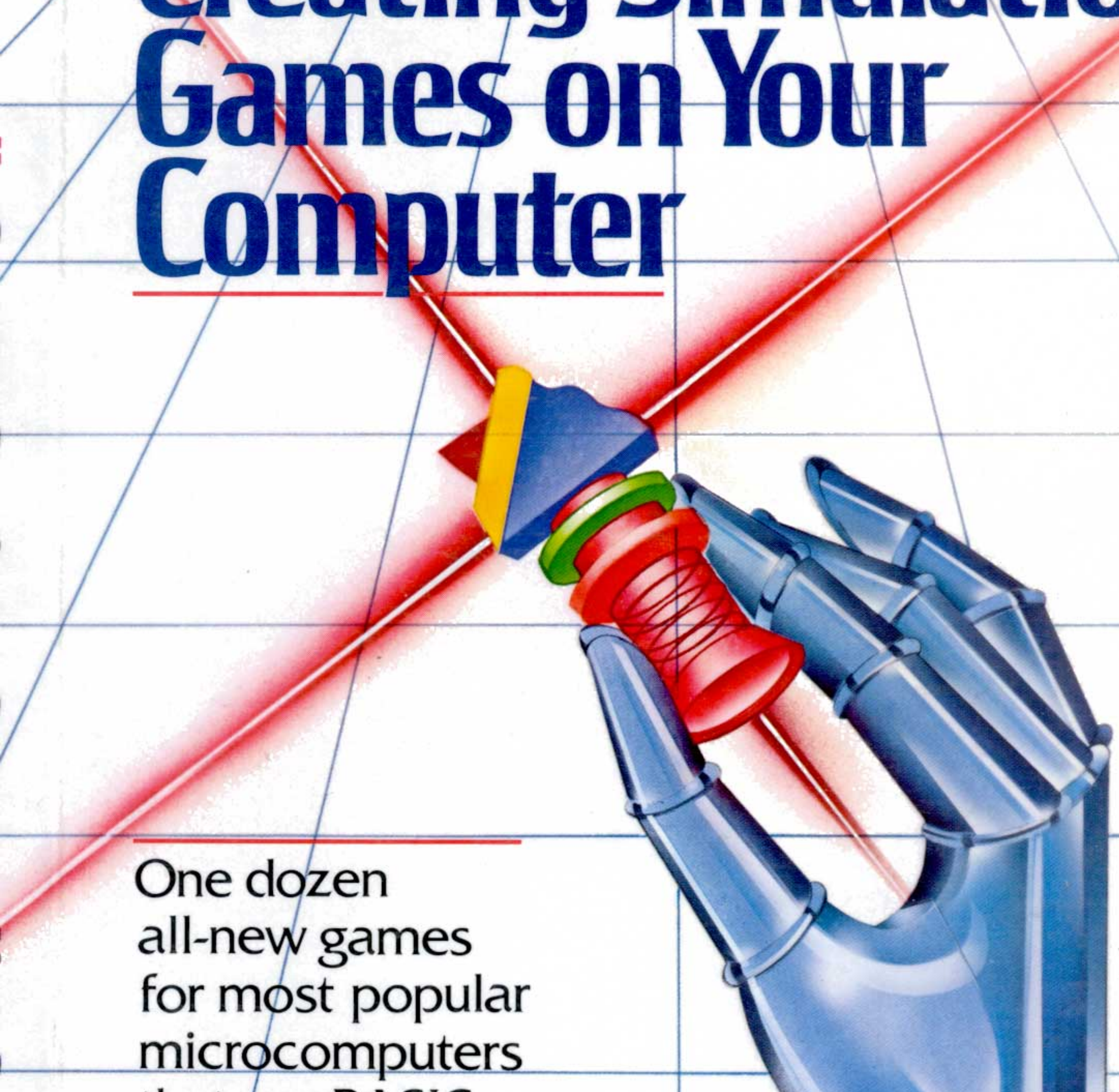
Tim Hartnell

Creating Simulation Games on Your Computer



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Author's Introduction

This book will give you and your computer power—the power to replicate reality in a quite uncanny way. I've included a wide range of programs that allow you to experience this power in action—from a program that simulates microbes fighting for the right to survive in a closed environment, to one that puts you in the cockpit of a particularly temperamental plane.

There is also more to this book than the ready-to-run programs. You'll discover how easy it is to analyze real-life situations so that you can create your own computer simulations, for both entertainment and instruction.

You now have the power. Use it.

Tim Hartnell
London, 1986

Getting the Programs Running on Your System

I wrote the programs in this book on an IBM PC. Since you may own or use different microcomputers, I've included the full BASIC program listings for the three most popular microcomputers: the Apple IIe, Commodore 64, and the IBM PC. BASIC listings that will run on IBM PCs, XTs, and compatibles without modification are presented throughout the chapters. Program listings specifically for the Apple IIe series and the Commodore 64* are included in the appendix at the end of the book.

I've written the programs in a subset of BASIC that will run on most microcomputers with only minimal changes. However, if you don't own an Apple IIc or IIe, Commodore 64, or IBM PC, some of the BASIC statements used in the programs may have to be changed slightly to run on your system. I've included the following notes so that if you do have to adapt the programs you'll be able to get them running as quickly as possible.

Screen Width

I've assumed that you have access to the READ and DATA commands, and that your screen is about 40 characters wide. If your computer's screen is not quite that wide, you may have to adapt the program output by adjusting the PRINT statements.

Random Numbers

Some of the programs need random numbers to operate. When I want a random number between one and zero, I use the command A = RND(1). If I need random integers in the range between 1 and 10, I use A = INT(RND(1) * 10) + 1. If your system can't use this statement, you'll have to substitute the form of the RND command that *will* run on your computer. Look up RND or "random numbers" in your system's BASIC manual.

*C64 users see note on p. 171.

My computer's BASIC generates the same *sequence* of random numbers each time a program is run. In order to get a genuinely random set of numbers, I have to *seed* the random number generator. I've used the rather terrifying-looking statement RANDOMIZE VAL (RIGHT$(TIME$,2)) to do this. If your random number generator requires a seed (again, this will be explained in your BASIC manual), replace this statement with your system's equivalent (or leave it out altogether, if you don't have an alternative).

If your computer doesn't use the BASIC statement DEFINT (often used in the line after RANDOMIZE as DEFINT A-Z) leave that line out completely as well. (See line 490 in the LIFE listing.)

Capital Letters

Note that the programs expect *input* in upper-case letters. If your computer can use lower-case letters, and if while running the program nothing happens when you type in letter commands, check to make sure that you're typing in capital letters.

Input Statements

You may also have to change my use of INKEY$ for single character input. If your computer can't use INKEY$, change these statements (throughout) to the input statement that works on your system. Change A$ = INKEY$ to either INPUT A$ or GET A$ (again, see your BASIC manual). The program should run without further changes. Use CALL KEY when working in TI Extended BASIC.

Note that some BASICs (such as Atari BASIC) do not let you include a string within an INPUT statement (as in INPUT "string"; A$). Replace this with PRINT "string" followed by a separate INPUT statement.

READing Arrays

Some BASICs cannot READ array values directly, as in READ A(7) or READ A$(7). You'll have to replace these statements with lines that put data in the array indirectly. First read the data into a variable. The appropriate array element can then be set equal to the variable, as in READ X:A(7) = X or READ X$:A$(7) = X$.

Printing the Results

Many of the programs "reprint" the screen after each turn. I've used the CLS command to CLear the Screen. If your system doesn't

use CLS, you'll have to replace it with the appropriate command. Use PRINT "CLR" on Commodore and Atari computers, HOME on Apples, and CALL CLEAR when working with TI Extended BASIC.

String-Handling

String-handling can cause a few problems, so I've kept it to a minimum. If your computer does not support the standard LEFT$, MID$, and RIGHT$ string-handling commands, consult your BASIC manual for the correct replacements. For example, the standard MID$(A$(2,3)) can be replaced with SEG$(A$,2,3) in TI Extended BASIC, with A$(2 TO 5) on Timex/Sinclair computers, and with A$(2,5) in Atari BASIC.

Delay Loops

Many of the programs include a delay loop (usually in the form FOR I = 1 TO 500:NEXT I). You should adjust these dummy loops (which are usually held in subroutines at the end of programs) so that the program's displays of instructions and the progress of the simulation are clear and easy to follow. See line 550 in the SIMULTANEOUS EQUATIONS listing for an example of how this works.

Variables

If your system won't accept variable names longer than two letters, enter just the first two letters (such as SC for SCORE). If it will accept a full variable name, but only recognize the first two letters, you will find that using the full variable name makes the program much easier to understand.

Functions

A number of the programs in this book use the BASIC statement DEF FN to define specific functions which are then "called" from different parts of the program. Most BASICs include some form of DEF FN, the most notable exception being Atari BASIC. Functions can usually be replaced with subroutines, or, if the expression or calculation is short enough, you can simply replace each use with the whole expression.

High-Resolution Graphics

The only program you may find difficult to adapt is POINT-DUTY

ROBOT, which requires high-resolution graphics (using a command like PSET or POINT). If your computer is capable of high-resolution graphics, you should consult your system's manual to find out the equivalent commands for your machine. If not, you'll find that the regular ROBOT LOGO listing is almost as much fun!

Memory

It is impossible to predict exactly how much memory the programs will take up on your system, but the majority of the programs in this book will fit well within 16K machines. In fact, the longest program, FLIGHT SIMULATOR, is less than 8K long.

If you have trouble getting a program into your system because of a shortage of memory, cut out as many REM statements as possible (check to make sure that no GOSUB or GOTO calls refer to the lines you want to delete) and try to shorten the PRINT statements.

General Instructions

These changes should cover the adaptations you'll have to make to get the programs running on your computer.

Please be sure to type programs in carefully. Remember that the instructions you give to a computer must be exactly correct—or the machine won't be able to run your program. If you have trouble getting a program to run, first proofread your typed-in version against the listing given in this book.

The manual for the BASIC that came with your computer is an indispensible tool. Check the manual to see what's wrong with any program lines that won't work—or that result in error messages. Make sure to use the exact forms of the commands as given in the manual.

Talking to someone who has a lot of programming experience—especially if it's with the computer you're using—can also be a tremendous help.

1

The Power of Simulations

Computer simulations give you the power to try your hand vicariously at almost any activity you can imagine. Running a multi-million-dollar manufacturing concern, flying to the moon, driving a racing car, or running the country as President—all these experiences can be yours through simulation programs.

In this book you'll find programs that allow you to take part in all these scenarios and more. You'll also be gently introduced to the art of creating computer simulations. After you've enjoyed the programs in the book, you'll have made a good start on being able to write your own. Studying the program listings, observing what the different variables represent and the way they interact and how mathematical formulas are used to replicate "real life" situations, will show you a number of easy-to-apply techniques that you can use in your own simulations.

Despite their obvious entertainment value, computer simulations are not just elaborate games. More sophisticated simulations are being used for training in many situations where reality is too expensive, too dangerous, or too complex to allow human beings to learn by direct experience. During airplane pilot training many, many hours of airtime are clocked in elaborate flight simulators—controlled, of course, by computers—rather than up in the air.

One of the real advantages of simulations is that they can be manipulated more easily than the real situation. For example, a pilot training on a flight simulator could attempt to land during a hurri-

cane with very little fuel, or an operator at a nuclear power station could be faced with the possibility of a meltdown. Operators in conventional and nuclear power plants around the world are now training on simulators, where they can hone their skills without facing real catastrophes. One example of the use of computer-controlled simulations in this area comes from Australia, where an electricity generating board has spent half a million dollars to buy a simulator to train its operators. This simulator, developed and marketed by an Australian company called Control Simulation Technology, allows a controller to simulate a number of emergency situations, so that staff can learn to cope with them. This "emergency" training would be impossible without the use of a simulator.

Another computer simulator, which might be seen as a little bit sinister, uses the reactions of a few test subjects to television and print advertising to simulate the reaction of a significant portion of the population. The simulator, developed by psychologist Marcus Tomlian, is claimed to be "the most sophisticated precision system for measuring consumer reactions to advertisements." The device, called *Mind Monitor*, is made up of a series of sensors that measure the brain and heart activity of a sample group of people. The simulator runs while an advertisement is shown to the test group, and gives a second-by-second readout from the sensors. The readings are then fed into the simulator, which analyzes the brain waves and cardiovascular readings and uses them to extrapolate the probable reaction of the general population. Mr. Tomlian claims that *Mind Monitor* can be used to find weak points in an advertising campaign so that the advertiser can "fine-tune" particular campaign elements. General Electric is believed to be at the forefront of developing computer simulations which help gauge viewers' reaction to advertising, while one of the world's biggest ad agencies, Young and Rubicam, is also investigating the field.

Simulation Limitations

A computer simulation, of course, must never be confused with the system it is simulating. All simulations are, to greater or lesser extents, *simplifications* of the system they represent. Low-level simulations, like the programs in this book, and the simulations you are likely to create in the next few months, are often drastic simplifications. Despite this, they can be surprisingly effective—trying to land a plane using our FLIGHT SIMULATION program can be almost as nerve-racking as the real thing.

You'll find that there is as much art as science involved in creating effective simulations. The science is in working out the for-

mulas that represent the interacting elements of the system you are trying to simulate. The art is in programming those formulas so that your interaction with the simulation is as "life like" and rewarding as possible. This means that the output must be realistic, and must be presented in a form that is readily understood.

For most simulations, the speed with which the program responds to user input is very important. If the simulation is occurring in "real time" (that is, a second of time elapsed within the simulation is supposed to equal a second of time in real life), it is important that the simulation is written so that this one-to-one correspondence between the times is as close as possible.

Simulations can be divided into two groups: those where the data is acted on in distinct groups or packages, and those where the data values flow into each other repeatedly and continuously. Queuing systems, where a set of elements to be processed (like a group of customers waiting in line at a bank counter) wait in a queue until the system is ready for them, are the main kind of discontinuous situations that are turned into simulations. In the second type of simulation, where data values flow into each other, values (such as the internal temperature of a nuclear reactor) change constantly over time.

It is important to try and determine, before you start programming your own simulation, which type of data or process predominates within the system you are going to program.

Any situation where elements are added to a queue at rate A and removed at rate B is a candidate for a discrete simulation. There are many, many situations like this in real life. Discrete queues exist in such different situations as collecting eggs in an old-fashioned farmyard (where a queue can simulate the difference in time between eggs being laid and gathered), highway accident victims waiting for ambulances, and airplanes waiting for clearance to take off.

Some systems can be simulated by either a discontinuous or a continuous model. Our SPACE LANDING SIMULATION lets you try to land a spacecraft on the moon. This program waits for an input before continuing (you type in a number between zero and nine, representing "thrust"). If the program did not wait for your key press, but kept going through its operational cycle over and over again, checking the keyboard during each cycle, and making changes *only if* it detected a valid key press, the simulation would clearly be a continuous one. There would be no instant when the velocity and position of the craft were not changing. Add a real-time control facility to our FLIGHT SIMULATION program, and you'd have another non-discrete simulation.

In the next chapter of this book, we'll look at the basic elements of a simulation, and show how to break down a problem so that you

can create a simulation of it. The later chapters explore many different types of simulations. You'll see a number of simulation techniques in action, and can study the programs to see how the results were achieved. The lessons you learn from these chapters can then be applied to help you create your own simulations.

Chapter three looks at loops and feedback, the fundamental elements of all simulations, and shows these in action with the SPACE LANDING SIMULATION program. From there we move to Monte Carlo simulations, where the effects of random inputs on a system are discussed. Chapter five presents the predator/prey simulation, where simultaneous equations model the interaction of two kinds of cells living within a culture medium, and competing for the right to survive.

The next chapter presents a version of John Conway's classic computer simulation LIFE, where birth and death occur in a less bloodthirsty way than in our predator/prey simulation. The first version of this program allows you to encode game-starting patterns as DATA statements, so that different evolutionary outcomes can be studied. Then you'll shown how to make the simple changes that allow your computer to generate the starting colony at random.

Chapters seven, eight, and nine, which look at robot simulations, are considerably more ambitious than the earlier ones. In these chapters, we will actually examine two simulations at once. First, we simulate the action of a computer language interpreter, which "understands" commands entered in RCL, a new computer language (Robot Control Language). Second, the programs use RCL commands to move a little "robot," which leaves Logo-like designs as it trundles around your computer's screen. The programs given here form a solid basis for developing your own complete "turtle graphics" program.

Artificial intelligence is one of the "hot" areas of computer science at the moment, and this book would not be complete without a program or two that showed how a simulation program can apparently endow a computer with intelligence. Chapter ten lets you attempt the fairly fruitless task of trying to beat your computer at the game CONNECT FOUR, and explains how the program assesses its "best" move. The move-selection technique can be adapted to many other board games. The following chapter introduces a program that replicates an 1890 Spanish machine that plays a particular chess endgame. The Quevedo Chess Machine was probably the first genuine attempt to produce a chess-playing machine, so it is appropriate that it is represented here.

From chess we move into the political arena, and show how the economy of the United States can be (admittedly very crudely) mod-

eled within a computer simulation. You take the role of the President, and your job is to try to control the economy. You may well have a deeper sympathy for the real occupant of the Oval Office after you find your best efforts blowing up in your face.

Money manipulation lies at the heart of chapter thirteen's simulation of a small stock market in action, as you invest in the fluctuating fortunes of five companies, trying to reach a financial goal you have set for yourself. If you find you have considerable skill in this area, you can see if it stands you in good stead in manufacturing. DETROIT CITY, presented in chapters fifteen and sixteen, confronts you with an even more difficult challenge. Your task is to try to bring an ailing automobile manufacturing company back to a more profitable life. Fail, and you're out of a job. Succeed, and you get a seat on the board.

We move from the world of business simulations to programs that simulate leisure activities. GRIDIRON, presented in chapters seventeen and eighteen, puts you up against the computer-controlled Silicon Cowboys, or you can use the program to mediate a clash between two human beings. The next program gives you the chance to play a three-set game of tennis against your computer. Again, if you prefer, you can use the simulation simply to keep track of the action, and play against another flesh-and-blood opponent.

In chapters twenty-one and twenty-two, you are at the wheel of a racing car, as you try out your driving skill on your choice of Grand Prix tracks in Britain, Germany, Italy, or Monaco. The tracks used within the program are based on the real-life tracks, but I doubt whether the skills you pick up here could very usefully (or safely) be transferred to genuine Grand Prix driving on those circuits.

Finally, in chapters twenty-three and twenty-four, we have our *simulation de resistance*, a complete flight simulator. The program simulates an airplane that is fiendishly difficult, but not impossible, to fly. You'll find that keeping track of four or five constantly changing factors at once will take all your concentration. But the satisfaction you'll feel on your first successful landing will make it all worth while.

As you can see, we have some fascinating territory ahead of us. Let's go.

2

The Components of a Simulation

In the simplest terms, a simulation is a computer model of cause and effect. Event A is linked to event B by equation X. Modify B, and C is affected, by linking factor Y. And so on. Isolate the links (X and Y, in the preceding examples), and you have the raw ingredients of a simulation.

If you turn on a light switch, electricity will flow through the circuit, and the light will come on. Cause and effect are easy to see in this situation:

```
CAUSE ---------> EFFECT ---------> EFFECT

SWITCH ON        CURRENT FLOWS      LIGHT GLOWS
```

It would be, of course, a trivial exercise to write a program to simulate the result of turning on a light switch. However, this should not blind us to the fact that, in essence, all simulations—no matter how complicated—that you write will show a clear linking between causes and effects.

More Complex Links

The links, of course, will not always be this simple and straightforward.

Some effects may only come into play when variables reach *trig-*

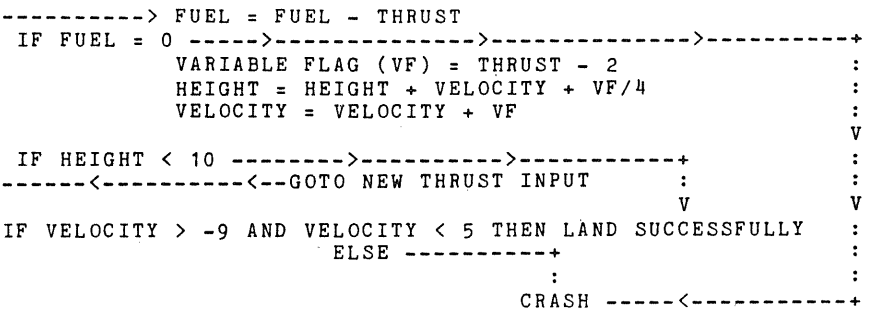
ger values. For example, the car engine in our GRAND PRIX simulation blows up if the engine temperature exceeds 200 degrees. Your own simulations may have a link that looks like this:

EVENT X leads, if A is present, to EVENT Y
leads, if B is present, to EVENT Z

Analyze the links and express them in a diagram like the above, perhaps substituting mathematical formulas for our "if A, then B" links, and you're well on the way to writing your own simulation program.

The first simulation program in this book (in the next chapter) puts you in the position of a pilot trying to land your spacecraft on the moon. The causal links in this program are reasonably straightforward, but still manage to produce very interesting and somewhat unpredictable outcomes.

Here are the links. THRUST is the input from the user, each time through the loop.



Although this may look a little complex at first sight, it is actually fairly simple. You can see that the causal loop diagram looks pretty much like a flow chart, and actually contains some lines that apparently could be programmed directly. When you look at the program (especially lines 170 to 240) you'll see that some of the lines above do appear almost unchanged in the program.

Feedback

Causal loops contain elements, or processes, that interact. They also contain feedback mechanisms. The results of one series of computations (in the moonlander simulation, for example, the results are the height, velocity, and fuel left) feed back to affect the next input (THRUST in this case). In this case the feedback is presented to the

user on the screen. The user, or player, then makes choices about his next input. In continuous simulations, the feedback information can be used *by the program* to automatically influence the state of the simulation.

In real life, feedback influences many situations, for example, in the operation of a thermostat on a room heater. If the room gets colder, the thermostat turns the heater up. When the room becomes warmer, the thermostat turns the heater down. In due course, the room cools, the temperature drops, and the cycle begins again.

Feedback does not always lead to a fluctuating output. For example, if I am angry with you, I may raise my voice. You shout back. I am further angered by you raising your voice and I raise my voice some more. You, in turn, are made more angry by my increased volume, and shout even more loudly at me. A *self-reinforcing* loop is set up. If the heater's thermostat was set so that the hotter the room became, the more heat was produced, a similar self-reinforcing feedback loop would be seen (and felt!).

Equilibrium Points

Many feedback loops have an *equilibrium point.* (In our thermostat example, the equilibrium point is the final steady temperature of the room.) A good simulation may, in effect, challenge the program user to discover that equilibrium point. There may well be, for example, a thrust input built into our moonlander program that allows the craft to sink gently down into the lunar dust.

Negative and Positive Loops

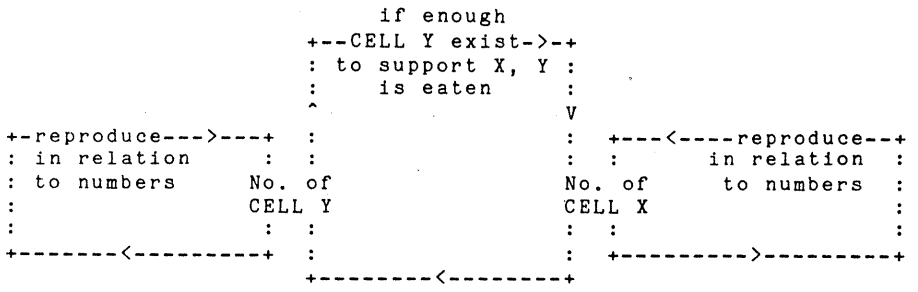
A *negative* feedback loop tends to push the system toward an equilibrium point. (As the room gets hotter, the thermostat turns the heater down.) A *positive* feedback loop tends to lead to dramatically accelerating or decelerating rates, pushing the system away from an equilibrium point. (As the room gets hotter, the heater is turned up more.)

