Companion Disk for *Macintosh Midnight Madness* at $19.95 each. (US funds only.) _____

Postage and handling charges: $1.00 per disk (domestic orders)
$2.00 per disk (foreign orders) _____

California residents add 6.5% sales tax; Washington state residents add 8.1% sales tax. _____

TOTAL _____

Name _____
(Please print)

Address _____

_____

City _____ State _____ ZIP _____

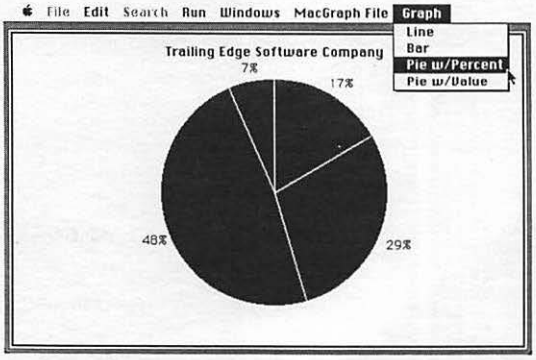
Payment: ☐ Check ☐ Money Order ☐ VISA ☐ American Express ☐ MasterCard

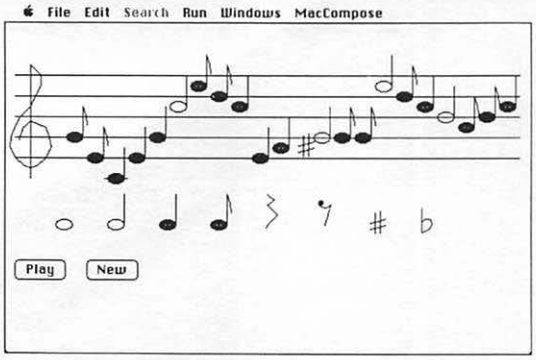
Credit Card No. _____ Exp. Date _____

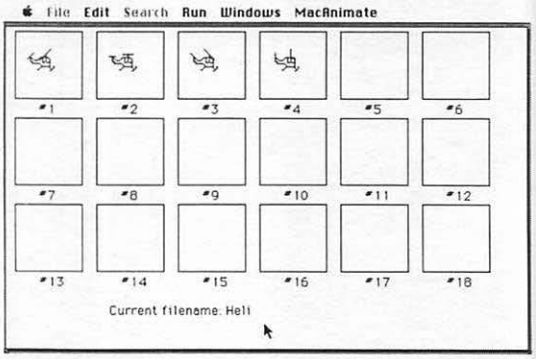
Signature _____

Please allow 4 weeks for delivery.

Here are just a few of the programs included on your Companion Disk for *Macintosh Midnight Madness:*







This Companion Disk is only available directly from Microsoft Press. To order, use the card below, or, if the card has already been used, refer to the introduction for ordering instructions.

Name_____

Address_____

_____

Place Stamp Here

Microsoft Press
Box 97200
10700 Northup Way
Bellevue, WA 98009

MACINTOSH™ MIDNIGHT MADNESS joins the growing Microsoft Press library of high-quality, critically-acclaimed books on the Macintosh.

MACINTOSH™ MIDNIGHT MADNESS

The Waite Group

Mitchell Waite • Dan Putterman • Don Urquhart • Chuck Blanchard

Explore the far-reaching horizons of Microsoft BASIC for the Apple Macintosh! Here is a wealth of clever, useful, and amazing BASIC programs—17 in all—that take full advantage of this feature-rich language. Complete with programming insights, techniques, and listings from The Waite Group, *Macintosh Midnight Madness* offers these valuable and inventive programs: a fast-moving animation program, a streamlined business graphics program, a graphics "construction set," a music composition program, and much more.

U.S.A.	**$18.95**
U.K.	£15.95
AUST.	$28.95 (recommended)
CAN.	$28.95

MICROSOFT PRESS

ISBN 0-914845-30-6