It is fairly easy to understand how a single feedback loop can form the heart of a simple simulation. However, most situations in real life, when analyzed, turn out to be made up of more than one feedback loop.

For example, in the predator/prey simulation in chapter five, we have two life forms whose survival is inextricably bound together. If one species dies out, the other will also die. If there are too few predators, the number of prey will increase, leading to more food, so more predators are born. These in turn will eat more prey. The situation is

dynamic, constantly changing as the simulation produces and uses its own feedback.

Here is how chapter five's program looks in a causal diagram:

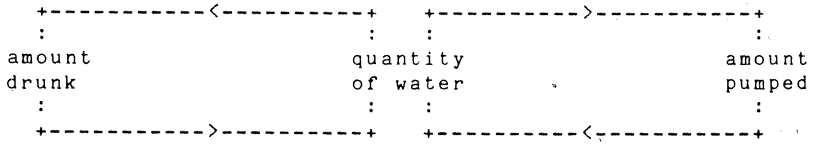


A situation like this can either stabilize, or can move so that either X or Y becomes dominant, with the other type of cell reduced to an ineffectual level.

Such simulations are fascinating to run, and their outcomes can be difficult to predict, even when you know the linking formulas well. In a simulation like this, where there are two negative feedback loops in operation, X and Y fluctuate about an equilibrium point as they act on each other.

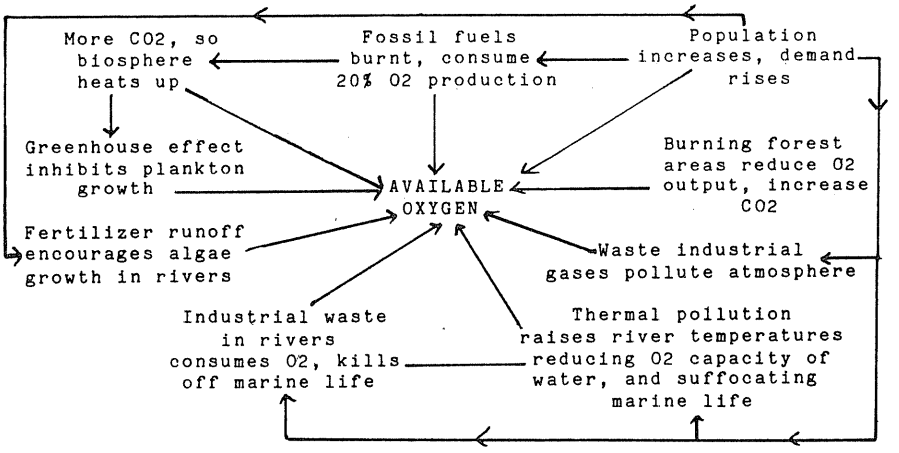
Your own simulation programs will be easier to write if you consider the behavior of the system you want to model in terms of positive or negative feedback loops.

Some relationships are easier to see than others. For example, this diagram shows the relationship between the work involved in pumping water from a well, the thirst produced by that work, and the amount of water produced:



This is a fairly clear situation, one that is probably simpler than any real-life situation you'll try to model with a simulation system. If a double loop is needed to show the relationship of something simple like this, it is highly likely that the systems you'll want to simulate will need two, or more, interacting loops.

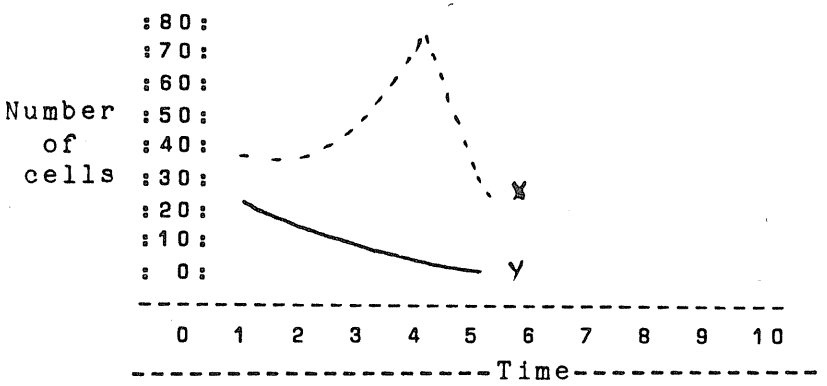
For example, the ecological system of oxygen use and replenishment on Earth can be shown with the following diagram:

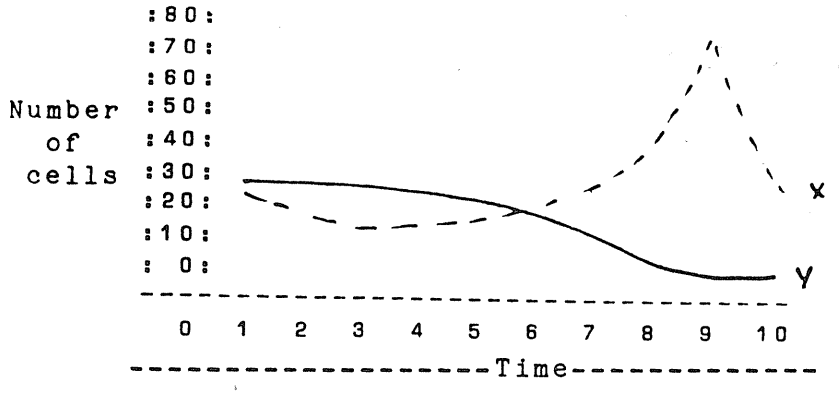


Time Against Action

You may well find that producing a graph of the action of a system makes it easier to understand both the dynamics of the system and the causal loops that are acting within it.

If we plot against time the populations of cell type X and cell type Y from the runs of chapter five's predator/prey simulation, we get graphs like these:





These graphs show dramatically how the two life forms are related. The crossover points of the lines also suggest where the equilibrium points of the system may be.

So the causal loop diagrams help us find the underlying relationships within the system we hope to simulate, and a graph of the outputs of the simulation plotted against time allows us to see cause and effect in action within the system. This graphed data can help us to see the effectiveness or otherwise of our simulation, and helps our understanding of what is actually going on as the simulation runs.

You should now have enough background information to understand the processes involved in the creation and running of the simulation programs that make up the rest of the book. Once you get the programs up and running, you may well want to draw causal diagrams to show the links between elements in these programs. As well, the output from some—but not all—of the simulations can be graphed, to give further insight into the working of the system being modeled.

3

Feedback in Action

In this chapter, we'll look at our first simulation program, one that has been around in one form or another since the earliest days of commercial computers. In those days, a lot of expensive corporate and academic computer time was consumed by would-be space pilots trying to land creaky old space ships on the moon.

Unlike the predator/prey simulations in chapter five, which use simultaneous equations, simulations like this one use a series of formulas held within a loop. After each run through the loop, the system operator receives feedback on the status of particular variables that are being modified (in this case, fuel, height, and velocity). On the basis of this feedback, the operator decides what input to enter, and then waits for the computer to report back on the result of processing that new input.

Here is how the series of mathematical operations is represented within the program loop. A$ is the user input, signifying thrust.

```
160 THRUST=VAL(A$)+.1
170 FUEL=FUEL-THRUST
180 FLAG=THRUST-2
190 THRUST=0
200 HEIGHT=HEIGHT+VELOCITY+FLAG/4
210 VELOCITY=VELOCITY+FLAG
```

Typically, the main loop has certain exit conditions (such as, in this simulation, when you crash, run out of fuel, or manage to land safely) that abort the cycle and end the run with a status report to the operator. Lines 220 and 240 in the next section of the program check to see if the cycle should leave the loop, while 230 sends it back for another run through:

```
220 IF HEIGHT<=10 THEN 240
230 IF HEIGHT>10 THEN 120
240 IF VELOCITY>-9 AND VELOCITY<5 THEN 2
90
```

Of course, you don't need to know this, or keep it in mind, when running a program like the SPACE LANDING SIMULATION in this chapter. As far as you're concerned, you're trying to land your ship, and the mechanics of handling your input are none of your concern.

In this program user input is limited to choosing thrust. You signify a high thrust by pressing the "9" key; a low thrust with the "1" key; and zero thrust with the "0" key. Intermediate values are entered by touching other number keys. There is no need to press the RETURN or ENTER key at this point, as INKEY$ (or GET$) are used to read the keyboard.

Let's see how an unskilled pilot makes out when trying to land a spacecraft using this simulation:

```
FUEL          VELOCITY      HEIGHT
208.33        -11.42        497.03
208.23        -9.520001     507.99
208.13        -7.62         517.04
208.03        -5.72         524.2
207.93        -3.82         529.45
207.83        -1.92         532.8
207.73        -.02          534.26
207.63         1.88         533.81
207.53         3.78         531.47
207.43         5.68         527.22
207.33         7.58         521.07


188.23        10.48         341.57
179.13         3.38         332.87
170.03        -3.72         331.28
160.93        -10.82        336.78
151.83        -17.92        349.39
```

```
 151.73      -16.02          366.84
 151.63      -14.12          382.39
 151.53      -12.22          396.05
 151.43      -10.32          407.8
 151.33      -8.42           417.66
 151.23      -6.52           425.61


 150.03       16.28          372.86
 149.93       18.18          356.11
 149.83       20.08          337.47
 149.73       21.98          316.92
 149.63       23.88          294.48
 149.53       25.78          270.13
 149.43       27.68          243.88
 149.33       29.58          215.74
 149.23       31.48          185.69
 149.13       33.38          153.75
 149.03       35.28          119.9
 148.93       37.18          84.15
 148.83       39.08          46.51
---------------------------------
YOU HAVE CRASHED INTO THE SURFACE...
---------------------------------
FINAL INSTRUMENT READINGS WERE:
 FUEL         VELOCITY     HEIGHT
 148.73       40.98
---------------------------------
NEW CRATER ON MOON 2.25 METERS DEEP!
YOUR SKILL RATING IS -438
```

The picture is very different when a skilled space jockey takes the controls:

```
 FUEL         VELOCITY     HEIGHT
 210.71       4.02         496.05
 210.61       5.92         491.57
 210.51       7.82         485.18
 210.41       9.72         476.89
 210.31       11.62        466.7
 210.21       13.52        454.61
 210.11       15.42        440.62
 210.01       17.32        424.73
```

```
 209.91          19.22          406.94
 200.81          12.12          389.5
 191.71          5.02           379.16
 182.61         -2.08           375.92
 182.51         -.18            377.53
 182.41          1.72           377.24
 182.31          3.62           375.05
 182.21          5.52           370.96
 182.11          7.42           364.97
 182.01          9.32           357.08


 150.91          20.22          126.75
 147.81          19.12          106.81
 144.71          18.02          87.97
 140.61          15.92          70.48
 134.51          11.82          55.59
 126.41          5.72           45.3
 124.31          5.62           39.61
 122.21          5.52           34.02
 118.11          3.42           29.03
 116.01          3.32           25.64
 113.91          3.22           22.35
 111.81          3.12           19.16
 108.71          2.02           16.32
 107.61          2.92           14.08
 106.51          3.82           10.94
YOU HAVE LANDED SAFELY!
YOUR SKILL RATING IS 9067
--------------------------------
FINAL INSTRUMENT READINGS WERE:
 FUEL           VELOCITY       HEIGHT
 105.41         4.72           0
--------------------------------
```

Here's the listing so you can do your bit for NASA:

```
10 REM SPACE LANDING SIMULATION I
20 RANDOMIZE VAL(RIGHT$(TIME$,2))
30 REM ******************************
40 REM SET STARTING VALUES
50 FUEL=200+RND(1)*40
60 VELOCITY=RND(1)*20-6
```

```
70 HEIGHT=500-RND(1)*10
80 CLS
90 PRINT " FUEL";TAB(12);" VELOCITY";TAB
(24);" HEIGHT"
100 REM ******************************
110 REM MAJOR CYCLE
120 GOSUB 430
130 IF FUEL<=0 THEN FUEL=0:THRUST=0:GOTO
 170
140 A$=INKEY$
150 IF A$<"0" OR A$>"9" THEN 140
160 THRUST=VAL(A$)+.1
170 FUEL=FUEL-THRUST
180 FLAG=THRUST-2
190 THRUST=0
200 HEIGHT=HEIGHT+VELOCITY+FLAG/4
210 VELOCITY=VELOCITY+FLAG
220 IF HEIGHT<=10 THEN 240
230 IF HEIGHT>10 THEN 120
240 IF VELOCITY>-9 AND VELOCITY<5 THEN 2
90
250 GOSUB 410
260 PRINT "YOU HAVE CRASHED INTO THE SUR
FACE..."
270 IF HEIGHT>0 THEN HEIGHT=-HEIGHT
280 GOTO 320
290 PRINT "YOU HAVE LANDED SAFELY!"
300 PRINT "YOUR SKILL RATING IS"INT(-100
0*FUEL/(VELOCITY-HEIGHT))
310 HEIGHT=0
320 GOSUB 410
330 PRINT "FINAL INSTRUMENT READINGS WER
E:"
340 PRINT " FUEL";TAB(12);" VELOCITY";TA
B(24);" HEIGHT"
350 GOSUB 430
360 GOSUB 410
370 IF HEIGHT>=0 THEN END
380 IF HEIGHT<0 THEN PRINT "NEW CRATER O
N MOON"INT(ABS(100*(HEIGHT+.2)/3))/100"M
ETERS DEEP!"
390 PRINT "YOUR SKILL RATING IS "INT(100
*FUEL/(VELOCITY-HEIGHT))
400 END
```

```
410 PRINT "-----------------------------
---"
420 RETURN
430 PRINT INT(100*FUEL)/100;
440 PRINT TAB(12);-INT(100*VELOCITY)/100
;
450 IF HEIGHT>=0 THEN PRINT TAB(24);INT(
100*HEIGHT)/100
460 IF HEIGHT<0 THEN PRINT
470 RETURN
```

Once you can land consistently with the program in its current form, change line 50 to the following, to create a whole new challenge:

```
50 FUEL=100+RND(1)*40
```

4

Monte Carlo Simulations

Monte Carlo simulations are those simulations that depend on chance or random factors. The random elements in such programs may be weighted to simulate probabilities within specified limits (such as the results of throwing a pair of dice) or may be more or less genuinely random. In this chapter, you'll see a fairly "open" Monte Carlo simulation in action.

Our program is designed to simulate the effect of Brownian movement on a very small particle suspended in a fluid. The random motion of such a particle, which is observed when the particle is less than about one-thousandth of a millimeter in diameter, is caused by the impact of the atoms or molecules of the fluid on the particle. Brownian movement can be seen as smoke disperses in still air, or as ink is diffused in a tumbler of water. It's named after Robert Brown, a Scottish botanist who in 1827 first noted, but was unable to explain, the movement seen when looking through a microscope at a solution of pollen grains in water.

The simulation is shown on a 10 by 10 grid, with a single pollen grain, depicted by "0". When you run the program, you enter the position where you want the grain to start, and also set up a "goal" position. The simulation ends when the pollen grain reaches the goal position.

Here's how it begins:

```
ENTER FIRST START CO-ORDINATE (LESS
THAN 10)
? 3
ENTER SECOND START CO-ORDINATE (LESS
THAN 10)
? 4

ENTER FIRST END CO-ORDINATE (LESS
THAN 10)
? 6
ENTER SECOND END CO-ORDINATE (LESS
THAN 10)
? 7

MOVE 1
. . . . . . . . . .
. . . . . . . . . .
. . . O . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . X . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
```

And here are some screen printouts as the simulated Brownian movement makes the grain drift about:

```
MOVE 5
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . O . . X . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
```

```
MOVE 9
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . O . X . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .

MOVE 11
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . O . . .
. . . . . . X . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
```

Finally, on the fourteenth move, the pollen grain reaches the target position, and the demonstration ends:

```
MOVE 14
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . O . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .
. . . . . . . . . .

DEMONSTRATION OVER
```

Here's the listing so that you can explore this Monte Carlo demonstration:

```
10 REM MONTE CARLO DEMONSTRATION
20 GOSUB 370:REM INITIALIZE
30 REM ****************************
40 REM MAJOR CYCLE
50 GOSUB 100:REM PRINT
60 IF P=EP AND Q=EQ THEN PRINT:PRINT "DE
MONSTRATION OVER":END
70 GOSUB 230:REM GENERATE MOVE
80 GOTO 50
90 REM ****************************
100 REM PRINTOUT
110 A$(P,Q)="O"
120 M=M+1
130 CLS:PRINT:PRINT
140 PRINT "MOVE"M
150 FOR X=1 TO 10
160 FOR Y=1 TO 10
170 PRINT A$(X,Y);" ";
180 NEXT Y
190 PRINT
200 NEXT X
210 RETURN
220 REM ****************************
230 REM GENERATE MOVE
240 A$(P,Q)="."
250 G=0
260 T=INT(RND(1)*4)+1
270 ON T GOSUB 310,320,330,340
280 IF G=0 THEN 260
290 IF G=1 AND RND(1)>.5 THEN 260
300 RETURN
310 IF P>1 THEN P=P-1:G=G+1:RETURN
320 IF P<10 THEN P=P+1:G=G+1:RETURN
330 IF Q>1 THEN Q=Q-1:G=G+1:RETURN
340 IF Q<10 THEN Q=Q+1:G=G+1:RETURN
350 RETURN
360 REM ****************************
370 REM INITIALIZE
380 CLS
390 RANDOMIZE VAL(RIGHT$(TIME$,2))
400 DIM A$(10,10)
```

```
410 FOR X=1 TO 10
420 FOR Y=1 TO 10
430 A$(X,Y)="."
440 NEXT Y
450 NEXT X
460 PRINT:PRINT
470 PRINT "ENTER FIRST START CO-ORDINATE
 (LESS      THAN 10)"
480 INPUT P
490 IF P<1 OR P>10 THEN 480
500 PRINT "ENTER SECOND START CO-ORDINAT
E (LESS     THAN 10)"
510 INPUT Q
520 IF Q<1 OR Q>10 THEN 510
530 PRINT:PRINT
540 PRINT "ENTER FIRST END CO-ORDINATE (
LESS        THAN 10)"
550 INPUT EP
560 IF EP=P OR EP<1 OR EP>10 THEN 550
570 PRINT "ENTER SECOND END CO-ORDINATE
(LESS       THAN 10)"
580 INPUT EQ
590 IF EQ=Q OR EQ<1 OR EQ>10 THEN 580
600 A$(P,Q)="O"
610 A$(EP,EQ)="X"
620 RETURN
```

5

Simultaneous Equations

We can also create simulations that use simultaneous equations to show the effects of two interacting factors on each other. These equations are often used in predator/prey simulations like the one we'll examine in this chapter.

In this example, we have two forms of cell living in a culture. Both cells feed on nutrients in the culture medium, and attempt to reproduce as the simulation runs. Cell X also needs to consume cell Y in order to survive. If there are too many of cell X, it will kill off all of cell Y, and will then die itself. If there are none of cell X, cell Y will reproduce wildly, and choke the medium.

You are allowed to set the starting numbers of cells X and Y in each run of the simulation. You have to try and create a population balance that will allow the cell colony to survive for as long as possible. Although the *degree of aggressiveness* of cell X toward Y changes from run to run of the program (so that you can't just learn which numbers will always work), it does not change within a single run, so you can try various combinations to see how they behave.

The program starts by reporting the *decay factor*, which is the degree of aggressiveness cell X displays toward Y. It then asks you to enter the starting populations:

```
DECAY FACTOR IS .1408966

ENTER NUMBER OF CELL X TO
START (LESS THAN 40)
? 37

WE HAVE 37 X CELLS

ENTER NUMBER OF CELL Y TO
START (LESS THAN 40)
? 25
```

Once you've made your choice, the program works out the life history of your cell cultures, keeping you up to date:

```
---------------
TIME ELAPSED: 1
 37 CELL X
 25 CELL Y
---------------
TIME ELAPSED: 2
 35 CELL X
 17 CELL Y
---------------
TIME ELAPSED: 3
 46 CELL X
 9 CELL Y
---------------
TIME ELAPSED: 4
 77 CELL X
 2 CELL Y
---------------
TIME ELAPSED: 5
 37 CELL X
 1 CELL Y

YOUR CELL CLASH SIMULATION SURVIVED
FOR 5 TIME PERIODS.
```

```
----------------------------------
THE BEST SURVIVAL TIME SO FAR IS 5
----------------------------------
DO YOU WANT A NEW RUN (Y OR N)?
```

The program also keeps track of the "longest life so far." It gives you an opportunity, in subsequent runs, to see the effect of different starting populations:

```
ENTER NUMBER OF CELL X TO
START (LESS THAN 40)
? 25

WE HAVE 25 X CELLS

ENTER NUMBER OF CELL Y TO
START (LESS THAN 40)
? 37

---------------
TIME ELAPSED: 4
 2 CELL X
 35 CELL Y
---------------
TIME ELAPSED: 5
 1 CELL X
 36 CELL Y


YOUR CELL CLASH SIMULATION SURVIVED
FOR 5 TIME PERIODS.
----------------------------------
THE BEST SURVIVAL TIME SO FAR IS

ENTER NUMBER OF CELL X TO
START (LESS THAN 40)
? 38

WE HAVE 38 X CELLS

ENTER NUMBER OF CELL Y TO
START (LESS THAN 40)
? 38
```

```
TIME ELAPSED: 2
 13 CELL X
 34 CELL Y
---------------
TIME ELAPSED: 3
 6 CELL X
 33 CELL Y
---------------
TIME ELAPSED: 4
 3 CELL X
 33 CELL Y
---------------
TIME ELAPSED: 5
 1 CELL X
 34 CELL Y


YOUR CELL CLASH SIMULATION SURVIVED
FOR 5 TIME PERIODS.
-----------------------------------
THE BEST SURVIVAL TIME SO FAR IS 5
-----------------------------------
DO YOU WANT A NEW RUN (Y OR N)?

ENTER NUMBER OF CELL X TO
START (LESS THAN 40)
? 22


WE HAVE 22 X CELLS


ENTER NUMBER OF CELL Y TO
START (LESS THAN 40)
? 30

---------------
TIME ELAPSED: 3
 13 CELL X
 23 CELL Y
---------------
TIME ELAPSED: 4
 14 CELL X
 21 CELL Y
```

```
---------------
TIME ELAPSED: 5
 15 CELL X
 18 CELL Y
---------------
TIME ELAPSED: 6
 19 CELL X
 15 CELL Y
---------------
TIME ELAPSED: 7
 27 CELL X
 12 CELL Y
---------------
TIME ELAPSED: 8
 41 CELL X
 7 CELL Y
---------------
TIME ELAPSED: 9
 74 CELL X
 2 CELL Y
---------------
TIME ELAPSED: 10
 32 CELL X
 1 CELL Y


YOUR CELL CLASH SIMULATION SURVIVED
FOR 10 TIME PERIODS.
-----------------------------------
THE BEST SURVIVAL TIME SO FAR IS 10
-----------------------------------
DO YOU WANT A NEW RUN (Y OR N)?
OK
```

The most crucial parts of the program are the equations that calculate the cell populations. These are lines 330 and 340:

```
330  CP=CP+((8*CP-CP*EP/3)*FD)
340  EP=EP+((4*EP-EP*CP)*.01)
```

Modify parts of these program statements and watch the effect this has on the progress of your simulation. You'll probably be surprised

to see the far-reaching effects of even the most apparently minor change. Here's the listing:

```
10 REM SIMULTANEOUS EQUATIONS
20 CLS
30 RANDOMIZE VAL(RIGHT$(TIME$,2))
40 HS=0
50 FD=RND(0)
60 PRINT:PRINT "DECAY FACTOR IS"FD
70 GOSUB 550
80 CLS
90 PRINT:PRINT
100 PRINT "ENTER NUMBER OF CELL X TO
          START (LESS THAN 40)"
110 INPUT CP:IF CP<1 OR CP>39 THEN 110
120 PRINT:PRINT
130 PRINT "WE HAVE"CP"X CELLS"
140 PRINT:PRINT
150 PRINT "ENTER NUMBER OF CELL Y TO
          START (LESS THAN 40)"
160 INPUT EP:IF EP<1 OR EP>39 THEN 160
170 CLS:PRINT:PRINT "PLEASE STAND BY..."

180 GOSUB 550:CLS
190 DA=1
200 IF CP>EP/FD THEN CP=EP/FD
210 PRINT "---------------"
220 PRINT "TIME ELAPSED:"DA
230 PRINT INT(CP)"CELL X"
240 PRINT INT(EP)"CELL Y"
250 REM ***************************
260 REM MAJOR CYCLE
270 GOSUB 550
280 DA=DA+1
290 PRINT "---------------"
300 PRINT "TIME ELAPSED:"DA
310 IF CP>EP/FD THEN CP=EP/FD
320 REM EQUATIONS FOLLOW; MODIFY PARTS
       OF THEM TO SEE WHAT HAPPENS
330 CP=CP+((8*CP-CP*EP/3)*FD)
340 EP=EP+((4*EP-EP*CP)*.01)
350 PRINT INT(CP)"CELL X"
360 PRINT INT(EP)"CELL Y"
370 IF EP<2 OR CP<2 THEN 410
```

```
380 GOSUB 550
390 GOTO 280
400 REM ****************************
410 IF DA>HS THEN HS=DA
420 PRINT:PRINT
430 PRINT "YOUR CELL CLASH SIMULATION SU
RVIVED"
440 PRINT "FOR"DA"TIME PERIODS."
450 PRINT "------------------------------
-----"
460 PRINT "THE BEST SURVIVAL TIME SO FAR
 IS"HS
470 GOSUB 550
480 PRINT "------------------------------
-----"
490 PRINT "DO YOU WANT A NEW RUN (Y OR N
)?"
500 A$=INKEY$
510 IF A$<>"Y" AND A$<>"N" THEN 500
520 IF A$="Y" THEN CLS:GOTO 60
530 PRINT "OK":PRINT:PRINT:END
540 REM ****************************
550 FOR J=1 TO 2000:NEXT J
560 RETURN
```

6

The Meaning of Life

In the previous chapter we looked at a program that simulated the action of two competing life forms occupying a single space. In that simulation, the growth and decay of the cells were governed by simultaneous equations. In this chapter, we'll look at two versions of a simulation classic, John Conway's LIFE. This simulation models the growth and development of a colony of cells living on a grid.

Developed by Conway when he was at Gonville and Caius College, in Cambridge, England, LIFE produces some amazing effects, whose richness is not even hinted at by the rules under which the cells live, reproduce, and die. To show this, we'll look at a colony of cells that starts off forming a square. This particular colony dies off after three "generations":

```
GENERATION 1


XXXXX          XXXXX
X   X          X   X
X   X          X   X
X   X          X   X
XXXXX          XXXXX
```

```
GENERATION 2

  XXX           XXX
 XXXXX         XXXXX
XX X XX       XX X XX
XXX XXX       XXX XXX
XX X XX       XX X XX
 XXXXX         XXXXX
  XXX           XXX
```

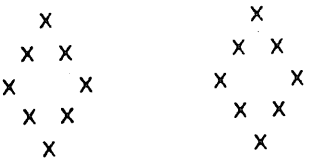
```
GENERATION 3

   X               X
  X X             X X
 X   X           X   X

X     X         X     X

 X   X           X   X
  X X             X X
   X               X
```

Another colony, which begins life in an "X" shape, evolves as follows (the program prints a "mirror image" colony to the right of the original colony in all these sample runs).

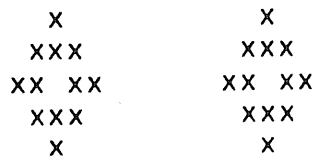
```
GENERATION 1


X   X           X   X
 X X             X X
  X               X
 X X             X X
X   X           X   X
```

GENERATION 2

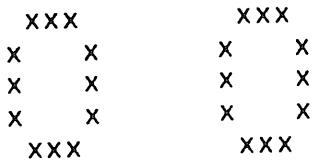
GENERATION 3



GENERATION 4



GENERATION 5



```
GENERATION 6

   X              X
  XXX            XXX
 X X X          X X X
XXX XXX        XXX XXX
 X X X          X X X
  XXX            XXX
   X              X
```

```
GENERATION 7

  XXX            XXX

X   X   X   X
X   X   X   X
X   X   X   X

  XXX            XXX
```

```
GENERATION 8

   X              X
   X              X
   X              X

XXX   XXX   XXX   XXX

   X              X
   X              X
   X              X
```

If we continue to run this simulation, each horizontal set of X's flips to become a vertical set, and the vertical sets become horizontal. This pattern of three alternating from horizontal to vertical is one of a number of patterns that regularly crop up in runs of the program. This particular pattern is commonly known as "traffic lights."

The Rules

Conway's rules are not very complicated, but they are sufficient to give rise to the marvelous effects we've been looking at. They assume each cell has eight neighbors. (We keep the outermost ring of cells empty; these are checked, but not printed out.) If a cell has two or three neighbors, it survives to the next generation. If a cell has four neighbors, it dies out in the next generation due to overcrowding. If there are exactly three cells neighboring an empty cell, a cell is "born" in that location in the next generation.

The rules are applied simultaneously across the whole grid. We do this by having a second grid, which records the changes as the first grid is scanned. The second grid is then copied into the first before it is printed.

This is the listing that produced the effects above. The DATA statements at the end can be, of course, changed to whatever initial colony you desire:

```
10 REM CONWAY'S LIFE SIMULATION
20 REM DEFINED INITIAL COLONY
30 GOSUB 460:REM INITIALIZE
40 REM ************************
50 REM MAJOR CYCLE
60 GENERATION=GENERATION+1
70 GOSUB 290:REM PRINTOUT
80 GOSUB 110:REM EVOLVE
90 GOTO 60
100 REM ************************
110 REM EVOLVE
120 FOR X=2 TO 12
130 FOR Y=2 TO 12
140 C=0
150 IF A$(X-1,Y-1)="X" THEN C=C+1
160 IF A$(X-1,Y)="X" THEN C=C+1
170 IF A$(X-1,Y+1)="X" THEN C=C+1
180 IF A$(X,Y-1)="X" THEN C=C+1
190 IF A$(X,Y+1)="X" THEN C=C+1
200 IF A$(X+1,Y-1)="X" THEN C=C+1
210 IF A$(X+1,Y)="X" THEN C=C+1
220 IF A$(X+1,Y+1)="X" THEN C=C+1
230 IF A$(X,Y)="X" AND C<>2 AND C<>3 THE
N B$(X,Y)=" "
240 IF A$(X,Y)=" " AND C=3 THEN B$(X,Y)=
"X"
```

```
250 NEXT Y
260 NEXT X
270 RETURN
280 REM ************************
290 REM PRINTOUT
300 CLS
310 PRINT
320 PRINT TAB(4);"GENERATION"GENERATION
330 PRINT
340 FOR X=2 TO 12
350 FOR Y=2 TO 12
360 A$(X,Y)=B$(X,Y)
370 PRINT A$(X,Y);
380 NEXT Y
390 FOR Y=12 TO 2 STEP-1
400 PRINT A$(X,Y);
410 NEXT Y
420 PRINT
430 NEXT X
440 RETURN
450 REM ************************
460 REM INITIALIZATION
470 CLS
480 RANDOMIZE VAL(RIGHT$(TIME$,2))
490 DEFINT A-Z
500 DIM A$(13,13),B$(13,13)
510 PRINT:PRINT "   PLEASE STAND BY..."
520 FOR X=1 TO 13
530 PRINT 14-X;
540 FOR Y=1 TO 13
550 REM FILL ARRAY WITH BLANKS
560 A$(X,Y)=" "
570 B$(X,Y)=A$(X,Y)
580 NEXT Y
590 NEXT X
600 READ D:IF D=99 THEN 630
610 READ E:A$(D,E)="X":B$(D,E)="X"
620 GOTO 600
630 GENERATION=0
640 RETURN
650 DATA 5,5,5,9,6,6,6,8
660 DATA 7,7
670 DATA 8,6,8,8,9,5,9,9
700 DATA 99
```

Colonies at Random

If you prefer to let your computer generate a starting colony at random, leaving you simply to admire its work, add the following lines:

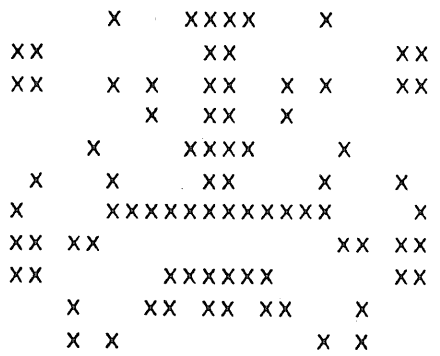
```
555 IF RND(1)>.5 THEN A$(X,Y)="X":GOTO 5
70

595 GOTO 630
```

The evolution of a randomly generated colony is always fascinating to watch, as these sample runs indicate:

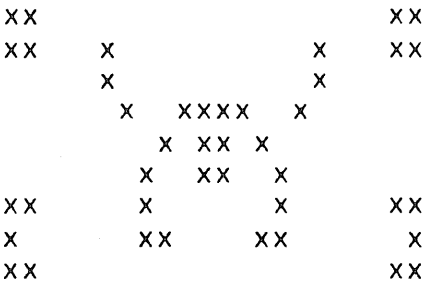
```
    GENERATION 1

 X   X XXXXXXXXXX X   X
X       XX   XX   XX       X
X   X X      XX      X X   X
 X         XXXXXX         X
     X       XX       X
    X   X            X   X
X XX      XXXXXX      XX X
 X    XXX X   X XXX    X
 X         XXXXXX         X
XXX                      XXX
 XXXXXX    XX    XXXXXX
```

```
    GENERATION 2

       XX XXXXXX XX
XX   X       XX       X   XX
XX      XXX XX XXX      XX
     X       XX       X
             XX
   XXX       XX       XXX
  XXXXX   XXXXXX   XXXXX
XX      XX        XX      XX
        XXXXXXXXXX
X    XX      XX      XX    X
X   XXX             XXX   X
```

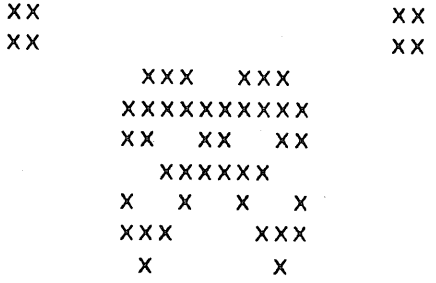
GENERATION 3



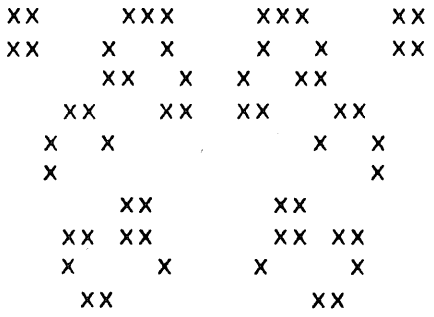
GENERATION 9



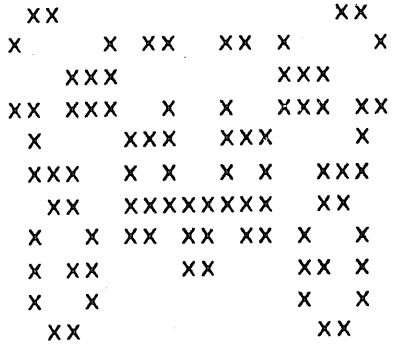
GENERATION 12



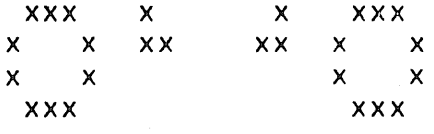
GENERATION 24



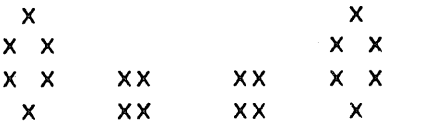
GENERATION 39



GENERATION 51



GENERATION 62



7

Robot Simulations

In this section of the book we will create programs that perform two simulations at once. First, the programs simulate the behavior of a robot who follows a series of commands we enter before the program is run. Second, the programs emulate a computer language interpreter, enabling the computer, and the computer-controlled robot, to understand instructions we give it in a *Robot Control Language* RCL, developed especially for this book.

In mid 1983 Muse Software, of Baltimore, released a superb robot simulation program under the name of *Robotwar.* This program allows you to pre-program a number of robots before setting them loose on a computer-screen battlefield to fight it out for victory. *Robotwar* allows you to program the robots in a language which is essentially English, with a few BASIC commands (such as GOTO and GOSUB) thrown in.

Our program, ROBOT LOGO and POINT-DUTY ROBOT (which is derived from the first program), are much simplier than *Robotwar,* yet still produce satisfying, and surprisingly interesting, results.

We'll look first at ROBOT LOGO. To show you what it can do, and to give you an idea of what an RCL listing looks like, here's a program that gets the robot to trace out my initials on the screen, leaving a trail as it goes:

```
GO 6,10
FACE 90
FORWARD 7
GO 8,26
FORWARD 5
PR
GO 6,16
FACE 180
FORWARD 6
GO 6,26
FORWARD 6
GO 6,34
FORWARD 6
PRINTOUT
*
```

This is the result of running that program:

```
X X X X X X X X     X           X
        X           X           X
        X           X X X X     X
        X           X           X
        X           X           X
        X           X           X
```

There are twelve commands in RCL, any of which, included in a program, can be abbreviated to its first two letters. The RCL program is written into the overall BASIC program, as a set of up to twenty DATA statements, terminated with a DATA statement that just contains an asterisk. These DATA lines are kept near the beginning of the program. The current line being processed appears at the top of the screen as the progam is running, so you can see the relevant line, and its effect, as it occurs.

The Language

Here is the complete vocabulary of RCL:

START (abbreviated to ST) Start again.

PRINTOUT (PR) Stop the robot action, clear the screen, and print out the current situation before continuing with the program run.

FORWARD (FO) This is followed by a single number, and it tells the robot to move forward the number of "steps" or "spaces" indicated by the number that follows the command.

BACK (BA) The opposite, naturally enough, of FORWARD.

TURN (TU) Followed by a number, this command turns the robot through the specified number of degrees; it starts a run at zero degrees, designated as facing the top of the screen.

HOME (HO) Returns the robot to the center of the screen, facing upwards.

CLEAN (CL) Cleans the previous steps away. (The action of this command, like the others, will become clear once you use it.)

GO This is followed by two numbers, which are the coordinates to which the robot moves *without* leaving a trail between its old position and the new one.

RANDOM (RA) Moves the robot to a randomly chosen position on the screen; acts as a random GO.

REPEAT (RE) Followed by a number, this command allows you to cycle through a section of the program a specified number of times before continuing. This can produce some fascinating effects, as you'll see shortly.

END REPEAT (EN) Terminates the REPEAT cycle; all the commands in the RCL program that lie between REPEAT and END REPEAT will be cycled through the number of times specified.

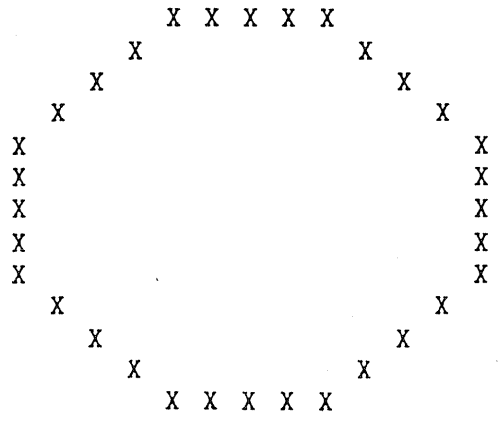
FACE (FA) Followed by a number, this turns the robot to face an absolute angle, with the top of the screen as zero degrees (whereas TURN is relative to the current angle the robot is facing).

This short set of commands can be combined to produce many startling results. If you are at all familiar with the Logo programming language, you will recognize that several of the RCL commands are very similar to the turtle graphic commands in Logo. Logo was developed under Seymour Papert, with Marvin Minsky, Harold Abelson, and Andrew diSessa, at the Massachusetts Institute of Technology by the Artificial Intelligence Group. It was designed so that the way it was used by programmers would be closer to the way human beings usually solve problems, rather than being heavily influenced by how machines run programs. Of course, our RCL is pretty limited in comparison with Logo, although it can easily be extended to whatever level of complexity you like. Studying the listing will show you how it is relatively easy to write a program that *interprets* another program written in a language you have created.

Despite its limitations, you can have a lot of fun with RCL—as the following sample runs indicate.

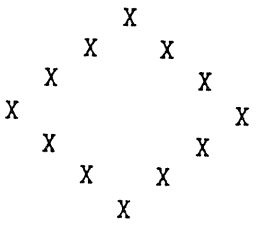
This RCL program produces octagons:

```
OCTAGON

GO 11,35
REPEAT 8
FORWARD 4
TURN 45
END REPEAT
PRINTOUT
*
```



You'll get diamonds with this one:

```
DIAMONDS

RANDOM
FACE 45
REPEAT 4
FORWARD 2
TURN 90
END REPEAT
PRINTOUT
START AGAIN
*
```



And this RCL listing creates squares:

```
SQUARE
GO 11,35
REPEAT 4
FORWARD 6
TURN 90
END REPEAT
PRINTOUT
*
```

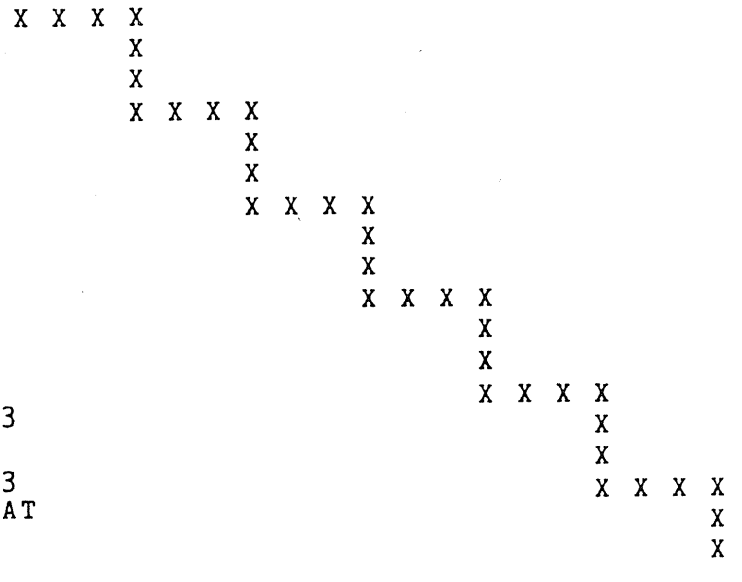
```
X X X X X X X
X           X
X           X
X           X
X           X
X           X
X X X X X X X
```

Descending triangles are easy. Note that we're using abbreviated commands in this RCL listing:

```
X
X X
X   X
X X X X
      X X
      X   X
      X X X X
            X X
            X   X
            X X X X
                  X X
                  X   X
                  X X X X
                        X X
                        X   X
                        X X X X
                              X X
                              X   X
                              X X X X
                                    X X
                                    X   X
                                    X X X X
                                          X
```

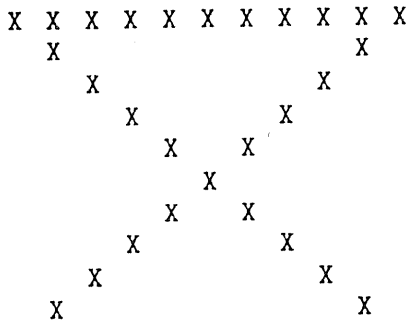
```
DESCENDING TRIANGLES

GO 5,5
RE 6
FO 3
TU 135
FO 3
TU 135
FO 3
FA 90
FO 3
FA 180
FO 3
FA 0
PR
EN
*
```

The next RCL program gets our robot to walk down stairs:



```
STAIRS

GO 1,1
RE 6
FACE 90
FORWARD 3
FACE 180
FORWARD 3
END REPEAT
PRINTOUT
*
```

If you're feeling very creative, you can also get the robot to trace out pictures, like my initials earlier, or this "side view of a table":



```
SIDE VIEW OF TABLE

GO 20,50
FACE 315
FORWARD 9
FACE 90
FORWARD 10
FACE 225
FORWARD 10
PRINTOUT
*
```

Writing a Program

As I said earlier, the RCL program is held in a series of DATA statements near the beginning of the listing:

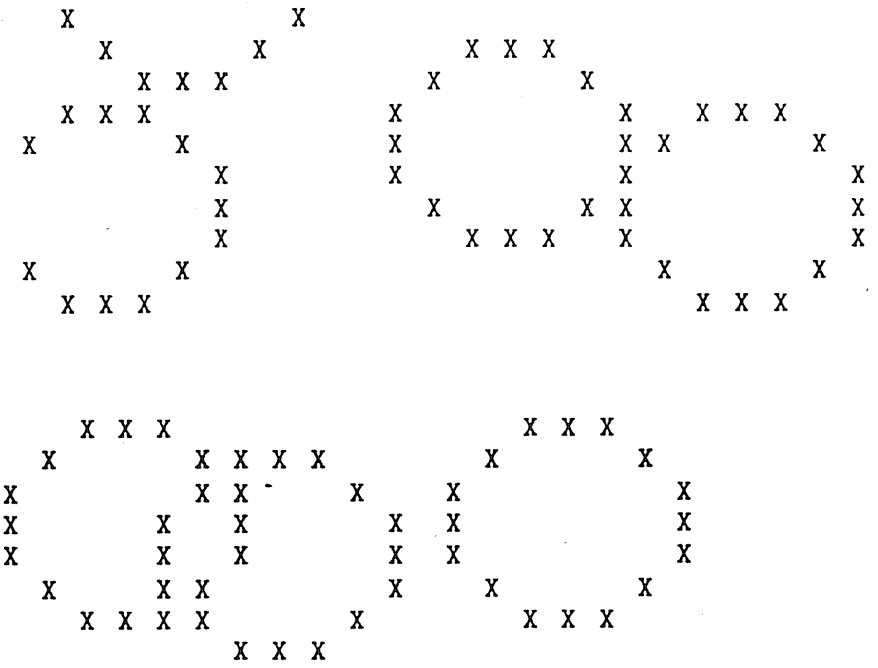
```
100 REM ROBOT LOGO
110 GOSUB 1730:REM INITIALIZE
120 GOTO 490
130 REM ******************************
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 DATA "*"
330 REM ******************************
```

Here's a listing to create random octagons. We can learn a lot about RCL by examining it:

```
OCTAGON

RANDOM
REPEAT 8
FORWARD 2
TURN 45
END REPEAT
PRINTOUT
START AGAIN
*
```

It begins with RANDOM, which moves the robot to a randomly chosen position on your screen. The dimensions of the screen are included within the program (see lines 1770 and 1780 in the listing in the next chapter), so it can be changed easily to work on your system no matter what its screen size.

Once the robot is in place, the computer comes to the line REPEAT 8. This tells it, naturally enough, that the next section of the program (down to the END REPEAT) is to be run through eight times. The robot moves FOWARD 2, then TURNs through 45 degrees. Once it has done this eight times, it has traced out an octagon, which PRINTOUT puts on the screen for you to see:



The final command, START AGAIN, sends action back to the first line of the program, to select a new random robot position. RCL automatically rejects values that are off the screen, so the program will not crash if you try to walk off the edge of the robot's world. It will simply draw the required material "off the screen," as it were, and then continue at the correct place when it returns to the screen.

From the examples we've looked at, you can see that the robot can be made to do a great deal. The biggest limitation is in the TURN and FACE commands. In its present form, it can only work in incre-

ments of 45 degrees, and will change any angle into the closest multiple of 45 before it sends the robot out along that path (see lines 1040 and 1620). This restriction was necessary in order to ensure that, despite the very rough resolution of the grid upon which the robot walks, a reasonable picture was still drawn by the robot's trail.

The full ROBOT LOGO listing is presented in the next chapter.

8

The ROBOT LOGO Listing

You're sure to have a lot of fun using this listing to get the robot to follow programs you have devised. Simply place them, in the form of DATA "REPEAT 8", in lines 140 though to 310 (note the use of quotation marks around the RCL statement). Line 320, where you see a lone asterisk in the DATA statement, tells the program that it has come to the end of your listing.

I got my program listings to the printer by running the program, then entering and running the following directly:

```
FOR Z=1 TO 20:LPRINT A$(Z):NEXT Z
```

In its present form the program can cope with RCL programs that are up to twenty lines long. If you want it to accept longer programs, simply change the 20 in lines 530 and 1820 to the number of commands you want to include. Remember that you need to allow for a command slot to hold the asterisk (end-of-program flag) line.

Here, then, is the listing so that you can run your own robot:

```
100 REM ROBOT LOGO
110 GOSUB 1730:REM INITIALIZE
120 GOTO 490
```

```
130 REM ****************************
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 DATA "*"
330 REM ****************************
340 REM INT UX,AX
350 UX=INT(UX+.5):AX=INT(AX+.5)
360 RETURN
370 REM ****************************
380 REM            PRINT OUT
390 CLS:REM OR LOCATE 1,1 OR SIMILAR
400 PRINT "STEP"PSN" > ";A$(PSN):PRINT
410 FOR J=1 TO DEPTH
420 FOR K=1 TO BREADTH
430 PRINT Z$(J,K);
440 NEXT K
450 PRINT
460 NEXT J
470 RETURN
480 REM ****************************
490 REM READ PROGRAM
500 COUNT=COUNT+1
510 READ A$(COUNT)
520 IF A$(COUNT)="*" THEN 550
530 IF COUNT<20 THEN 500
540 REM ****************************
550 REM EXECUTE PROGRAM
560 PSN=0:REM PROGRAM STEP NUMBER
```

```
570 PSN=PSN+1
580 IF PSN=21 THEN 580:REM END
590 FLAG=0
600 M$=A$(PSN)
610 IF M$="*" THEN 610:REM END
620 N$=LEFT$(M$,2)
630 IF N$="ST" THEN 560:REM START AGAIN
640 IF N$="PR" THEN GOSUB 380:REM PRINTO
UT
650 IF N$="FO" THEN FLAG=1
660 IF N$="BA" THEN FLAG=2
670 IF N$="TU" THEN FLAG=3
680 IF N$="HO" THEN FLAG=4
690 IF N$="CL" THEN FLAG=5
700 IF N$="GO" THEN FLAG=6
710 IF N$="RA" THEN FLAG=7
720 IF N$="RE" THEN FLAG=8
730 IF N$="EN" THEN FLAG=9
740 IF N$="FA" THEN FLAG=10
750 ON FLAG GOSUB 780,940,1000,1160,1220
,1260,1400,1460,1530,1580
760 GOTO 570
770 REM ******************************
780 REM              FORWARD
790 M$=MID$(M$,4)
800 IF ASC(M$)=87 THEN M$=MID$(M$,6)
810 F$="F"
820 NUM=VAL(M$)
830 FOR E=1 TO NUM
840 IF UX<1 OR UX>DEPTH THEN 880
850 IF AX<1 OR AX>BREADTH THEN 880
860 Z$(UX,AX)=T$
870 REM DELETE THE '*2' AT END OF NEXT
 TWO LINES IF BETTER ON YOUR SYSTEM
880 IF F$="F" THEN UX=UX+UP:AX=AX+AC*2
890 IF F$="B" THEN UX=UX-UP:AX=AX-AC*2
900 GOSUB 340
910 NEXT E
920 RETURN
930 REM ******************************
940 REM               BACK
950 M$=MID$(M$,4)
960 IF ASC(M$)=75 THEN M$=MID$(M$,3)
970 F$="B"
```

```
980 GOTO 820
990 REM ******************************
1000 REM                TURN
1010 M$=MID$(M$,4)
1020 IF ASC(M$)=78 THEN M$=MID$(M$,3)
1030 NUM=VAL(M$)
1040 Y=INT((NUM+17.5)/45)
1050 IF Y=0 OR Y=8 THEN RETURN
1060 FOR J=1 TO Y
1070 IF UP=-1 AND AC=0 THEN AC=1:GOTO 11
30
1080 IF UP=0 AND AC=1 THEN UP=1:GOTO 113
0
1090 IF UP=1 AND AC=0 THEN AC=-1:GOTO 11
30
1100 IF UP=0 AND AC=-1 THEN UP=-1:GOTO 1
130
1110 IF UP=-1 AND AC=-1 OR UP=1 AND AC=1
 THEN AC=0:GOTO 1130
1120 IF UP=-1 AND AC=1 OR UP=1 AND AC=-1
 THEN UP=0
1130 NEXT J
1140 RETURN
1150 REM ******************************
1160 REM                HOME
1170 AX=INT((BREADTH+.5)/2)
1180 UX=INT((DEPTH+.5)/2)
1190 UP=-1:AC=0:REM FACES UP
1200 RETURN
1210 REM ******************************
1220 REM                CLEAN
1230 GOSUB 1870
1240 RETURN
1250 REM ******************************
1260 REM             GO X,Y
1270 P=0
1280 P=P+1
1290 IF MID$(M$,P,1)="," THEN 1320
1300 IF P<LEN(M$) THEN 1280
1310 RETURN:REM ERROR
1320 UX=VAL(MID$(M$,4,P-1))
1330 AX=VAL(RIGHT$(M$,LEN(M$)-P))
1340 GOSUB 340
1350 IF UX<1 OR UX>DEPTH THEN 1380
```

```
1360 IF AC<1 OR AC>BREADTH THEN 1380
1370 Z$(UX,AX)=R$
1380 RETURN
1390 REM ******************************
1400 REM              RANDOM
1410 AX=INT(RND(1)*BREADTH)
1420 UX=INT(RND(1)*DEPTH)
1430 Z$(UX,AX)=R$
1440 RETURN
1450 REM ******************************
1460 REM              REPEAT
1470 M$=MID$(M$,4)
1480 IF ASC(M$)=69 THEN M$=MID$(M$,5)
1490 RECOUNT=VAL(M$)
1500 MARKER=PSN
1510 RETURN
1520 REM ******************************
1530 REM           END REPEAT
1540 RECOUNT=RECOUNT-1
1550 IF RECOUNT>0 THEN PSN=MARKER
1560 RETURN
1570 REM ******************************
1580 REM              FACE
1590 M$=MID$(M$,4)
1600 IF ASC(M$)=69 THEN M$=MID$(M$,3)
1610 NUM=VAL(M$)
1620 Y=INT((NUM+17.5)/45)*45
1630 IF Y=0 OR Y=360 THEN UP=-1:AC=0
1640 IF Y=45 THEN UP=-1:AC=1
1650 IF Y=90 THEN UP=0:AC=1
1660 IF Y=135 THEN UP=1:AC=1
1670 IF Y=180 THEN UP=1:AC=0
1680 IF Y=225 THEN UP=1:AC=-1
1690 IF Y=270 THEN UP=0:AC=-1
1700 IF Y=315 THEN UP=-1:AC=-1
1710 RETURN
1720 REM ******************************
1730 REM INITIALIZE
1740 CLS
1750 RANDOMIZE VAL(RIGHT$(TIME$,2))
1760 REM   ADJUST NEXT TWO LINES FOR
         BEST RESULTS ON YOUR SYSTEM
1770 BREADTH=80:REM CHARACTERS ACROSS
1780 DEPTH=24:REM CHARACTERS DOWN
```

```
1790 BREADTH=BREADTH-1
1800 DEPTH=DEPTH-3
1810 UP=-1:AC=0:REM STARTS FACING UP
1820 DIM A$(20):REM FOR ROBOT PROGRAM
1830 DIM Z$(DEPTH,BREADTH):REM DISPLAY
1840 T$="X":REM PUT SYMBOL HERE YOU
     WANT TO USE FOR ROBOT'S TRAIL
1850 AX=0:UX=0
1860 REM FILL ARRAY WITH SPACES
1870 FOR J=1 TO DEPTH
1880 FOR K=1 TO BREADTH
1890 Z$(J,K)=" "
1900 NEXT K
1910 NEXT J
1920 RETURN
```

9

The Point-Duty Robot

While ROBOT LOGO is interesting as far as it goes, once I had used it for a while, I felt that it really didn't go far enough. The program was developed, like the others in this book, so they would run on just about any computer furnished with BASIC, and therefore used an array to keep track of the robot's movement and current position.

The POINT-DUTY ROBOT program that follows makes use of the PSET command included in the BASIC on my IBM PC to draw dots at a much finer resolution than the first program—320 by 200, rather than 80 by 24. Using a machine-specific command like PSET, of course means that if a listing of the program for your computer is not included in this book, you may have a little more trouble than usual in getting the program to run. However, the results are superb, and the effort involved in getting the program to run is certainly worth it. If your computer doesn't use PSET to plot a point on the screen, check your computer's BASIC manual for a similar command, such as SET, POINT, PLOT, that you can use as a replacement.

Here is the POINT-DUTY ROBOT listing, which is based on the ROBOT LOGO program in the previous chapter. It has not been renumbered, so you should find it easy to modify the first listing into the second one. The RCL commands are the same, except that PRINTOUT is no longer supported. It is not needed, as the program prints out automatically as it is running.

Note that line 1735 in the listing that follows is an IBM-specific command that moves the computer into graphics mode. You will

need to drop or convert this line if you're running the program on a different computer.

```
100 REM POINT-DUTY ROBOT
110 GOSUB 1730:REM INITIALIZE
120 GOTO 490
130 REM ******************************
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 DATA "*"
330 REM ******************************
340 REM INT UX,AX
350 UX=INT(UX+.5):AX=INT(AX+.5)
360 RETURN
480 REM ******************************
490 REM READ PROGRAM
500 COUNT=COUNT+1
510 READ A$(COUNT)
520 IF A$(COUNT)="*" THEN 550
530 IF COUNT<20 THEN 500
540 REM ******************************
550 REM EXECUTE PROGRAM
560 PSN=0:REM PROGRAM STEP NUMBER
570 PSN=PSN+1
580 IF PSN=21 THEN 580:REM END
590 FLAG=0
600 M$=A$(PSN)
610 IF M$="*" THEN 610:REM END
```

```
620 N$=LEFT$(M$,2)
630 IF N$="ST" THEN 560:REM START AGAIN
650 IF N$="FO" THEN FLAG=1
660 IF N$="BA" THEN FLAG=2
670 IF N$="TU" THEN FLAG=3
680 IF N$="HO" THEN FLAG=4
700 IF N$="GO" THEN FLAG=5
710 IF N$="RA" THEN FLAG=6
720 IF N$="RE" THEN FLAG=7
730 IF N$="EN" THEN FLAG=8
740 IF N$="FA" THEN FLAG=9
750 ON FLAG GOSUB 780,940,1000,1160,1260
,1400,1460,1530,1580
760 GOTO 570
770 REM ******************************
780 REM             FORWARD
790 M$=MID$(M$,4)
800 IF ASC(M$)=87 THEN M$=MID$(M$,6)
810 F$="F"
820 NUM=VAL(M$)
830 FOR E=1 TO NUM
840 IF UX<1 OR UX>DEPTH THEN 880
850 IF AX<1 OR AX>BREADTH THEN 880
860  PRESET (AX,UX):PSET (AX,UX)
880 IF F$="F" THEN UX=UX+UP:AX=AX+AC
890 IF F$="B" THEN UX=UX-UP:AX=AX-AC
900 GOSUB 340
910 NEXT E
920 RETURN
930 REM ******************************
940 REM              BACK
950 M$=MID$(M$,4)
960 IF ASC(M$)=75 THEN M$=MID$(M$,3)
970 F$="B"
980 GOTO 820
990 REM ******************************
1000 REM               TURN
1010 M$=MID$(M$,4)
1020 IF ASC(M$)=78 THEN M$=MID$(M$,3)
1030 NUM=VAL(M$)
1040 Y=INT((NUM+11.25)/22.5)
1050 IF Y=0 OR Y=16 THEN RETURN
1060 FOR J=1 TO Y
1065 IF UP=-2 AND AC=0 OR UP=2 AND AC=2
THEN AC=1:GOTO 1130
```

```
1070 IF UP=-2 AND AC=1 THEN AC=2:GOTO 11
30
1075 IF UP=-2 AND AC=2 OR UP=0 AND AC=-2
 THEN UP=-1:GOTO 1130
1080 IF UP=-1 AND AC=2 OR UP=1 AND AC=-2
 THEN UP=0:GOTO 1130
1085 IF UP=0 AND AC=2 OR UP=2 AND AC=-2
THEN UP=1:GOTO 1130
1090 IF UP=1 AND AC=2 THEN UP=2:GOTO 113
0
1095 IF UP=2 AND AC=1 THEN AC=0:GOTO 113
0
1100 IF UP=2 AND AC=0 THEN AC=-1:GOTO 11
30
1105 IF UP=2 AND AC=-1 THEN AC=-2:GOTO 1
130
1110 IF UP=-1 AND AC=-2 THEN UP=-2:GOTO
1130
1115 IF UP=-2 AND AC=-2 THEN AC=-1:GOTO
1130
1120 IF UP=-2 AND AC=-1 THEN AC=0
1130 NEXT J
1140 RETURN
1150 REM ********************************
1160 REM              HOME
1170 AX=INT((BREADTH+.5)/2)
1180 UX=INT((DEPTH+.5)/2)
1190 UP=-2:AC=0:REM FACES UP
1200 RETURN
1210 REM ********************************
1220 REM              CLEAN
1230 GOSUB 1870
1240 RETURN
1250 REM ********************************
1260 REM           GO X,Y
1270 P=0
1280 P=P+1
1290 IF MID$(M$,P,1)="," THEN 1320
1300 IF P<LEN(M$) THEN 1280
1310 RETURN:REM ERROR
1320 UX=VAL(MID$(M$,4,P-1))
1330 AX=VAL(RIGHT$(M$,LEN(M$)-P))
1340 GOSUB 340
1350 IF UX<1 OR UX>DEPTH THEN 1380
1360 IF AC<1 OR AC>BREADTH THEN 1380
```

```
1370 PSET (AX,UX)
1380 RETURN
1390 REM ******************************
1400 REM              RANDOM
1410 AX=INT(RND(1)*BREADTH)
1420 UX=INT(RND(1)*DEPTH)
1430 PSET(AX,UX)
1440 RETURN
1450 REM ******************************
1460 REM              REPEAT
1470 M$=MID$(M$,4)
1480 IF ASC(M$)=69 THEN M$=MID$(M$,5)
1490 RECOUNT=VAL(M$)
1500 MARKER=PSN
1510 RETURN
1520 REM ******************************
1530 REM           END REPEAT
1540 RECOUNT=RECOUNT-1
1550 IF RECOUNT>0 THEN PSN=MARKER
1560 RETURN
1570 REM ******************************
1580 REM              FACE
1590 M$=MID$(M$,4)
1600 IF ASC(M$)=69 THEN M$=MID$(M$,3)
1610 NUM=VAL(M$)
1620 Y=INT((NUM+11.25)/22.5)*22.5
1630 IF Y=0 OR Y=360 THEN UP=-2:AC=0
1635 IF Y=22.5 THEN UP=-2:AC=1
1640 IF Y=45 THEN UP=-2:AC=2
1645 IF Y=67.5 THEN UP=-1:AC=2
1650 IF Y=90 THEN UP=0:AC=2
1655 IF Y=112.5 THEN UP=1:AC=2
1660 IF Y=135 THEN UP=2:AC=2
1665 IF Y=157.5 THEN UP=2:AC=1
1670 IF Y=180 THEN UP=2:AC=0
1675 IF Y=202.5 THEN UP=2:AC=-1
1680 IF Y=225 THEN UP=2:AC=-2
1685 IF Y=247.5 THEN UP=1:AC=-2
1690 IF Y=270 THEN UP=0:AC=-2
1695 IF Y=292.5 THEN UP=-1:AC=-2
1700 IF Y=315 THEN UP=-2:AC=-2
1705 IF Y=337.5 THEN UP=-2:AC=-1
1710 RETURN
1720 REM ******************************
```

```
1730 REM INITIALIZE
1735 SCREEN 1:REM THIS IS AN
     IBM-SPECIFIC GRAPHICS COMMAND
1740 CLS
1750 RANDOMIZE VAL(RIGHT$(TIME$,2))
1760 REM    ADJUST NEXT TWO LINES FOR
          BEST RESULTS ON YOUR SYSTEM
1770 BREADTH=320:REM CHARACTERS ACROSS
1780 DEPTH=200:REM CHARACTERS DOWN
1790 BREADTH=BREADTH-1
1800 DEPTH=DEPTH-3
1810 UP=-2:AC=0:REM STARTS FACING UP
1820 DIM A$(20):REM FOR ROBOT PROGRAM
1920 RETURN
```

There are many enjoyable programs you can write for your little robot to follow. As you can see from the FACE and TURN sections, the program supports angle changes of 17.5 degrees, rather than the coarser 45 degrees that was all the ROBOT LOGO could cope with.

When you have POINT-DUTY ROBOT up and running, you might like to try the following programs.

The first one is GLASS MAGNOLIA:

```
GO 100,170
REPEAT 5
FORWARD 13
TURN 72
END REPEAT
START AGAIN
*
```

Adding a single, additional line to that program produces CHURCH WINDOW:

```
GO 100,170
REPEAT 4
FORWARD 13
TURN 90
END REPEAT
TURN 22.5
START AGAIN
*
```

HAMPTON COURT ROSE is an effective demonstration of the little robot in action:

```
GO 100,170
REPEAT 2
FORWARD 3
TURN 22.5
FORWARD 6
TURN 22.5
FORWARD 9
TURN 22.5
FORWARD 12
TURN 22.5
FORWARD 12
TURN 22.5
FORWARD 7
TURN 90
END REPEAT
START AGAIN
*
```

RCL continues to amaze with SPIRAL NEBULA:

```
GO 100,170
FORWARD 2
TURN 22.5
FORWARD 5
TURN 22.5
FORWARD 8
TURN 22.5
FORWARD 11
TURN 22.5
FORWARD 15
TURN 22.5
FORWARD 7
START AGAIN
*
```

CRAZY CRITTER decorates your screen with something surprising:

```
GO 100,170
REPEAT 2
FORWARD 10
TURN 90
FORWARD 12
END REPEAT
TURN 22.5
START AGAIN
*
```

And this is SIGNALMAN FREUD (who worked for the Vienna Railroad Company):

```
GO 100,170
TURN 135
FORWARD 25
REPEAT 4
FORWARD 10
TURN 90
END REPEAT
START AGAIN
*
```

In our next program, BUBBLES, we use two REPEAT loops. Note these are not, and cannot be, nested, as RCL does not support nested loops:

```
RANDOM
REPEAT 16
FORWARD 2
TURN 25
END REPEAT
RANDOM
REPEAT 16
FORWARD 1
TURN 25
END REPEAT
START AGAIN
*
```

Removing the second RANDOM line from BUBBLES turns the program into one I have called THE EYES ARE WATCHING YOU:

```
RANDOM
REPEAT 16
FORWARD 2
TURN 25
END REPEAT
REPEAT 16
FORWARD 1
TURN 25
END REPEAT
START AGAIN
*
```

From that we move to HAND ME DOWN MY DANCING CANE:

```
RANDOM
FORWARD 15
TURN 315
BACK 5
TURN 22.5
START AGAIN
*
```

And, finally, ONE-WAY STREET:

```
RANDOM
FORWARD 15
TURN 315
BACK 6
FORWARD 6
TURN 270
FORWARD 6
START AGAIN
*
```

10

Simulating Intelligence

An enormous amount of energy is now being spent to get computers to behave in ways that appear intelligent. Artificial Intelligence (AI) research has looked into many of the simple human exhibitions of intelligence, such as game playing. It has produced some highly creditable results—as shown by the current generation of chess machines. *Expert systems*, in which the computer uses the encoded expertise of human specialists to reach decisions and give advice, is another particularly fruitful area of AI development. Expert systems have been developed in a wide range of disciplines. They can now diagnose certain classes of diseases, assist in chemical synthesis, and help in the search for mineral deposits. The scope of AI research has broadened over the last twenty years and now also covers such topics as perception (vision and speech) and the understanding of human (natural) languages.

In this chapter, we'll concentrate on the game-playing side of artificial intelligence. The simulation we'll develop plays a very good game of CONNECT FOUR, in which two players take turns placing pieces in the lowest available position in the columns on a game board, trying to be the first to get four of their pieces to form a line in any direction.

It is interesting to note that computer programs that appear to display intelligence often work quite differently from the way human beings approach the same problems. Typically, computer systems analyze the tens of thousands of possible moves, ranking them hier-

achically, and choosing the best possible next move. Human players, on the other hand, appear to make their decisions almost intuitively. Human experts, although they may use some or all of the same raw data as an expert system working in the same field, do not examine every piece of information that could possibly be relevant before deciding which of the potential outcomes has the highest probability of being correct.

Similarly, in our artificial intelligence simulation program, the computer works out its moves in a manner that is quite alien to our own thinking. Despite this, it plays extremely well, and will prove a difficult, almost impossible, opponent to defeat. It assigns a value to each possible move, and then evaluates each of these moves in terms of whether this will help win the game. It then selects the move with the best potential.

When you're making your own moves, you're far more likely to just look at the board, check whether there is any danger of the computer completing a row of four, and if so, attempt to block it, or select a move that "feels" as though it could help lead you to victory.

The lesson is clear. When writing your own artificial intelligence programs, look for the end result you want to achieve, rather than trying to emulate your own thinking processes.

Let's look at our CONNECT FOUR program in action. You enter your move as a number between one and eight, and the computer automatically places your piece (a small letter "o") at the *lowest* available position in the row designated by the number you have entered. The computer pieces are represented by the letter "M":

```
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
1 2 3 4 5 6 7 8

YOUR MOVE...
? 4
```

```
........
........
........
........
........
..Mo....
12345678

YOUR MOVE...
? 6

........
........
........
........
........
..MoMo..
12345678

YOUR MOVE...
? 5

........
........
........
........
...Mo...
..MoMo..
12345678

YOUR MOVE...
? 6
```

```
........
........
........
.....M..
...Moo..
..MoMo..
12345678

YOUR MOVE...
? 7


........
........
........
....MM..
...Moo..
..MoMoo.
12345678

YOUR MOVE...
? 7


........
........
.....M..
....MM..
...Mooo.
..MoMoo.
12345678

I HAVE WON
```

The victory here is along the diagonal from the top of column six down to the bottom of column three.

Enter this program to start your our experiments in artificial intelligence:

```
10 REM CONNECT FOUR
20 REM A. W. PEARSON
30 CLS
40 PRINT
50 PRINT
60 PRINT "CONNECT FOUR"
70 PRINT
80 PRINT "ENTER YOUR MOVE AS A NUMBER BE
TWEEN"
90 PRINT "1 AND 8, ENTER 0 FOR A NEW GAM
E..."
100 FOR F=1 TO 1000:NEXT F
110 DIM A$(10,10),B(10,2)
120 FLAG=0
130 REM CHANGE NEXT LINE FOR YOUR OWN
      CHOICE OF SYMBOLS (C$-COMPUTER)
140 C$="M":H$="o":REM M FOR MACHINE!
150 FOR F=1 TO 8
160 B(F,1)=6
170 NEXT F
180 FOR F=1 TO 6
190 FOR G=1 TO 8
200 A$(F,G)="."
210 NEXT G
220 NEXT F
230 REM ************************
240 REM ACCEPT HUMAN MOVE
250 GOSUB 430
260 PRINT:PRINT "YOUR MOVE..."
270 INPUT A
280 IF A=0 THEN RUN
290 IF A<1 OR A>8 THEN 270
300 L=0
310 IF A$(L+1,A)<>"." OR L=6 THEN 340
320 L=L+1
330 GOTO 310
340 IF L=0 THEN 270
350 A$(L,A)=H$
360 B(A,1)=B(A,1)-1
370 GOSUB 430
380 GOSUB 560
390 GOSUB 430
400 GOTO 260
410 REM ************************
```

```
420 REM PRINT BOARD
430 CLS
440 FOR F=1 TO 6
450 FOR G=1 TO 8
460 PRINT A$(F,G);
470 NEXT G
480 PRINT
490 NEXT F
500 PRINT "12345678"
510 PRINT
520 IF FLAG=1 THEN PRINT "I HAVE WON":EN
D
530 RETURN
540 REM **************************
550 REM COMPUTER MOVES
560 PRINT "MY MOVE..."
570 MV=0
580 FOR F=1 TO 8
590 B(F,2)=0
600 NEXT F
610 FOR F=1 TO 8
620 FOR X=-1 TO 1
630 FOR Y=-1 TO 1
640 IF B(F,1)=0 THEN 680
650 IF A$(B(F,1)+X,F+Y)="" OR A$(B(F,1)+
X,F+Y)="." THEN 680
660 IF A$(B(F,1)+X,F+Y)=H$ THEN GOSUB 81
0
670 IF A$(B(F,1)+X,F+Y)=C$ THEN GOSUB 91
0
680 NEXT Y
690 NEXT X
700 NEXT F
710 P=0
720 FOR F=1 TO 8
730 IF B(F,2)>P THEN P=B(F,2):N=F
740 NEXT F
750 A$(B(N,1),N)=C$
760 B(N,1)=B(N,1)-1
770 N=0
780 P=0
790 RETURN
800 REM **************************
810 MV=2
```

```
820 M1=MV
830 IF A$(B(F,1)+(X*2),F+(Y*2))=H$ THEN
MV=MV+10
840 IF A$(B(F,1)-X,F-Y)=H$ THEN MV=MV+20

850 IF MV<>M1+10 THEN 870
860 IF A$(B(F,1)+(X*3),F+(Y*3))=H$ THEN
MV=MV+1000
870 B(F,2)=B(F,2)+MV
880 M1=0
890 RETURN
900 REM **************************
910 MV=2
920 M1=MV
930 IF A$(B(F,1)+(X*2),F+(Y*2))=C$ THEN
MV=MV+9
940 IF A$(B(F,1)-X,F-Y)=C$ THEN MV=MV+20

950 IF MV<>M1+9 THEN 970
960 IF A$(B(F,1)+(X*3),F+(Y*3))=C$ THEN
MV=MV+2000:FLAG=1
970 B(F,2)=B(F,2)+MV
980 RETURN
```

11

The Quevedo Chess Machine

The first recorded attempt to produce a machine that would play chess was made in Spain in 1890. The scientist Torres y Quevedo produced a little device that would play the end game of a king and rook against a king, taking the side with the rook. The machine was always able to force mate.

After reading about Quevedo's machine in David Levy's fascinating book *Chess and Computers* (Computer Science Press, Inc., Potomac, Maryland; 1976), I decided to try and write a program that would simulate the machine's behavior. The machine can move in one of six possible ways. This program reports which of the six moves it has used on each turn.

You'll find that the computer makes a rapid assessment of the situation. Here is an example of the program in action. You play the single king (the "$" sign). The computer's king is the "K" and its rook is the "R":

```
I USED MOVE 1


     ABCDEFGH
   8 ........ 8
   7 ........ 7
   6 ........ 6
   5 .R..K... 5
   4 ........ 4
   3 $....... 3
   2 ........ 2
   1 ........ 1

     ABCDEFGH


>> MOVE TO (LETTER, NO.)? A2
```

```
I USED MOVE 1


     ABCDEFGH
   8 ........ 8
   7 ........ 7
   6 ........ 6
   5 R...K... 5
   4 ........ 4
   3 ........ 3
   2 $....... 2
   1 ........ 1

     ABCDEFGH


>> MOVE TO (LETTER, NO.)? B2
```

```
I USED MOVE 1

    ABCDEFGH
 8 ........ 8
 7 ........ 7
 6 ........ 6
 5 .R..K... 5
 4 ........ 4
 3 ........ 3
 2 .$...... 2
 1 ........ 1

    ABCDEFGH

>> MOVE TO (LETTER, NO.)? C2

I USED MOVE 1

    ABCDEFGH
 8 ........ 8
 7 ........ 7
 6 ........ 6
 5 ..R.K... 5
 4 ........ 4
 3 ........ 3
 2 ..$..... 2
 1 ........ 1

    ABCDEFGH

>> MOVE TO (LETTER, NO.)? D2
```

```
I USED MOVE 1


     ABCDEFGH
   8 ........ 8
   7 ........ 7
   6 ........ 6
   5 ...RK... 5
   4 ........ 4
   3 ........ 3
   2 ...$.... 2
   1 ........ 1

     ABCDEFGH


>> MOVE TO (LETTER, NO.)? E2
```

```
I USED MOVE 2


     ABCDEFGH
   8 ........ 8
   7 ........ 7
   6 ........ 6
   5 ....K... 5
   4 ...R.... 4
   3 ........ 3
   2 ....$... 2
   1 ........ 1

     ABCDEFGH


>> MOVE TO (LETTER, NO.)? F2
```

```
I USED MOVE 1

    ABCDEFGH
  8 ........ 8
  7 ........ 7
  6 ........ 6
  5 ....K... 5
  4 ....R... 4
  3 ........ 3
  2 .....$.. 2
  1 ........ 1

    ABCDEFGH

>> MOVE TO (LETTER, NO.)? F1

I USED MOVE 1

    ABCDEFGH
  8 ........ 8
  7 ........ 7
  6 ........ 6
  5 ....K... 5
  4 .....R.. 4
  3 ........ 3
  2 ........ 2
  1 .....$.. 1

    ABCDEFGH

>> MOVE TO (LETTER, NO.)? Q

THANKS FOR THE GAME
```

Here's the listing so that you can take on Senor Quevedo's machine for yourself:

```
10 REM QUEVEDO CHESS MACHINE
20 GOSUB 1510:REM INITIALISE
30 GOTO 60
40 GOSUB 1320:REM PRINT BOARD
50 GOSUB 110:REM COMPUTER MOVES
60 GOSUB 1320
70 GOSUB 1120:REM ACCEPT HUMAN MOVE
80 GOTO 40
90 END
100 REM ***************
110 REM COMPUTER MOVES
120 IF QUIT=1 THEN 1080
130 W1=WK
140 REM ***************
150 REM MOVE ONE
160 MOVE=1
170 KM=INT(BK/10)
180 RM=INT(R/10)
190 IF ABS(KM-RM)>3 THEN 330
200 A(R)=46
210 X=INT(BK/10):Y=INT(R/10)
220 IF X>Y THEN 270
230 IF A(R-10)<>46 THEN 270
240 IF A(R-19)=BK OR A(R-21)=BK OR A(R-2
0)=BK THEN 270
250 IF A(R-11)=BK OR A(R-9)=BK THEN 270
260 R=R-10:GOTO 300
270 IF A(R+10)<>46 THEN A(R)=R:GOTO 330
280 IF A(R+19)=BK OR A(R+21)=BK OR A(R+2
0)=BK THEN A(R)=R:GOTO 330
290 R=R+10
300 A(R)=ASC("R")
310 RETURN
320 REM ***************
330 REM MOVE TWO
340 MOVE=2
350 KM=BK-10*KM
360 RM=R-10*RM
370 IF ABS(KM-RM)<2 THEN 480
380 A(R)=46
```

```
390 IF R>11 THEN IF (A(R-12)=BK OR A(R-2
)=BK OR A(R+8)=BK) THEN A(R)=R:GOTO 480
400 IF R>11 THEN IF (A(R-1)=BK OR A(R-11
)=BK OR A(R+9)=BK) THEN A(R)=R:GOTO 480
410 Y=BK-10*INT(BK/10)
420 Z=R-10*INT(R/10)
430 IF (Z=1 OR Y>Z) AND A(R+1)=46 THEN R
=R+1:GOTO 450
440 R=R-1
450 A(R)=ASC("R")
460 RETURN
470 REM ***************
480 REM MOVE THREE
490 MOVE=3
500 WM=WK-10*INT(WK/10)
510 BM=BK-10*INT(BK/10)
520 IF ABS(WM-BM)<3 THEN 600
530 IF A(WK-1)<>46 OR A(WK-18)=BK OR A(W
K-2)=BK OR A(WK+8)=BK THEN 610
540 IF A(WK-11)=BK OR A(WK+9)=BK OR A(WK
-22)=BK THEN 610
550 A(WK)=46
560 WK=WK-1
570 A(WK)=ASC("K")
580 RETURN
590 REM ***************
600 REM MOVES FOUR, FIVE AND SIX
610 Z=ABS(INT(BK/10)-INT(WK/10))
620 IF Z=0 THEN 950
630 IF 2*INT(Z/2)=Z THEN 790
640 REM ***************
650 REM MOVE FOUR
660 MOVE=4
670 A(R)=46
680 IF A(R-10)<>46 THEN 720
690 IF A(R-9)=BK OR A(R-11)=BK THEN 720
700 IF A(R-19)=BK OR A(R-21)=BK OR A(R-2
0)=BK THEN 720
710 R=R-10:GOTO 760
720 IF A(R+10)<>46 THEN A(R)=R:GOTO 790
730 IF A(R+19)=BK OR A(R+21)=BK OR A(R+2
0)=BK THEN A(R)=ASC("R"):GOTO 790
740 IF A(R+11)=BK OR A(R+9)=BK THEN A(R)
=ASC("R"):GOTO 790
```

```
750 R=R+10
760 A(R)=ASC("R")
770 RETURN
780 REM ***************
790 REM MOVE FIVE
800 MOVE=5
810 J=INT(BK/10)
820 K=BK-10*J
830 L=INT(WK/10)
840 M=WK-10*L
850 Z=10:IF J<L THEN Z=-10
860 X=1:IF K<M THEN X=-1
870 A(WK)=46
880 W1=WK
890 WK=WK+Z+X
900 G=ABS(WK-BK)
910 IF G=1 OR G=9 OR G=10 OR G=11 THEN W
K=W1:A(WK)=75:GOTO 950
920 A(WK)=ASC("K")
930 RETURN
940 REM ***************
950 REM MOVE SIX
960 MOVE=6
970 A(R)=46
980 IF R>11 THEN IF A(R-12)=BK OR A(R-2)
=BK OR A(R+8)=BK OR A(R-1)<>46 THEN 1070

990 IF R>11 THEN IF (A(R-1)=BK OR A(R-11
)=BK OR A(R+9)=BK) THEN 1070
1000 Y=BK-10*INT(BK/10)
1010 Z=R-10*INT(R/10)
1020 IF (Z=1 OR Y>Z) AND A(R+1)=46 THEN
R=R+1:GOTO 1040
1030 R=R-1
1040 A(R)=ASC("R")
1050 RETURN
1060 REM ***************
1070 GOSUB 1320
1080 PRINT:PRINT
1090 PRINT "I CONCEDE TO THE MASTER"
1100 END
1110 REM ******************
1120 REM ACCEPT HUMAN MOVE
1130 REM ENTER 'Q' TO QUIT
```

```
1140 MOVE=0
1150 PRINT ">> MOVE TO (LETTER, NO.)";
1160 INPUT G$
1170 IF G$="Q" THEN 1280
1180 IF LEN(G$)<>2 THEN 1160
1190 Z=ASC(G$)
1200 IF Z<65 OR Z>72 THEN 1160
1210 X=VAL(RIGHT$(G$,1))
1220 IF X<1 OR X>8 THEN 1160
1230 A(BK)=46
1240 BK=10*(Z-64)+X
1250 IF A(BK)=ASC("R") THEN QUIT=1
1260 A(BK)=ASC("$")
1270 RETURN
1280 PRINT:PRINT
1290 PRINT "THANKS FOR THE GAME"
1300 END
1310 REM ************
1320 REM PRINT BOARD
1330 CLS
1340 PRINT:PRINT
1350 IF MOVE>0 THEN PRINT "I USED MOVE"M
OVE
1360 IF MOVE=0 THEN PRINT
1370 PRINT:PRINT
1380 PRINT TAB(11);"ABCDEFGH"
1390 FOR J=8 TO 1 STEP -1
1400 PRINT TAB(8);J;
1410 FOR K=10 TO 80 STEP 10
1420 PRINT CHR$(A(J+K));
1430 NEXT K
1440 PRINT J
1450 NEXT J
1460 PRINT
1470 PRINT TAB(11);"ABCDEFGH"
1480 PRINT:PRINT
1490 RETURN
1500 REM ***************
1510 REM INITIALISATION
1520 CLS
1530 RANDOMIZE VAL(RIGHT$(TIME$,2))
1540 MOVE=0
1550 QUIT=0
1560 DIM A(130)
```

```
1570 FOR J=10 TO 80 STEP 10
1580 FOR K=1 TO 8
1590 A(J+K)=46:REM ASCII OF "."
1600 NEXT K
1610 NEXT J
1620 REM ** PLACE PIECES **
1630 REM BLACK KING - HUMAN
1640 BK=INT(RND(1)*3)+1
1650 BK=10*BK+BK+INT(RND(1)*5)
1660 A(BK)=ASC("$")
1670 REM WHITE KING - COMPUTER
1680 WK=INT(RND(1)*4)+4
1690 WK=10*WK+WK+INT(RND(1)*2)
1700 IF WK=BK THEN 1680
1710 A(WK)=ASC("K")
1720 REM WHITE ROOK - COMPUTER
1730 R=INT(RND(1)*4)+4
1740 R=10*R+R+INT(RND(1)*2)
1750 IF R=WK OR R=BK THEN 1730
1760 IF ABS(R-BK)<12 THEN 1730
1770 A(R)=ASC("R")
1780 RETURN
```

12

Into the Political Arena

As we discussed earlier, computer programs can also be used to simulate any process where the links between elements of the process can be expressed as one or more mathematical relationships. The political simulation in this chapter, WASHINGTON, D.C., shows this very clearly. It's governed by mathematical relationships that represent a grossly over-simplified version of the American economy.

You take the role of the hapless occupant of the Oval Office, running—as you'll soon see—an economy that is somewhat out of kilter. To retain your popular support (and the Presidency) you have to try to keep the whole thing together. You need to do your best to improve the standard of living, keep inflation and unemployment down, stimulate private investment, and generally maintain an acceptable growth in the economy, all at same time. You'll discover that a President's lot is not a happy one.

The simulation begins with a report on the state of the nation:

```
PRESIDENT HARTNELL:
YOUR ADMINISTRATION HAS BEEN IN
        POWER FOR .25 YEARS
---------------------------------
-----STATE OF THE NATION---------
---------------------------------
POPULATION 3000819
NO. UNEMPLOYED 300000     9 %
```

```
CURRENT WAGES $ 100   INFLATION 5 %
GOVT. EXPENDITURE LAST QTR. $M 118
UNEMPLOYMENT COST $M 0
INCOME FROM TAXES $M 0
BUDGET SURPLUS(+)/DEFICIT(-) $M 0
GROSS DOMESTIC PRODUCT $M 440
---------------------------------
PUBLIC INVESTMENT 0 Q 1 $M 236
---------------------------------
```

You start each run with a population of around 3,000,000 and an unemployment rate of about 10%. You are then asked to make some snap judgments on levels of government spending, cost of wages, and on your administration's immigration policy:

```
OK, PRESIDENT HARTNELL...
ENTER GOVERNMENT SPENDING $M? 102
ENTER COST OF WAGES $M? 41
IS YOUR ADMINISTRATION IN FAVOR OF
IMMIGRATION THIS QUARTER (Y/N)?
                        OK...N
```

At the end of my second quarter in office, I found that while I had somehow kept inflation and unemployment under control, I was suddenly faced with a budget deficit of over $69 million! On the positive side, public investment (and therefore, I hoped, public confidence) was on the increase, up from $236 million at the end of the first quarter to more than $257 million at this point. I decide to increase spending slightly:

```
PRESIDENT HARTNELL:
YOUR ADMINISTRATION HAS BEEN IN
        POWER FOR .5 YEARS
---------------------------------
-----STATE OF THE NATION---------
---------------------------------
POPULATION 3001638
NO. UNEMPLOYED 287879     9 %
CURRENT WAGES $ 41   INFLATION 9 %
GOVT. EXPENDITURE LAST QTR. $M 102
UNEMPLOYMENT COST $M 11.8
INCOME FROM TAXES $M 44.4
BUDGET SURPLUS(+)/DEFICIT(-) $M-69.4
GROSS DOMESTIC PRODUCT $M 449.2
```

```
---------------------------------
PUBLIC INVESTMENT 0 Q 2 $M 275.7
---------------------------------
OK, PRESIDENT HARTNELL...
ENTER GOVERNMENT SPENDING $M? 107
ENTER COST OF WAGES $M? 43
```

I also decide to let a few of the world's tired and hungry masses into the land of milk and budget deficits:

```
IS YOUR ADMINISTRATION IN FAVOR OF
IMMIGRATION THIS QUARTER (Y/N)?
                        OK...Y
HOW MANY IMMIGRANTS WILL YOU ALLOW
         INTO THE US?
? 1000
```

At the end of my first year, the deficit has grown to $216 million, and standard of living has increased by 12%:

```
YOUR ADMINISTRATION HAS BEEN IN
        POWER FOR 1 YEARS
---------------------------------
-----STATE OF THE NATION---------
---------------------------------
POPULATION 3004277
NO. UNEMPLOYED 272309     9 %
CURRENT WAGES $ 46  INFLATION 9 %
GOVT. EXPENDITURE LAST QTR. $M 111
UNEMPLOYMENT COST $M 12.5
INCOME FROM TAXES $M 50.2
BUDGET SURPLUS(+)/DEFICIT(-) $M-216.7
GROSS DOMESTIC PRODUCT $M 486.2
CHANGE IN LIVING STANDARD 12 %
---------------------------------
PUBLIC INVESTMENT 0 Q 4 $M 364.4
---------------------------------
OK, PRESIDENT HARTNELL...
ENTER GOVERNMENT SPENDING $M? 120
ENTER COST OF WAGES $M? 65
IS YOUR ADMINISTRATION IN FAVOR OF
IMMIGRATION THIS QUARTER (Y/N)?
                        OK...N
```

I stumble on, narrowly avoiding disasters each time I turn my head. Things start getting really hairy toward the end of my second year in office:

```
PRESIDENT HARTNELL:
YOUR ADMINISTRATION HAS BEEN IN
        POWER FOR 1.75 YEARS
---------------------------------
-----STATE OF THE NATION---------
---------------------------------
POPULATION 3008238
NO. UNEMPLOYED 377324     12 %
CURRENT WAGES $ 66   INFLATION 12 %
GOVT. EXPENDITURE LAST QTR. $M 125
UNEMPLOYMENT COST $M 24.9
INCOME FROM TAXES $M 69.4
BUDGET SURPLUS[+]/DEFICIT[-] $M-436.8
GROSS DOMESTIC PRODUCT $M 866
CHANGE IN LIVING STANDARD 13 %
---------------------------------
PUBLIC INVESTMENT 1 Q 3 $M 243.2
---------------------------------
OK, PRESIDENT HARTNELL...
ENTER GOVERNMENT SPENDING $M? 126
ENTER COST OF WAGES $M? 67
```

The outcome is inevitable. My time is up:

```
PRESIDENT HARTNELL, YOUR
ADMINISTRATION'S POOR ECONOMIC
PERFORMANCE HAS LED TO AN UNACCEPTABLE
RISE IN UNEMPLOYMENT
          AMONG OTHER THINGS...
---------------------------------
THE LACK OF CONFIDENCE IN YOUR
ADMINISTRATION IS SO BAD THERE ARE
CALLS FOR YOU TO RESIGN...YOU STEP
ASIDE TO ALLOW THE VICE-PRESIDENT TO
        OCCUPY THE OVAL OFFICE
---------------------------------
YOU WERE PRESIDENT FOR 2.25 YEARS
DURING YOUR TERM OF OFFICE, THE
POPULATION ROSE BY 9059
```

```
THE UNEMPLOYMENT RATE BECAME 17 %
AND THE INFLATION RATE BECAME 17.4 %
STANDARD OF LIVING CHANGED BY 17 %
AND THE BUDGET SURPLUS/DEFICIT
WAS $M-597.5
```

This is a program you may well enjoy modifying. For example, changing the income you get from taxes, will alter the simulation in a radical way. You can also fiddle with the thresholds at which the public starts waving their fists.

Line 50 governs the increase in population from quarter to quarter. A steeper increase here will make it harder to keep the lid on unemployment.

I've been pretty generous with my use of REM statements in this program, so you should find it relatively easy to track down the variables you'd like to modify. Here are the major ones, as listed in the initialization section of the program:

```
1150 REM ******************************
1160 REM INITIALIZATION
1170 CLS
1180 RANDOMIZE VAL(RIGHT$(TIME$,2))
1190 ML=1000*1000
1200 P=3*ML:REM POPULATION
1210 U=P/10:REM UNEMPLOYMENT
1220 IV=236:REM INVESTMENT
1230 GE=118:REM GOVERNMENT EXPENDITURE
1240 GU=0:REM COST OF UNEMPLOYMENT
1250 GI=0:REM INCOME FROM TAXES
1260 WN=100:REM NEW WAGES
1270 WO=100:REM OLD WAGES
1280 IP=5:REM INFLATION PERCENT
1290 GDP=440:REM GROSS DOMESTIC PRODUCT
1300 AGDP=440:REM BASE YEAR GDP
1310 RGDP=440:REM REAL GDP
1320 CN=354:REM ECONOMIC CONSTANT
     (USED THROUGHOUT SIMULATION)
1330 Z=1:GAME=0:FLAG=0
1340 Y=0:REM YEAR
1350 PRINT "ENTER YOUR LAST NAME"
1360 INPUT A$
1370 RETURN
```

The part of the program that does all the calculating is also fairly easy to unravel, once you know the principal variables:

```
490 REM ******************************
500 REM CALCULATIONS
510 CN=CN+(CN*IP/100)
520 U=P*(GE+IV)/(CN*10)+P*(IP/1000)
530 GU=U*WN/ML:REM UNEMPLOYMENT COST
540 GI=(((P-U)*WN*.4)/ML):REM INCOME
                              FROM TAXES
550 BD=BD+GI-GU-GE:REM BUDGET DEFICIT
560 AGDP=AGDP*(1+(IP/100))
570 GDP=GE+IV+((P-U)*WN/ML)
580 RGDP=GDP*440/AGDP
590 IP=((GE+IV)/CN*.1+(WN/WO)/100)*100
600 IV=(CN*67)/(IP*IP)
610 WO=WN
620 Z=Z+1:IF Z>4 THEN Z=1:Y=Y+1
630 RETURN
640 REM ******************************
650 REM CHECK BUDGET DEFICIT
660 IF BD>-1000 THEN RETURN
670 GAME=1
680 FLAG=1
690 RETURN
700 REM ******************************
710 REM CHECK STANDARD OF LIVING
720 IF Y<.75 THEN RETURN
730 IF INT((2*((RGDP/AGDP)*100)-100)/3)>
-15 THEN RETURN
740 GAME=1
750 FLAG=2
760 RETURN
770 REM ******************************
780 REM CHECK INFLATION RATE
790 IF IP<15 THEN RETURN
800 GAME=1
810 FLAG=3
820 RETURN
830 REM ******************************
840 REM CHECK UNEMPLOYMENT
850 IF INT(U*100/P)<15 THEN RETURN
```

```
860 GAME=1
870 FLAG=4
880 RETURN
890 REM ****************************
```

Here is the complete listing of the WASHINGTON, D.C. program:

```
10 REM WASHINGTON D.C.
20 GOSUB 1160:REM INITIALIZE
30 REM ****************************
40 REM MAJOR CYCLE
50 P=INT(P+(P*273/ML))
60 GOSUB 160:REM PRINTOUT
70 GOSUB 510:REM CALCULATE
80 REM NOW CHECK END GAME
90 GOSUB 710:REM STANDARD OF LIVING
100 GOSUB 780:REM INFLATION RATE
110 GOSUB 840:REM UNEMPLOYMENT
120 IF GAME=1 THEN CLS:GOTO 890
130 GOTO 50
140 REM ****************************
150 REM PRINTOUT
160 CLS
170 PRINT "PRESIDENT ";A$;":"
180 PRINT "YOUR ADMINISTRATION HAS BEEN
IN                POWER FOR"Y+Z/4"YEARS"
190 PRINT "------------------------------
----"
200 PRINT "-----STATE OF THE NATION-----
----"
210 PRINT "------------------------------
----"
220 PRINT "POPULATION"P
230 PRINT "NO. UNEMPLOYED"INT(U)"  "INT(
100*U/P)"%"
240 PRINT "CURRENT WAGES $"WO" INFLATION
"INT(IP)"%"
250 PRINT "GOVT. EXPENDITURE LAST QTR. $
M"GE
260 PRINT "UNEMPLOYMENT COST $M"INT(10*G
U)/10
270 PRINT "INCOME FROM TAXES $M"INT(GI*1
0)/10
```

```
280 PRINT "BUDGET SURPLUS[+]/DEFICIT[-]
$M"INT[BD*10]/10
290 PRINT "GROSS DOMESTIC PRODUCT $M"INT
[GDP*10]/10
300 IF Y+Z/4>.5 THEN PRINT "CHANGE IN LI
VING STANDARD"INT[[2*[[RGDP/AGDP]*100]-1
00]/3]"%"
310 PRINT "-----------------------------
----"
320 PRINT "PUBLIC INVESTMENT"Y"Q"Z"$M"IN
T[IV*10]/10
330 PRINT "-----------------------------
----"
340 PRINT "OK, PRESIDENT ";A$;"..."
350 INPUT "ENTER GOVERNMENT SPENDING $M"
;GE
360 INPUT "ENTER COST OF WAGES $M";WN
370 PRINT "IS YOUR ADMINISTRATION IN FAV
OR OF"
380 PRINT "IMMIGRATION THIS QUARTER [Y/N
]?"
390 X$=INKEY$
400 IF X$<>"Y" AND X$<>"N" THEN 390
410 PRINT TAB[20];"OK...";X$
420 FOR H=1 TO 1000:NEXT H
430 IF X$<>"Y" THEN RETURN
440 PRINT "HOW MANY IMMIGRANTS WILL YOU
ALLOW                INTO THE US?"
450 INPUT M
460 IF M<0 THEN 450
470 P=P+M
480 RETURN
490 REM ****************************
500 REM CALCULATIONS
510 CN=CN+[CN*IP/100]
520 U=P*[GE+IV]/[CN*10]+P*[IP/1000]
530 GU=U*WN/ML:REM UNEMPLOYMENT COST
540 GI=[[[P-U]*WN*.4]/ML]:REM INCOME
                                FROM TAXES
550 BD=BD+GI-GU-GE:REM BUDGET DEFICIT
560 AGDP=AGDP*[1+[IP/100]]
570 GDP=GE+IV+[[P-U]*WN/ML]
580 RGDP=GDP*440/AGDP
590 IP=[[GE+IV]/CN*.1+[WN/W0]/100]*100
```

```
600 IV=(CN*67)/(IP*IP)
610 WO=WN
620 Z=Z+1:IF Z>4 THEN Z=1:Y=Y+1
630 RETURN
640 REM ****************************
650 REM CHECK BUDGET DEFICIT
660 IF BD>-1000 THEN RETURN
670 GAME=1
680 FLAG=1
690 RETURN
700 REM ****************************
710 REM CHECK STANDARD OF LIVING
720 IF Y<.75 THEN RETURN
730 IF INT((2*((RGDP/AGDP)*100)-100)/3)>
-15 THEN RETURN
740 GAME=1
750 FLAG=2
760 RETURN
770 REM ****************************
780 REM CHECK INFLATION RATE
790 IF IP<15 THEN RETURN
800 GAME=1
810 FLAG=3
820 RETURN
830 REM ****************************
840 REM CHECK UNEMPLOYMENT
850 IF INT(U*100/P)<15 THEN RETURN
860 GAME=1
870 FLAG=4
880 RETURN
890 REM ****************************
900 REM END OF THE GAME
910 PRINT "PRESIDENT ";A$;", YOUR"
920 PRINT "ADMINISTRATION'S POOR ECONOMI
C"
930 PRINT "PERFORMANCE HAS LED TO AN UNA
CCEPTABLE"
940 IF FLAG=1 THEN PRINT "BUDGET DEFICIT
"
950 IF FLAG=2 THEN PRINT "DROP IN THE ST
ANDARD OF LIVING"
960 IF FLAG=3 THEN PRINT "RISE IN THE IN
FLATION RATE"
```

```
970 IF FLAG=4 THEN PRINT "RISE IN UNEMPL
OYMENT"
980 PRINT "          AMONG OTHER THINGS..
."
990 PRINT "-----------------------------
----"
1000 PRINT "THE LACK OF CONFIDENCE IN YO
UR"
1010 PRINT "ADMINISTRATION IS SO BAD THE
RE ARE"
1020 PRINT "CALLS FOR YOU TO RESIGN...YO
U STEP"
1030 PRINT "ASIDE TO ALLOW THE VICE-PRES
IDENT TO"
1040 PRINT "        OCCUPY THE OVAL OFFIC
E"
1050 FOR H=1 TO 1000:NEXT H
1060 PRINT "-----------------------------
-----"
1070 PRINT "YOU WERE PRESIDENT FOR"Y+(Z*
.25)"YEARS"
1080 PRINT "DURING YOUR TERM OF OFFICE,
THE"
1090 PRINT "POPULATION ROSE BY"P-3*ML
1100 PRINT "THE UNEMPLOYMENT RATE BECAME
"INT(U*1000/P)/10"%"
1110 PRINT "AND THE INFLATION RATE BECAM
E"INT(10*IP)/10"%"
1120 PRINT "STANDARD OF LIVING CHANGED B
Y"INT((2*((RGDP/AGDP)*100)-100)/3)"%"
1130 PRINT "AND THE BUDGET SURPLUS/DEFIC
IT          WAS $M"INT(10*BD)/10
1140 END
1150 REM ****************************
1160 REM INITIALIZATION
1170 CLS
1180 RANDOMIZE VAL(RIGHT$(TIME$,2))
1190 ML=1000*1000
1200 P=3*ML:REM POPULATION
1210 U=P/10:REM UNEMPLOYMENT
1220 IV=236:REM INVESTMENT
1230 GE=118:REM GOVERNMENT EXPENDITURE
1240 GU=0:REM COST OF UNEMPLOYMENT
```

```
1250 GI=0:REM INCOME FROM TAXES
1260 WN=100:REM NEW WAGES
1270 WO=100:REM OLD WAGES
1280 IP=5:REM INFLATION PERCENT
1290 GDP=440:REM GROSS DOMESTIC PRODUCT
1300 AGDP=440:REM BASE YEAR GDP
1310 RGDP=440:REM REAL GDP
1320 CN=354:REM ECONOMIC CONSTANT
     [USED THROUGHOUT SIMULATION]
1330 Z=1:GAME=0:FLAG=0
1340 Y=0:REM YEAR
1350 PRINT "ENTER YOUR LAST NAME"
1360 INPUT A$
1370 RETURN
```

13

Playing the Stock Market

The numbers that a computer manipulates can represent anything—cloud density, intricate subatomic reactions within a complex chemical experiment, or the number of warriors taking part in a Roman raid on an English village. When computers were first used in business, the numbers generally stood for more mundane things like statistics, sales, and dollars. In the simulation in this chapter, we'll stick to the extremely important, if mundane, subject of money.

You play a broker dealing in a small market of five companies. You start the simulation with $15,000 and are asked to enter a financial target for the run:

```
ENTER YOUR GOAL FOR THIS SIMULATION,
      $16,000 TO $100,000
? 250000
TOO HIGH!

ENTER YOUR GOAL FOR THIS SIMULATION,
      $16,000 TO $100,000
? 16000
```

Once you've done that, the starting state of the market is revealed:

```
-------------------------------------------
DAY 1          YOUR GOAL IS  $ 16000
-------------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  23      59      28        59      41
CHANCE OF DECREASE (%):
  31      26      55        8       17
CURRENT VALUE PER SHARE:
$ 1.49 $ 1.99 $ 2.49  $ 2.99 $ 3.49
NO. OF SHARES HELD:
  2000    1500    1200     1000    800
BANK $ 265  TOTAL WORTH $ 15000
-------------------------------------------
DO YOU WANT TO SELL ANY SHARES (Y/N)?
```

One cycle of buying and/or selling represents a day of trading. Each day, you are told the chance of each share rising or falling in price. Based on that information, you can decide what to buy or sell:

```
-------------------------------------------
DAY 1          YOUR GOAL IS  $ 16000
-------------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  23      59      28        59      41
CHANCE OF DECREASE (%):
  31      26      55        8       17
CURRENT VALUE PER SHARE:
$ 1.49 $ 1.99 $ 2.49  $ 2.99 $ 3.49
NO. OF SHARES HELD:
  2000    1500    1200     1000    800
BANK $ 265  TOTAL WORTH $ 15000
-------------------------------------------
WHICH ONES TO SELL?    OK 1
HOW MANY OF 1 TO SELL? 3000
YOU DON'T HAVE THAT MANY!
? 1500
```

```
DAY 1          YOUR GOAL IS  $ 16000
-------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  23      59      28        59      41
CHANCE OF DECREASE (%):
  31      26      55        8       17
CURRENT VALUE PER SHARE:
$ 1.49 $ 1.99 $ 2.49  $ 2.99 $ 3.49
NO. OF SHARES HELD:
  500     1500    1200      1000    800
BANK $ 2500  TOTAL WORTH $ 15000
-------------------------------------
WHICH COMPANY TO BUY?     OK 4
HOW MANY OF 4 TO BUY? 750
```

You can only sell and buy shares once each day, so you must choose wisely. After you've made your decisions, the computer will tell you how you rate as a stockbroker. Some of the assessments, as I'm sure you'll discover, can be quite harsh:

```
-------------------------------------
DAY 2          YOUR GOAL IS  $ 16000
-------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  51      11      43        32      35
CHANCE OF DECREASE (%):
  49      43      8         49      46
CURRENT VALUE PER SHARE:
$ 1.49 $ 2.1  $ 2.36  $ 3.16 $ 3.49
NO. OF SHARES HELD:
  600     1500    1200      1750    800
BANK $ 108  TOTAL WORTH $ 15329.06
-------------------------------------

YOUR RATING AFTER THAT ROUND OF
TRADING IS 'BAD'

   <PRESS SPACEBAR TO CONTINUE >
```

However, if you persevere, you may well prosper in the end. Just don't allow yourself to be discouraged by assessments such as "hopeless":

```
-------------------------------------------
DAY 8          YOUR GOAL IS  $ 16000
-------------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  18      72      89        24      32
CHANCE OF DECREASE (%):
  4       25      1         55      50
CURRENT VALUE PER SHARE:
$ 1.53 $ 2.31 $ 2.57   $ 2.69 $ 3.68
NO. OF SHARES HELD:
  2100    400     1200     1750    800
BANK $ 191   TOTAL WORTH $ 15103.32
-------------------------------------------
WHICH ONES TO SELL?     OK 1
HOW MANY OF 1 TO SELL? 2100


-------------------------------------------
DAY 11         YOUR GOAL IS  $ 16000
-------------------------------------------
COMPANY NUMBER:
  1       2       3         4       5
CHANCE OF INCREASE (%):
  87      30      18        27      30
CHANCE OF DECREASE (%):
  4       50      51        44      52
CURRENT VALUE PER SHARE:
$ 1.58 $ 2.44 $ 2.69   $ 2.65 $ 3.68
NO. OF SHARES HELD:
  600     0       2400     1750    800
BANK $ 355   TOTAL WORTH $ 15352.79
-------------------------------------------

YOUR RATING AFTER THAT ROUND OF
TRADING IS 'HOPELESS'

   <PRESS SPACEBAR TO CONTINUE >
```

```
DAY 17          YOUR GOAL IS  $ 16000
-------------------------------------
COMPANY NUMBER:
  1       2       3        4       5
CHANCE OF INCREASE (%):
  47      65      38       8       47
CHANCE OF DECREASE (%):
  32      7       44       25      40
CURRENT VALUE PER SHARE:
$ 1.78  $ 2.5   $ 2.61   $ 2.98  $ 3.83
NO. OF SHARES HELD:
  0       0       2900     1750    800
BANK $ 229   TOTAL WORTH $ 16109.47
-------------------------------------
YOU'VE HIT YOUR FINANCIAL GOAL!
```

The STOCK MARKET listing is presented in the following chapter.

14

The STOCK MARKET Listing

When you're ready to challenge the best brains of Wall Street, enter and run the following listing. Just don't be too ambitious with your financial goals, or you'll never attain financial security.

```
10 REM STOCK MARKET
20 CLS
30 RANDOMIZE VAL(RIGHT$(TIME$,2))
40 DIM S(5),N(5),P(5),D(5)
50 S(1)=1.49:S(2)=1.99:S(3)=2.49:S(4)=2.
99:S(5)=3.49
60 N(1)=2000:N(2)=1500:N(3)=1200:N(4)=10
00:N(5)=800
70 BB=265:TV=15000:QQ=15000:DAY=1
80 PRINT:PRINT "ENTER YOUR GOAL FOR THIS
 SIMULATION,"
90 PRINT TAB(8);"$16,000 TO $100,000"
100 INPUT GOAL
110 IF GOAL<16000 THEN PRINT "TOO LOW!":
GOTO 80
120 IF GOAL>100*1000 THEN PRINT "TOO HIG
H!":GOTO 80
```

```
130 REM ************************
140 REM MAJOR LOOP
150 FOR C=1 TO 5
160 REM ADJUST THE 55 IN NEXT LINE TO
MODIFY GAME; 80 VERY HARD, 30 VERY EASY
170 D[C]=INT[RND[1]*55]+1
180 P[C]=INT[RND[1]*[100-D[C]]]+1
190 NEXT C
200 GOSUB 230
210 GOTO 460
220 REM ************************
230 REM PRINTOUT
240 CLS
250 PRINT "------------------------------
------"
260 PRINT "DAY"DAY"        YOUR GOAL IS
$"GOAL
270 PRINT "------------------------------
------"
280 PRINT "COMPANY NUMBER:"
290 PRINT TAB[2];1;TAB[9];2;TAB[16];3;TA
B[25];4;TAB[32];5
300 PRINT "CHANCE OF INCREASE [%]:"
310 PRINT TAB[2];P[1];TAB[9];P[2];TAB[16
];P[3];TAB[25];P[4];TAB[32];P[5]
320 PRINT "CHANCE OF DECREASE [%]:"
330 PRINT TAB[2];D[1];TAB[9];D[2];TAB[16
];D[3];TAB[25];D[4];TAB[32];D[5]
340 PRINT "CURRENT VALUE PER SHARE:"
350 PRINT "$";INT[S[1]*100]/100;TAB[8];"
$";INT[S[2]*100]/100;
360 PRINT TAB[15];"$";INT[S[3]*100]/100;
TAB[23];"$";INT[S[4]*100]/100;
370 PRINT TAB[30];"$";INT[S[5]*100]/100
380 PRINT "NO. OF SHARES HELD:"
390 PRINT TAB[2];N[1];TAB[9];N[2];TAB[16
];N[3];TAB[24];N[4];TAB[31];N[5]
400 PRINT "BANK $"INT[BB]" TOTAL WORTH $
"TV
410 PRINT "------------------------------
------"
420 IF TV>GOAL THEN PRINT "YOU'VE HIT YO
UR FINANCIAL GOAL!";END
430 RETURN
```

```
440 REM ************************
450 REM          ** SELL **
460 PRINT "DO YOU WANT TO SELL ANY SHARE
S [Y/N]?"
470 A$=INKEY$
480 IF A$<>"Y" AND A$<>"N" THEN 470
490 IF A$="N" THEN 690
500 GOSUB 230
510 PRINT "WHICH ONES TO SELL?";
520 A$=INKEY$
530 IF A$<"1" OR A$>"5" THEN 520
540 C=VAL[A$]
550 PRINT "    OK"C
560 PRINT "HOW MANY OF"C"TO SELL";
570 INPUT N
580 IF N>N[C] THEN PRINT "YOU DON'T HAVE
 THAT MANY!":GOTO 570
590 REM ************************
600 REM ADJUST FIGURES AFTER SALE
610 BB=BB+S[C]*N:REM ADD VALUE TO BANK
620 N[C]=N[C]-N:REM SUBTRACT NO. SOLD
630 TV=0:REM SET TOTAL WORTH TO ZERO
640 REM NOW DETERMINE CURRENT WORTH
650 FOR C=1 TO 5
660 TV=TV+N[C]*S[C]
670 NEXT C
680 TV=TV+BB:REM ADD IN BANK BALANCE
690 GOSUB 230
700 REM ************************
710 REM          ** BUY **
720 PRINT "DO YOU WANT TO BUY ANY SHARES
 [Y/N]?"
730 A$=INKEY$
740 IF A$<>"Y" AND A$<>"N" THEN 730
750 IF A$="N" THEN 890
760 GOSUB 230
770 PRINT "WHICH COMPANY TO BUY?";
780 A$=INKEY$
790 IF A$<"1" OR A$>"5" THEN 780
800 C=VAL[A$]
810 PRINT "    OK"C
820 PRINT "HOW MANY OF"C"TO BUY";
830 INPUT N
840 IF N*S[C]>BB THEN PRINT "YOU DON'T H
```

```
AVE ENOUGH MONEY!":GOTO 830
850 REM ************************
860 REM ADJUST FIGURES AFTER BUY
870 BB=BB-S[C]*N
880 N[C]=N[C]+N
890 TV=0
900 FOR C=1 TO 5
910 TV=TV+N[C]*S[C]
920 NEXT C
930 TV=TV+BB
940 GOSUB 230
950 REM ************************
960 REM  MODIFY ALL INDICATORS
970 TV=0
980 FOR C=1 TO 5
990 K=INT[RND[1]*100]+1
1000 IF K<P[C] THEN S[C]=S[C]*[1+[P[C]/1
000]]
1010 K=INT[RND[1]*100]+1
1020 IF K<D[C] THEN S[C]=S[C]/[1+[D[C]/1
000]]
1030 TV=TV+[S[C]*N[C]]
1040 NEXT C
1050 TV=TV+BB
1060 QQ=QQ*1.005
1070 W=[TV*100/QQ]-100
1080 IF W=0 THEN W=.1
1090 W=W+6
1100 IF W<1 THEN W=1
1110 IF W>15 THEN W=15
1120 RESTORE
1130 FOR T=1 TO W
1140 READ A$
1150 NEXT T
1160 PRINT
1170 REM ************************
1180 REM GIVE RATING, START NEW ROUND
1190 PRINT "YOUR RATING AFTER THAT ROUND
 OF"
1200 PRINT "TRADING IS '";A$;"'"
1210 PRINT:PRINT "   <PRESS SPACEBAR TO
CONTINUE >"
1220 IF INKEY$<>" " THEN 1220:REM NOTE
          SPACE BETWEEN QUOTE MARKS
```

```
1230 DAY=DAY+1
1240 GOTO 150
1250 DATA "HOPELESS","VERY, VERY POOR"
1260 DATA "TERRIBLE","AWFUL","BAD"
1270 DATA "VERY ORDINARY","AVERAGE"
1280 DATA "REASONABLE","A LITTLE ABOVE A
VERAGE"
1290 DATA "FAIRLY GOOD","GOOD","VERY GOO
D"
1300 DATA "GREAT","EXCELLENT","SUPERLATI
VE"
```

If you want to modify the degree of difficulty of this simulation, change the 55 in line 170. The lower the number (down to 30), the easier it is to make a profit. The higher the number (up to 80), the more difficult it becomes. The simulation will not run even remotely realistically if you use values less than 30, or greater than 80, in line 170.

15

Running an Automobile Company

The complex processes of manufacturing and sales are presented, albeit in a very simplified form, in this simulation. It took sixty years for the automobile market to become saturated in the United States. You have been unfortunate enough to be appointed as president of a major car manufacturing concern the very same month that the car market really hits bottom. To save the day—and your reputation as a hard-hitting, straight-from-the-shoulder, trouble-shootin', crisis-solvin' executive—you must get the tottering firm back on its feet.

You take over just as the accountants announce that the company is losing $60 million a year. Your task, needless to say, is to try and make the company profitable.

Here's how it begins:

```
INDUSTRY SALES 50000 IN MONTH 0
--------------------------------
YOU HAVE 12000 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 22.9 PER MONTH
--------------------------------
```

As you can see, the total sales within the automobile industry for the month before the simulation began (month 0) were 50,000

units. You start the simulation with your company holding about a quarter of the total industry sales, or around 12,500 vehicles. You have four factories, which are currently producing more vehicles than you can sell:

```
--------------------------------
MAXIMUM MONTHLY OUTPUT:
  FACTORY 1: 8900
  FACTORY 2: 3250
  FACTORY 3: 2500
  FACTORY 4: 1625
--------------------------------
TOTAL OUTPUT IS 16275
--------------------------------
EFFICIENCY LEVEL IS 77 %
DO YOU WANT TO EXPAND OUTPUT (Y/N)?
                              N
DO YOU WANT TO SELL FACTORY 4 (Y/N)?
                              N
```

When the simulation begins, the average annual wage for each employee is around $23,000. This will rise each three months, due to union demands for adjustments to keep up with inflation. Although you cannot reduce wages, or refuse to include the raise due to inflation, you can decide how many people to hire or fire, and at what price you will sell each vehicle. When the simulation begins, each car sells for around $12,000:

```
INDUSTRY SALES 50000 IN MONTH 0
--------------------------------
YOU HAVE 12000 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 22.9 PER MONTH
--------------------------------
HOW MANY EMPLOYEES TO HIRE? 0
HOW MANY EMPLOYEES TO FIRE? 567
--------------------------------
YOU HAVE 11433 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 21.9 PER MONTH
--------------------------------
WHAT IS YOUR SELLING PRICE? 12345
```

Once you've answered all the relevant questions, the simulation reports back to you on how well—or otherwise—you have performed:

```
INDUSTRY SALES 48833 IN MONTH 1
YOUR SALES: 13386  [ 27.4 % OF TOTAL ]
---------------------------------
YOU HAVE 11433 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 21.9 PER MONTH
---------------------------------
AVERAGE COST PER VEHICLE  IS $ 10192
AND AVERAGE SELLING PRICE IS $ 12345
SO THE AVERAGE PROFIT IS $ 2152
OR $M 28.8 PER MONTH
---------------------------------
PROFIT FOR THE MONTH IS $M 6.9
& TOTAL PROFIT TO DATE IS $M 6.9
---------------------------------
DO YOU WANT TO RESIGN (Y/N)?
                          N
```

That wasn't too bad. You actually made a profit.
The process continues:

```
INDUSTRY SALES 48833 IN MONTH 1
YOUR SALES: 13386  [ 27.4 % OF TOTAL ]
---------------------------------
YOU HAVE 10233 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 19.6 PER MONTH
---------------------------------
AVERAGE COST PER VEHICLE  IS $ 10192
AND AVERAGE SELLING PRICE IS $ 12345
SO THE AVERAGE PROFIT IS $ 2152
OR $M 28.8 PER MONTH
---------------------------------
PROFIT FOR THE MONTH IS $M 6.9
& TOTAL PROFIT TO DATE IS $M 6.9
---------------------------------
WHAT IS YOUR SELLING PRICE? 24000
TOO BIG A CHANGE FOR THE MARKET
WHAT IS YOUR SELLING PRICE? 14000
INDUSTRY SALES 51485 IN MONTH 2
YOUR SALES: 6435  [ 12.5 % OF TOTAL ]
```

```
--------------------------------
YOU HAVE 10233 EMPLOYEES
AVERAGE WAGES ARE $ 22995
 OR $M 19.6 PER MONTH
--------------------------------
AVERAGE COST PER VEHICLE  IS $ 11630
AND AVERAGE SELLING PRICE IS $ 14000
SO THE AVERAGE PROFIT IS $ 2369
OR $M 15.2 PER MONTH
--------------------------------
PROFIT FOR THE MONTH IS $M-4.4
& TOTAL PROFIT TO DATE IS $M 2.5
--------------------------------
DO YOU WANT TO RESIGN (Y/N)?
                          N
```

Just when you think you're getting it all under control, inflation exacts its toll:

```
INFLATION RATE THIS QUARTER IS 2.5 %
AVERAGE WAGES BILL WILL NOW RISE TO
        $ 23569    PER EMPLOYEE

             ANY KEY TO CONTINUE
```

Your next month is not very good:

```
INDUSTRY SALES 49184 IN MONTH 3
YOUR SALES: 6837  ( 13.9 % OF TOTAL )
--------------------------------
YOU HAVE 9743 EMPLOYEES
AVERAGE WAGES ARE $ 23569.88
 OR $M 19.1 PER MONTH
--------------------------------
AVERAGE COST PER VEHICLE  IS $ 11835
AND AVERAGE SELLING PRICE IS $ 14500
SO THE AVERAGE PROFIT IS $ 2664
OR $M 18.2 PER MONTH
--------------------------------
PROFIT FOR THE MONTH IS $M-1
& TOTAL PROFIT TO DATE IS $M 1.5
--------------------------------
DO YOU WANT TO RESIGN (Y/N)?
```

You start the simulation, as you've seen, with four factories. You have the option of at any time selling off factory number four. Alternatively, you can increase the output of the factories. You'll find that the minimum cost per vehicle (and therefore the maximum profit per sale) occurs when your factories are running at 85% efficiency.

Let's decide to sell off factory four, to let the income from that sale offset our losses:

```
YOUR MONTHLY SALES ARE 5517
---------------------------------
MAXIMUM MONTHLY OUTPUT:
  FACTORY 1: 8900
  FACTORY 2: 3250
  FACTORY 3: 2500
  FACTORY 4: 1625
---------------------------------
TOTAL OUTPUT IS 16275
---------------------------------
EFFICIENCY LEVEL IS 33 %
DO YOU WANT TO EXPAND OUTPUT (Y/N)?
                              N
DO YOU WANT TO SELL FACTORY 4 (Y/N)?
                              Y
FACTORY 4 IS VALUED FOR SALE AT $M104
YOU CAN'T REBUY IT LATER IF
YOU SELL IT...
DO YOU WANT TO SELL (Y/N)?
                              Y
```

I've tried this simulation several times. Each time, the same fate occurs. Perhaps I'm just not cut out to run a multi-million-dollar business:

```
INDUSTRY SALES 48991 IN MONTH 10
YOUR SALES: 5727  ( 11.6 % OF TOTAL )
---------------------------------
YOU HAVE 9703 EMPLOYEES
AVERAGE WAGES ARE $ 24521.51
 OR $M 19.8 PER MONTH
---------------------------------
AVERAGE COST PER VEHICLE  IS $ 12418
AND AVERAGE SELLING PRICE IS $ 15400
SO THE AVERAGE PROFIT IS $ 2981
OR $M 17 PER MONTH
```

```
---------------------------------
PROFIT FOR THE MONTH IS $M-2.8
& TOTAL PROFIT TO DATE IS $M 68.4
---------------------------------
DO YOU WANT TO RESIGN (Y/N)?



YOU JUST MADE YOUR TWELFTH MONTHLY
LOSS IN A ROW.....
      YOUR EMPLOYMENT
      IS HEREBY TERMINATED!!
```

A much better outcome is, however, possible for those who are more skilled than I am:

```
WELL DONE! THE COMPANY HAS MADE MORE
   THAN $M200.     YOU'VE BEEN MADE
         A MEMBER OF THE BOARD
```

Here are the principal variables, as they are assigned at the start of this simulation:

```
1630 REM ************************
1640 REM INITIALIZATION
1650 CLS
1660 RANDOMIZE VAL(RIGHT$(TIME$,2))
1670 DIM M(5),Y(5)
1680 NE=12000:REM STARTING NO EMPLOYEES
1690 AW=22995:REM STARTING AVERAGE WAGE
1700 AC=11100:REM COST PRICE/VEHICLE
1710 AS=12000:REM SELLING PRICE
1720 MI=50*1000:MC=10100
1730 Y(3)=12500
1740 MS=25:EF=77:FA=160:SF=0:MT=0
1750 FOR J=1 TO 5
1760 READ M(J)
1770 NEXT J
1780 RETURN
1790 DATA 8900,3250,2500,1625,16275
```

As you can see, the REM statements allow you to trace the various formulas that are used in this simulation:

```
220 INPUT "HOW MANY EMPLOYEES TO HIRE";H
E
230 NE=NE+HE:IF HE>0 THEN 260
240 INPUT "HOW MANY EMPLOYEES TO FIRE";H
E
250 NE=NE-HE
260 GOSUB 650
270 P1=AS:REM SET P1 EQUAL TO OLD PRICE
280 INPUT "WHAT IS YOUR SELLING PRICE";A
S
290 REM NEXT LINE REJECTS TOO BIG A
          CHANGE IN SELLING PRICE
300 IF ABS(P1-AS)>2500 THEN PRINT "TOO B
IG A CHANGE FOR THE MARKET":GOTO 280
310 CLS
320 PRINT:PRINT:PRINT
330 MI=INT(RND(1)*4000)+48*1000:REM THIS
       MONTH'S SALES BY INDUSTRY
340 C=C+1:REM COUNTS NUMBER OF MONTHS
350 IF C<3 THEN 470
360 M=INT(RND(1)*10+1)/4:REM INFLATION
370 CLS
380 PRINT "INFLATION RATE THIS QUARTER I
S"M"%"
390 PRINT "AVERAGE WAGES BILL WILL NOW R
ISE TO"
400 AW=(AW*M/100)+AW
410 PRINT TAB(8);"$"INT(AW)"  PER EMPLOY
EE"
420 IF INKEY$<>"" THEN 420
430 PRINT:PRINT TAB(12);"ANY KEY TO CONT
INUE"
440 IF INKEY$="" THEN 440
450 FA=(FA*M/100)+FA
460 C=0
470 Y(1)=NE*15/12:REM SALES BASED ON
                NUMBER OF EMPLOYEES
480 Y(2)=(100-AS/FA)*MI/100:REM SALES
  BASED ON MONTHLY INDUSTRY SALES
490 REM NEXT LINES SET LOWEST FIGURE
    FROM Y(1),Y(2),M(5) EQUAL TO Y(3)
```

```
500 IF Y(1)<Y(2) AND Y(1)<M(5) THEN Y(3)
=Y(1):GOTO 540
510 IF Y(2)<Y(1) AND Y(2)<M(5) THEN Y(3)
=Y(2):GOTO 540
520 Y(3)=M(5)
530 REM NEXT LINES DETERMINE
          MONTHLY SALES
540 IF ABS(P1-AS)<501 THEN Y(3)=3.6*Y(3)
/3
550 IF Y(3)>M(5) THEN Y(3)=Y(3)-1975:GOT
O 550
560 MC=(MC*M/100)+MC
570 EF=Y(3)/M(5)*100:REM EFFICIENCY %
 AS SALES DIVIDED BY TOTAL OUTPUT
580 AC=(MC*(ABS(85-EF)/3)/100)+MC:REM
       AVERAGE COST PER VEHICLE
590 MP=((Y(3)*(AS-AC))-(NE*AW/12)):REM
       MONTHLY PROFIT
600 MP=INT(MP/(100*1000))
610 TP=TP+MP/10:REM TOTAL PROFIT
                    IN MILLIONS
620 M=0
```

The complete listing for DETROIT CITY is in the next chapter.

16

The DETROIT CITY Listing

Here's the complete listing of the DETROIT CITY program:

```
10 REM DETROIT CITY
20 GOSUB 1640:REM INITIALIZE
30 GOTO 110
40 MT=MT+1:REM COUNTS MONTHS
50 GOSUB 650
60 IF TP>200 THEN 1560
70 PRINT "DO YOU WANT TO RESIGN (Y/N)?"
80 GOSUB 1010
90 IF A$="Y" THEN PRINT "OK, CHIEF":END
100 GOSUB 1380
110 GOSUB 650
120 FOR T=1 TO 1000:NEXT T
130 GOSUB 850
140 PRINT "DO YOU WANT TO EXPAND OUTPUT
(Y/N)?"
150 GOSUB 1010
160 IF A$="Y" THEN 1080
170 IF SF=1 THEN 210
180 PRINT "DO YOU WANT TO SELL FACTORY 4
 (Y/N)?"
```

```
190 GOSUB 1010
200 IF A$="Y" THEN 1250
210 GOSUB 650
220 INPUT "HOW MANY EMPLOYEES TO HIRE";H
E
230 NE=NE+HE:IF HE>0 THEN 260
240 INPUT "HOW MANY EMPLOYEES TO FIRE";H
E
250 NE=NE-HE
260 GOSUB 650
270 P1=AS:REM SET P1 EQUAL TO OLD PRICE
280 INPUT "WHAT IS YOUR SELLING PRICE";A
S
290 REM NEXT LINE REJECTS TOO BIG A
          CHANGE IN SELLING PRICE
300 IF ABS(P1-AS)>2500 THEN PRINT "TOO B
IG A CHANGE FOR THE MARKET":GOTO 280
310 CLS
320 PRINT:PRINT:PRINT
330 MI=INT(RND(1)*4000)+48*1000:REM THIS
       MONTH'S SALES BY INDUSTRY
340 C=C+1:REM COUNTS NUMBER OF MONTHS
350 IF C<3 THEN 470
360 M=INT(RND(1)*10+1)/4:REM INFLATION
370 CLS
380 PRINT "INFLATION RATE THIS QUARTER I
S"M"%"
390 PRINT "AVERAGE WAGES BILL WILL NOW R
ISE TO"
400 AW=(AW*M/100)+AW
410 PRINT TAB(8);"$"INT(AW)"  PER EMPLOY
EE"
420 IF INKEY$<>"" THEN 420
430 PRINT:PRINT TAB(12);"ANY KEY TO CONT
INUE"
440 IF INKEY$="" THEN 440
450 FA=(FA*M/100)+FA
460 C=0
470 Y(1)=NE*15/12:REM SALES BASED ON
                NUMBER OF EMPLOYEES
480 Y(2)=(100-AS/FA)*MI/100:REM SALES
  BASED ON MONTHLY INDUSTRY SALES
490 REM NEXT LINES SET LOWEST FIGURE
    FROM Y(1),Y(2),M(5) EQUAL TO Y(3)
```

```
500 IF Y(1)<Y(2) AND Y(1)<M(5) THEN Y(3)
=Y(1):GOTO 540
510 IF Y(2)<Y(1) AND Y(2)<M(5) THEN Y(3)
=Y(2):GOTO 540
520 Y(3)=M(5)
530 REM NEXT LINES DETERMINE
          MONTHLY SALES
540 IF ABS(P1-AS)<501 THEN Y(3)=3.6*Y(3)
/3
550 IF Y(3)>M(5) THEN Y(3)=Y(3)-1975:GOT
O 550
560 MC=(MC*M/100)+MC
570 EF=Y(3)/M(5)*100:REM EFFICIENCY %
 AS SALES DIVIDED BY TOTAL OUTPUT
580 AC=(MC*(ABS(85-EF)/3)/100)+MC:REM
       AVERAGE COST PER VEHICLE
590 MP=((Y(3)*(AS-AC))-(NE*AW/12)):REM
       MONTHLY PROFIT
600 MP=INT(MP/(100*1000))
610 TP=TP+MP/10:REM TOTAL PROFIT
                    IN MILLIONS
620 M=0
630 GOTO 40
640 REM **************************
650 REM REPORT PRINTOUT
660 CLS
670 PRINT "INDUSTRY SALES"MI"IN MONTH"MT

680 IF MT>0 THEN PRINT "YOUR SALES:"INT(
Y(3))" ("INT(Y(3)*1000/MI)/10"% OF TOTAL
 )"
690 PRINT "------------------------------
---"
700 PRINT "YOU HAVE"NE"EMPLOYEES"
710 PRINT "AVERAGE WAGES ARE $"AW
720 PRINT " OR $M"INT(AW*NE/(100*1000)/1
2)/10"PER MONTH"
730 PRINT "------------------------------
---"
740 IF MT=0 THEN RETURN
750 PRINT "AVERAGE COST PER VEHICLE  IS
$"INT(AC)
760 PRINT "AND AVERAGE SELLING PRICE IS
$"INT(AS)
```

```
770 PRINT "SO THE AVERAGE PROFIT IS $"IN
T[AS-AC]
780 PRINT "OR $M"INT[[AS-AC]*Y[3]/[100*1
000]]/10"PER MONTH"
790 PRINT "-----------------------------
---"
800 PRINT "PROFIT FOR THE MONTH IS $M"MP
/10
810 PRINT "& TOTAL PROFIT TO DATE IS $M"
INT[TP*10]/10
820 PRINT "-----------------------------
---"
830 RETURN
840 REM ************************
850 REM MONTH REPORT
860 CLS
870 IF MT>0 THEN PRINT "YOUR MONTHLY SAL
ES ARE"INT[Y[3]]
880 PRINT "-----------------------------
---"
890 PRINT "MAXIMUM MONTHLY OUTPUT:"
900 PRINT TAB[3];"FACTORY 1:"INT[M[1]]
910 PRINT TAB[3];"FACTORY 2:"INT[M[2]]
920 PRINT TAB[3];"FACTORY 3:"INT[M[3]]
930 IF SF=1 THEN 960
940 PRINT TAB[3];"FACTORY 4:"INT[M[4]]
950 PRINT "-----------------------------
---"
960 PRINT "TOTAL OUTPUT IS"INT[M[5]]
970 PRINT "-----------------------------
---"
980 PRINT "EFFICIENCY LEVEL IS"INT[EF]"%
"
990 RETURN
1000 REM ************************
1010 REM GET REPLIES
1020 A$=INKEY$
1030 IF A$<>"Y" AND A$<>"N" THEN 1020
1040 PRINT TAB[22];A$
1050 FOR J=1 TO 500:NEXT J
1060 RETURN
1070 REM ************************
1080 REM INCREASE OUTPUT?
1090 IF M[4]=0 THEN X=15:GOTO 1110
```

```
1100 X=18
1110 PRINT "IT WILL COST $M"X" TO EXPAND
"
1120 PRINT TAB(8);"OUTPUT BY 1%"
1130 PRINT "-----------------------------
----"
1140 PRINT "HOW MANY % DO YOU WISH TO RA
ISE OUTPUT?"
1150 INPUT EP:IF EP<0 OR EP>100 THEN 115
0
1160 M(5)=0
1170 FOR T=1 TO 4
1180 M(T)=M(T)+M(T)*EP/100
1190 M(5)=M(5)+M(T)
1200 NEXT T
1210 TP=TP-EP*X
1220 FOR T=1 TO 500:NEXT T
1230 GOTO 170
1240 REM **************************
1250 REM SALE OF FACTORY FOUR
1260 PRINT "FACTORY 4 IS VALUED FOR SALE
 AT $M104"
1270 PRINT "YOU CAN'T REBUY IT LATER IF
             YOU SELL IT..."
1280 PRINT "DO YOU WANT TO SELL (Y/N)?"
1290 GOSUB 1010
1300 IF A$="N" THEN 210
1310 TP=TP+104
1320 SF=1
1330 M(5)=M(1)+M(2)+M(3)
1340 M(4)=0
1350 GOTO 170
1360 REM **************************
1370 REM CHECK ON LOSSES
1380 IF MP>0 THEN SA=0:GOTO 1480
1390 SA=SA+1
1400 IF SA>11 THEN 1420
1410 GOTO 1480
1420 CLS:PRINT
1430 PRINT "YOU JUST MADE YOUR TWELFTH M
ONTHLY"
1440 PRINT "LOSS IN A ROW.............
..."
1450 PRINT TAB(6);"YOUR EMPLOYMENT"
```

```
1460 PRINT TAB(6);"IS HEREBY TERMINATED!
!"
1470 END
1480 IF TP>=-250 THEN 1530
1490 CLS:PRINT
1500 PRINT "UNDER YOUR MANAGEMENT, THE C
OMPANY HAS"
1510 PRINT "LOST MORE THAN $M250!"
1520 GOTO 1450
1530 IF TP>200 THEN 1570
1540 RETURN
1550 REM **************************
1560 REM SWEET SWEET SUCCESS!!!
1570 CLS:PRINT
1580 PRINT "WELL DONE! THE COMPANY HAS M
ADE MORE"
1590 PRINT "   THAN $M200.    YOU'VE BEE
N MADE"
1600 PRINT "         A MEMBER OF THE BOAR
D"
1610 FOR T=1 TO 2000:NEXT T
1620 END
1630 REM **************************
1640 REM INITIALIZATION
1650 CLS
1660 RANDOMIZE VAL(RIGHT$(TIME$,2))
1670 DIM M(5),Y(5)
1680 NE=12000:REM STARTING NO EMPLOYEES
1690 AW=22995:REM STARTING AVERAGE WAGE
1700 AC=11100:REM COST PRICE/VEHICLE
1710 AS=12000:REM SELLING PRICE
1720 MI=50*1000:MC=10100
1730 Y(3)=12500
1740 MS=25:EF=77:FA=160:SF=0:MT=0
1750 FOR J=1 TO 5
1760 READ M(J)
1770 NEXT J
1780 RETURN
1790 DATA 8900,3250,2500,1625,16275
```

17

Life at the Super Bowl

It all started back in 1823, at a very upper class school in England. A Rugby School student, William Webb Ellis, was playing soccer one day when he picked up the ball, tucked it under his arm, and ran frantically across his opponent's goal. In this moment the game that later became rugby football was born. From rugby football came rugby league, and eventually GRIDIRON.

Some students from Harvard in 1874 saw the game, as it had then evolved, under way at Montreal University, and liked what they saw. They took some of the Montreal rules and used them to modify a soccerlike game that was already gaining favor in the States.

The game took off, but was so rough and caused so many injuries that at the turn of the century many colleges called for it to be banned. However, Teddy Roosevelt, who liked the game (and most other rugged sports), suggested that instead of banning it, the game should be made simpler. A committee formed of leading coaches, managers, and players met in 1906 to consider Roosevelt's suggestion, and from this committee came the GRIDIRON we know today.

In our program, you can either play against the computer team (known as the "Silicon Cowboys") or against another human being. In the game shown here, I decided to play against the computer:

```
ONE PLAYER OR TWO
? 1
```

```
AND THE NAME OF THE VISITING TEAM?
? HARTNELL'S RAIDERS
```

In this simulation, you have the option of throwing, carrying, or punting (including field goal attempts) the ball. The program allows for four fifteen-minute quarters, and tests your decision-making skills and reflexes.

```
THERE ARE 60 MINUTES TO GO
        SILICON COWBOYS TO KICK OFF
YOU ARE ON YOUR OWN 35 YARD LINE
SILICON COWBOYS HAVE...
KICKED 1 YARDS
KICKED 2 YARDS
KICKED 3 YARDS

                    KICKED 52 YARDS
                     KICKED 53 YARDS
                     KICKED 54 YARDS
                     KICKED 55 YARDS
THE BALL IS CAUGHT!
AND RETURNED 1 YARDS
AND RETURNED 2 YARDS
AND RETURNED 3 YARDS


     AND RETURNED 27 YARDS
      AND RETURNED 28 YARDS
      AND RETURNED 29 YARDS
---------------------------------
THE BALL IS DOWN ON
HARTNELL'S RAIDERS'S 39 YARD LINE
      > PRESS ANY KEY <
SILICO 0 HARTNE 0
 60 MINUTES TO GO
---------------------------------
HARTNELL'S RAIDERS IN POSSESSION
     0 DOWN
     10 YARDS TO GO
---------------------------------
START AT 39 YARD LINE
NOW ON 39 YARD LINE
 61 YARDS TO TOUCHDOWN
```

```
---------------------------------
ON THIS PLAY HARTNELL'S RAIDERS CAN
EITHER 1 - THROW
       2 - CARRY
    OR 3 - PUNT
```

Once you've decided on your play, the computer will begin a count from one to eleven. You have to get rid of the ball during that count. If you don't do so in time, you'll be sacked and lose yardage or possession.

```
HARTNELL'S RAIDERS, YOUR QUARTERBACK HAS

        GOT THE BALL
---------------------------------
WAIT FOR THE COUNT, HARTNELL'S RAIDERS,
        THEN HIT ANY KEY...
 1
  2
   3
    4
     5
      6
---------------------------------
NICE PUNT...
YOU'VE KICKED 24 YARDS
---------------------------------
```

The rules behind this simulation tempt you to wait as long as possible before delivering the ball. The longer you wait, the farther the ball will travel. For example, if you decide to throw the ball, and you stop the count on two, the ball will only travel ten yards, but if you'd stopped the count on ten, it would have gone forty yards.

```
THE BALL IS CAUGHT!
AND RETURNED 1 YARDS
AND RETURNED 2 YARDS
AND RETURNED 3 YARDS

  AND RETURNED 17 YARDS
   AND RETURNED 18 YARDS
   AND RETURNED 19 YARDS
   AND RETURNED 20 YARDS
---------------------------------
```

```
THE BALL IS DOWN ON
SILICON COWBOYS'S 58 YARD LINE

SILICO 0 HARTNE 0
 59.7 MINUTES TO GO
---------------------------------
SILICON COWBOYS IN POSSESSION
     0 DOWN
     10 YARDS TO GO
---------------------------------
START AT 58 YARD LINE
NOW ON 58 YARD LINE
 42 YARDS TO TOUCHDOWN
---------------------------------
ON THIS PLAY SILICON COWBOYS CAN
EITHER 1 - THROW
       2 - CARRY
    OR 3 - PUNT
```

As you can see, the fact that you've thrown a given distance does not mean the play will be completed successfully. The chances of a play being complete are linked to the distance thrown.

```
 TOUCHDOWN!!!
   TOUCHDOWN!!!
     TOUCHDOWN!!!
       TOUCHDOWN!!!
         TOUCHDOWN!!!
SILICON COWBOYS 6
HARTNELL'S RAIDERS 0
TO PLAY FOR EXTRA POINT
      > PRESS ANY KEY <
```

There is a lot of action in this simulation, and you're sure to enjoy dressing it up even more. Here are a few additional scenes of the program in action:

```
AND RETURNED 27 YARDS
 AND RETURNED 28 YARDS
 AND RETURNED 29 YARDS
 AND RETURNED 30 YARDS
 AND RETURNED 31 YARDS
```

```
---------------------------------
THE BALL IS DOWN ON
HARTNELL'S RAIDERS'S 44 YARD LINE
      > PRESS ANY KEY <
                      OK
 PERIOD OVER
   PERIOD OVER
     PERIOD OVER
       PERIOD OVER
         PERIOD OVER
           PERIOD OVER
             PERIOD OVER
               PERIOD OVER
                 PERIOD OVER
                   PERIOD OVER
SILICON COWBOYS 27
HARTNELL'S RAIDERS 6
      > PRESS ANY KEY <



             PERIOD OVER
               PERIOD OVER
                 PERIOD OVER
                   PERIOD OVER
                     PERIOD OVER
                       PERIOD OVER
SILICON COWBOYS 27
HARTNELL'S RAIDERS 6
      > PRESS ANY KEY <
                      OK
 15 MINUTES TO GO

---------------------------------
HARTNELL'S RAIDERS IN POSSESSION
    0 DOWN
    10 YARDS TO GO
---------------------------------
START AT 44 YARD LINE
NOW ON 44 YARD LINE
 56 YARDS TO TOUCHDOWN
---------------------------------
ON THIS PLAY HARTNELL'S RAIDERS CAN
EITHER 1 - THROW
       2 - CARRY
    OR 3 - PUNT
```

```
   3
    4
     5
      6
       7
-----------------------------------
GREAT RUNNING BY THE OPPOSITION HAS
CAUSED YOU TO LOSE 3 YARDS
      > PRESS ANY KEY <
                      OK
 GAME OVER
   GAME OVER
     GAME OVER
       GAME OVER
         GAME OVER
           GAME OVER
             GAME OVER
               GAME OVER
                 GAME OVER
                   GAME OVER
                     GAME OVER
SILICON COWBOYS 40
HARTNELL'S RAIDERS 6
```

The listing of GRIDIRON is given in the next chapter.

18

The GRIDIRON Listing

When you want to try out for the Green Bay Packers, the New York Jets, or the Miami Dolphins, enter and run this listing:

```
10 REM GRIDIRON
20 CLS
30 RANDOMIZE VAL[RIGHT$[TIME$,2]]
40 GOSUB 70
50 GOTO 220
60 REM ************************
70 FOR X=1 TO 1500:NEXT X
80 RETURN
90 REM ************************
100 PRINT A$;SA
110 PRINT B$;SB
120 RETURN
130 REM ************************
140 IF Z$=A$ THEN Z$=B$:RETURN
150 Z$=A$:RETURN
160 REM ************************
170 IF INKEY$<>"" THEN 170
180 PRINT "      > PRESS ANY KEY <"
190 IF INKEY$="" THEN 190
```

```
200 PRINT TAB(20);"OK":RETURN
210 REM ************************
220 REM INITIALIZE
230 DEF FNA(X)=INT(RND(1)*X)+1
240 PRINT "ONE PLAYER OR TWO"
250 INPUT X
260 IF X<1 OR X>2 THEN 250
270 IF X=1 THEN VC=1:A$="SILICON COWBOYS
";:GOTO 300
280 PRINT "WHAT IS THE NAME OF THE HOME
TEAM?"
290 INPUT A$:IF A$="" THEN 290
300 PRINT "AND THE NAME OF THE VISITING
TEAM?"
310 INPUT B$:IF B$="" THEN 310
320 Z$=A$:NU=35
330 CLS
340 PRINT "THERE ARE"INT(10*(60-(W/4)))/
10"MINUTES TO GO"
350 PRINT TAB(8);Z$" TO KICK OFF"
360 PRINT "YOU ARE ON YOUR OWN"NU"YARD L
INE"
370 IF VC=1 AND Z$=A$ THEN GOSUB 70:GOTO
 400
380 PRINT "TO KICK OFF..."
390 GOSUB 170
400 A=FNA(20)+40
410 PRINT Z$;" HAVE..."
420 FOR X=1 TO A
430 PRINT TAB(X/3);"KICKED"X"YARDS"
440 NEXT X
450 NU=NU+X
460 GOSUB 70
470 PRINT "THE BALL IS CAUGHT!"
480 GOSUB 70
490 A=FNA(30)+10
500 FOR X=1 TO A
510 PRINT TAB(X/5);"AND RETURNED"X"YARDS
"
520 NEXT X
530 NU=ABS(100-NU+X)
540 GOSUB 140
550 PRINT "-----------------------------
----"
```

```
560 PRINT "THE BALL IS DOWN ON"
570 PRINT Z$"'S"NU"YARD LINE"
580 IF Z$=A$ AND VC=1 THEN GOSUB 70:GOTO
 600
590 GOSUB 170
600 TG=10:D=0:SL=NU
610 IF W=60 OR W=180 THEN 2010
620 IF W=120 THEN 2070
630 IF W=240 THEN 2140
640 CLS
650 PRINT LEFT$(A$,6);SA;LEFT$(B$,6);SB
660 PRINT INT(10*(60-(W/4)))/10"MINUTES
TO GO"
670 GOSUB 70
680 PRINT "------------------------------
----"
690 PRINT Z$" IN POSSESSION"
700 PRINT TAB(4);D"DOWN"
710 PRINT TAB(4);TG"YARDS TO GO"
720 PRINT "------------------------------
----"
730 PRINT "START AT"SL"YARD LINE"
740 PRINT "NOW ON"NU"YARD LINE"
750 PRINT 100-NU"YARDS TO TOUCHDOWN"
760 PRINT "------------------------------
----"
770 PRINT "ON THIS PLAY ";
780 IF Z$=A$ THEN PRINT A$;" CAN":GOTO 8
00
790 PRINT B$;" CAN"
800 PRINT "EITHER 1 - THROW"
810 PRINT "        2 - CARRY"
820 PRINT "    OR 3 - PUNT"
830 P=0
840 IF Z$=A$ AND VC=1 AND D<3 THEN P=2:G
OTO 900
850 IF Z$=A$ AND VC=1 AND TG<7 THEN P=2:
GOTO 900
860 IF Z$=A$ AND VC=1 AND (100-NU)<31 TH
EN P=3:GOTO 900
870 IF Z$=A$ AND VC=1 THEN P=1:GOTO 900
880 K$=INKEY$:IF K$<"1" OR K$>"3" THEN 8
80
890 P=VAL(K$):PRINT TAB(10);"OK"P
```

```
900 GOSUB 70
910 W=W+1
920 CLS
930 PRINT Z$;", YOUR QUARTERBACK HAS"
940 PRINT TAB(8);"GOT THE BALL"
950 PRINT "-----------------------------
----"
960 PRINT "WAIT FOR THE COUNT, ";Z$;","
970 PRINT TAB(8);"THEN HIT ANY KEY..."
980 IF INKEY$<>"" THEN 980
990 GOSUB 70
1000 GOSUB 2200
1010 IF E=11 THEN 2340
1020 PRINT "-----------------------------
-----"
1030 ON P GOTO 1050,1310,1590
1040 REM **************************
1050 PRINT "YOU'VE THROWN"E*5"YARDS"
1060 PRINT TAB(4);"AND THE PLAY IS..."
1070 A=FNA(8)
1080 IF A=1 THEN 1520
1090 A=FNA(E+1)
1100 IF A=1 THEN PRINT TAB(20);"...COMPL
ETE":GOTO 1220
1110 PRINT TAB(20);"...INCOMPLETE":D=D+1

1120 GOSUB 170
1130 PRINT "-----------------------------
-----"
1140 IF D>3 THEN 1160
1150 GOTO 610
1160 PRINT "THAT WAS YOUR 4TH DOWN"
1170 PRINT "AND YOU'VE LOST POSSESSION!!
"
1180 D=0:TG=10:NU=ABS(100-NU):SL=NU
1190 GOSUB 70
1200 GOSUB 140
1210 GOTO 610
1220 GOSUB 170
1230 NU=NU+(E*5):TG=TG-(E*5)
1240 IF NU>100 THEN 1800
1250 IF TG<1 THEN 1280
1260 D=D+1:IF D>3 THEN 1160
1270 GOTO 610
```

```
1280 D=0:TG=10:SL=NU
1290 GOTO 610
1300 REM ************************
1310 A=FNA(15)
1320 IF A=1 THEN 1510
1330 E=A-5
1340 IF E<0 THEN 1440
1350 IF E=0 THEN E=1:GOTO 1370
1360 PRINT "GOOD SNAP, PASS AND RUN"
1370 PRINT "YOU'VE GAINED"E"YARDS"
1380 GOSUB 170
1390 TG=TG-E:NU=ABS(NU+E):D=D+1
1400 IF NU>100 THEN 1800
1410 IF TG<1 THEN 1280
1420 IF D>3 THEN 1160
1430 GOTO 610
1440 PRINT "GREAT RUNNING BY THE OPPOSIT
ION HAS"
1450 PRINT "CAUSED YOU TO LOSE"ABS(E)"YA
RDS"
1460 TG=TG-E:NU=NU+E:D=D+1
1470 GOSUB 170
1480 IF D>3 THEN 1160
1490 GOTO 610
1500 REM ************************
1510 PRINT "BAD SNAP...YOU'VE"
1520 PRINT "FUMBLED...AND"
1530 PRINT "YOU'VE LOST POSSESSION..."
1540 NU=100-NU:D=0:TG=10:SL=NU
1550 REM ************************
1560 GOSUB 170
1570 GOTO 460
1580 REM ************************
1590 PRINT "NICE PUNT..."
1600 PRINT "YOU'VE KICKED"E*4"YARDS"
1610 NU=NU+E*4
1620 IF NU>100 THEN 1650
1630 PRINT "-----------------------------
-----"
1640 GOTO 460
1650 A=FNA(3)
1660 IF A>1 THEN 1740
1670 PRINT "BUT YOU'VE MISSED THE GOAL!!
"
```

```
1680 IF NU-E*4<80 THEN NU=ABS(100-(NU-E*
4)):GOTO 1700
1690 NU=20
1700 D=0:TG=10:SL=NU
1710 GOSUB 140
1720 GOSUB 170
1730 GOTO 610
1740 PRINT ".........AND SCORED!"
1750 IF Z$=B$ THEN SB=SB+3:GOTO 1770
1760 SA=SA+3
1770 GOSUB 100
1780 GOSUB 170
1790 NU=35:GOTO 330
1800 CLS
1810 FOR X=1 TO 5
1820 PRINT TAB(X*2);"TOUCHDOWN!!!"
1830 NEXT X
1840 IF Z$=A$ THEN SA=SA+6:GOTO 1860
1850 SB=SB+6
1860 GOSUB 100
1870 PRINT "TO PLAY FOR EXTRA POINT"
1880 GOSUB 170
1890 PRINT "----------------------------
-----"
1900 PRINT "THE BALL IS SNAPPED...PREPAR
E TO KICK!"
1910 GOSUB 70
1920 GOSUB 2200
1930 IF E>9 THEN PRINT "YOU MISSED":NU=2
0:GOTO 1970
1940 PRINT "YOU SCORED...":NU=35
1950 IF Z$=A$ THEN SA=SA+1:GOTO 1980
1960 SB=SB+1:GOTO 1980
1970 GOSUB 140
1980 GOSUB 100
1990 GOSUB 170
2000 GOTO 330
2010 FOR X=1 TO 10
2020 PRINT TAB(2*X);"PERIOD OVER"
2030 NEXT X
2040 GOSUB 100
2050 GOSUB 170
2060 GOTO 660
2070 FOR X=1 TO 10
```

```
2080 PRINT TAB(2*X);"HALF TIME"
2090 NEXT X
2100 GOSUB 100
2110 Z$=B$
2120 GOSUB 170
2130 NU=35:W=W+2:GOTO 330
2140 FOR X=1 TO 10
2150 PRINT TAB(2*X);"GAME OVER"
2160 NEXT X
2170 GOSUB 100
2180 END
2190 REM ************************
2200 E=0:X=10
2210 IF Z$=A$ AND VC=1 THEN PRINT "THIS
ONE FOR ";A$:GOTO 2290
2220 E=E+1:X=X-1
2230 PRINT TAB(E);E
2240 FOR Y=1 TO X*1.5
2250 IF INKEY$<>"" THEN Y=X*1.5+1:RETURN

2260 NEXT Y
2270 IF E=11 THEN RETURN
2280 GOTO 2220
2290 FOR E=1 TO FNA(7)+2
2300 FOR J=1 TO 60:NEXT J
2310 PRINT TAB(E);E
2320 NEXT E
2330 RETURN
2340 PRINT "TOO LATE!"
2350 PRINT "YOU'VE BEEN SACKED!"
2360 E=FNA(4)
2370 IF E=3 THEN 2430
2380 PRINT "AND LOST FIVE YARDS!"
2390 TG=TG+5:D=D+1:NU=NU-5
2400 GOSUB 170
2410 IF D>3 THEN 1160
2420 GOTO 610
2430 PRINT "AND LOST POSSESSION!"
2440 D=0:NU=ABS(100-NU+5):SL=NU:TG=10
2450 GOSUB 170
2460 GOSUB 140
2470 GOTO 610
```

19

The Grand Slam

In this sports simulation, you have a chance to play a three-set match of tennis against your computer. If you prefer, you can also play against another human being, with the simulation reporting on, and moderating, the action.

Tennis got its start in England in the middle of the last century. By 1877 it was such a popular game that a national championship was staged at Wimbledon. There is a maximum of five sets in a match for men, and three for women. You have to win a maximum of six games to win a set. You need to lead by two games in order to win a set.

The simulation calls on your decision-making skill and tests your reflexes. Your first decision concerns the speed of your serve. If you elect to play against the computer, it will always serve first, in order to allow you to see it in action. You'll learn a lot more about the simulation from watching the computer serve than from reading this introduction.

The simulation is weighted so that fast serves have a better chance of an ace than do slow serves, but there is also a greater chance of a fault. Slow serves will rarely result in an ace, but are also unlikely to be faults.

After the serve, the simulation calls on your reflexes. The screen clears and indicates whose court the ball is in. After a brief pause, the computer will begin a countdown to −1. To hit the ball, you need to wait until the count reaches zero, and then press any key.

If you "swing" too soon or too late, you'll miss the ball, and the computer will tell you whether the ball was in or out of play. Note that you can choose to leave a ball, if you think it is going to go out. If you "hit" the ball by striking a key just as the count reaches zero, the screen will clear and show the ball in the other player's court. This process continues until one player or the other misses the ball.

The program begins by asking you whether there will be one human player or two. If there is only one, it will ask for the player's name with the prompt NAME OF SECOND PLAYER?:

```
ONE HUMAN PLAYER OR TWO? 1
NAME OF SECOND PLAYER? TIMOTY
```

This simulation needs names that are six letters long. If you enter a longer name, the computer will cut it down to size. The computer player's name, as you'll see in a moment, is "Bjornx". The match begins with Bjornx serving:

```
BJORNX SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

      1   > IT'S A FAST SERVE...
```

Bjornx elects a fast serve, and the mere human must attempt to return it:

```
TIMOTY, THE BALL IS
IN YOUR COURT
----------------------
HIT ANY KEY, WHEN YOU SEE THE ZERO,
     TO RETURN THE BALL...
            5
               4
                  3
                     2
                        1
YOU MISSED THE BALL, AND...
   IT WAS IN...BAD MISTAKE
```

Unfortunately, Timoty is not playing with his usual fine form. The score is shown before Bjornx serves again:

```
----------------------
             SET SET SET
----------------------
               1   2   3   GAME
BJORNX         0   0   0   30
TIMOTY         0   0   0   0
----------------------
BJORNX SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       1  > IT'S A FAST SERVE...
```

The scoring system in our simulation follows the real game, with a minimum of four points needed to win a game: 15, 30, 40, and game. If both sides score 40, "deuce" is declared, and the first player to score a point is said to have the "advantage." A further point is needed to win. If the opponent gets a point instead of the player with the "advantage," the score returns to "deuce." Of course, you do not have to worry about this scoring system, as the computer obligingly keeps track of everything for you.

Here are a few more "snapshots" of the game in progress:

```
GAME TO BJORNX


----------------------
             SET SET SET
----------------------
               1   2   3   GAME
BJORNX         1   0   0   0
TIMOTY         0   0   0   0
----------------------
TIMOTY SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       1  > IT'S A FAST SERVE...
```

```
          ....OUT....
        ...SECOND SERVE...
TIMOTY SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       2   > IT'S A SLOW SERVE...
```

```
----------------------
             SET SET SET
----------------------
              1   2   3   GAME
BJORNX        6   0   0   0
TIMOTY        1   0   0   40
----------------------
TIMOTY SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       2   > IT'S A SLOW SERVE...
```

```
----------------------
             SET SET SET
----------------------
              1   2   3   GAME
BJORNX        6   0   0   15
TIMOTY        1   1   0   0
----------------------
BJORNX SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       1   > IT'S A FAST SERVE...
```

It appears that the human race is no match for the mighty computer:

```
----------------------
             SET SET SET
----------------------
              1   2   3   GAME
BJORNX        6   4   0   30
TIMOTY        1   2   0   40
----------------------
TIMOTY SERVING
DO YOU WANT TO SERVE 1 - FAST
                     OR 2 - SLOW

       2   > IT'S A SLOW SERVE...
```

```
----------------------
             SET SET SET
----------------------
              1   2   3   GAME
BJORNX        6   4   0   {DEUCE
TIMOTY        1   2   0   {DEUCE
----------------------
```

```
----------------------
             SET SET SET
----------------------
              1   2   3   GAME
BJORNX        6   6   6   0
TIMOTY        1   4   4   0
----------------------
```

20

The TENNIS Listing

When you're ready to take on Bjornx for a set or two, enter and run the following listing:

```
10 REM TENNIS
20 CLS
30 RANDOMIZE VAL(RIGHT$(TIME$,2))
40 AA=0:BB=0:T=0:KA=0
50 XA=0:YA=0:ZA=0
60 XB=0:YB=0:ZB=0
70 DEF FNA(X)=INT(RND(1)*X)+1
80 INPUT "ONE HUMAN PLAYER OR TWO";A
90 IF A<1 OR A>2 THEN 80
100 IF A=1 THEN A$="BJORNX":VC=1
110 IF VC=1 THEN 160
120 PRINT "PLEASE ENTER A SIX-LETTER NAM
E"
130 INPUT "NAME OF FIRST PLAYER";A$
140 IF LEN(A$)<6 THEN A$=A$+" ":GOTO 140

150 A$=LEFT$(A$,6)
160 INPUT "NAME OF SECOND PLAYER";B$
```

```
170 IF LEN(B$)<6 THEN B$=B$+" ":GOTO 170

180 B$=LEFT$(B$,6)
190 S=1:AA=1:BB=1
200 CLS
210 P$=A$:R$=B$
220 REM ********************************
230 IF P$=A$ THEN R$=B$
240 IF P$=B$ THEN R$=A$
250 PRINT P$;" SERVING"
260 PRINT "DO YOU WANT TO SERVE 1 - FAST
"
270 PRINT "                    OR 2 - SLOW
"
280 IF P$=A$ AND VC=1 AND SC=0 THEN KB=1
:GOSUB 1720:GOTO 330
290 IF P$=A$ AND VC=1 AND SC=1 THEN KB=2
:GOSUB 1720:GOTO 330
300 K$=INKEY$
310 IF K$<"1" OR K$>"2" THEN 300
320 KB=VAL(K$)
330 PRINT:PRINT TAB(6);KB;TAB(10);"> IT'
S A ";
340 IF KB=1 THEN PRINT "FAST";
350 IF KB=2 THEN PRINT "SLOW";
360 PRINT " SERVE..."
370 GOSUB 1720
380 IF KB=1 THEN EB=FNA(3):GOTO 400
390 EB=FNA(8)
400 IF EB=1 THEN 450
410 IF EB=3 AND SC=0 THEN 520
420 IF EB=3 AND SC=1 THEN 590
430 GOTO 670
440 REM ********************************
450 CLS:PRINT
460 PRINT TAB(8);"....ACE...."
470 GOSUB 1720
480 SC=0
490 IF P$=A$ THEN 1140
500 GOTO 1150
510 REM ********************************
520 CLS:PRINT
530 PRINT TAB(12);"....OUT...."
540 PRINT TAB(8);"...SECOND SERVE..."
```

```
550 GOSUB 1720
560 SC=1
570 GOTO 230
580 REM ********************************
590 CLS:PRINT
600 PRINT TAB(12);"....OUT...."
610 PRINT TAB(9);"....DOUBLE FAULT..."
620 GOSUB 1720
630 SC=0
640 IF P$=A$ THEN 1150
650 GOTO 1140
660 REM ********************************
670 SC=0
680 CLS:PRINT
690 IF INKEY$<>"" THEN 690
700 PRINT R$;", THE BALL IS":PRINT "IN Y
OUR COURT"
710 PRINT "----------------------"
720 IF R$=A$ AND VC=1 THEN 750
730 PRINT "HIT ANY KEY, WHEN YOU SEE THE
 ZERO,           TO RETURN THE BALL..."
740 IF INKEY$<>"" THEN 740
750 X=4*FNA(3):Y=X
760 GOSUB 1720
770 E=5
780 PRINT TAB(2*(11-E));E
790 Y=Y-1
800 S$=INKEY$
810 IF S$<>"" AND E=0 THEN 890
820 IF S$<>"" THEN 990
830 IF Y>0 THEN 790
840 E=E-1:Y=X
850 IF E<-1 THEN 990
860 IF E=-1 AND R$=A$ AND VC=1 THEN 890
870 GOTO 780
880 IF KB=1 THEN EA=FNA(2):GOTO 1000
890 EA=FNA(4)
900 IF E=0 AND R$=A$ AND VC=1 THEN EA=FN
A(8)
910 IF EA=1 THEN 940
920 IF R$=A$ THEN R$=B$:GOTO 670
930 R$=A$:GOTO 670
940 PRINT R$;", YOU'VE HIT THE BALL"
950 PRINT TAB(8);"OUT OF PLAY..."
```

```
960 GOSUB 1720
970 IF R$=A$ THEN R$=B$:GOTO 1150
980 GOTO 1140
990 EA=FNA(4)
1000 IF EA=1 THEN 1070
1010 PRINT "YOU MISSED THE BALL, AND..."
1020 GOSUB 1720
1030 PRINT "   IT WAS IN...BAD MISTAKE"
1040 GOSUB 1720
1050 IF R$=A$ THEN R$=B$:GOTO 1150
1060 GOTO 1140
1070 PRINT "YOU MISSED THE BALL AND..."
1080 GOSUB 1720
1090 PRINT "   IT WAS OUT..WELL LEFT"
1100 GOSUB 1720
1110 IF R$=A$ THEN R$=B$:GOTO 1140
1120 GOTO 1150
1130 REM ********************************
1140 AA=AA+1:GOTO 1160
1150 BB=BB+1
1160 IF AA<5 AND BB<5 THEN 1230
1170 IF (BB>4 AND AA<4) OR (BB>4 AND BB-
AA>1) THEN AA=1:BB=1:GOTO 1500
1180 IF (AA>4 AND BB<4) OR (AA>4 AND AA-
BB>1) THEN AA=1:BB=1:GOTO 1440
1190 IF AA>4 AND AA>BB THEN C$="ADV":D$=
"---":GOTO 1320
1200 IF BB>4 AND BB>AA THEN D$="ADV":C$=
"---":GOTO 1320
1210 C$="{DEUCE":D$="{DEUCE":GOTO 1320
1220 REM ********************************
1230 RESTORE
1240 FOR D=1 TO AA
1250 READ C$
1260 NEXT D
1270 RESTORE
1280 FOR D=1 TO BB
1290 READ D$
1300 NEXT D
1310 REM ********************************
1320 CLS
1330 PRINT "----------------------"
1340 PRINT "           SET SET SET"
```

```
1350 PRINT "----------------------"
1360 PRINT "              1   2   3  GAME"

1370 PRINT A$;"      ";XA;" ";YA;" ";ZA;"
 ";C$
1380 PRINT B$;"      ";XB;" ";YB;" ";ZB;"
 ";D$
1390 PRINT "----------------------"
1400 GOSUB 1720
1410 IF T<>1 THEN 230
1420 END
1430 REM ******************************
1440 CLS
1450 PRINT "GAME TO ";A$
1460 GOSUB 1720
1470 IF S=1 THEN XA=XA+1:C$="O":D$="O":G
OTO 1560
1480 IF S=2 THEN YA=YA+1:C$="O":D$="O":G
OTO 1580
1490 IF S=3 THEN ZA=ZA+1:C$="O":D$="O":G
OTO 1600
1500 CLS
1510 PRINT "GAME TO ";B$
1520 GOSUB 1720
1530 IF S=1 THEN XB=XB+1:C$="O":D$="O":G
OTO 1560
1540 IF S=2 THEN YB=YB+1:C$="O":D$="O":G
OTO 1580
1550 IF S=3 THEN ZB=ZB+1:C$="O":D$="O":G
OTO 1600
1560 IF (XA>5 AND XB<5) OR (XA<5 AND XB>
5) THEN 1630
1570 IF (XA>5 AND XA-XB>1) OR (XB>5 AND
XB-XA>1) THEN 1630
1580 IF (YA>5 AND YB<5) OR (YA<5 AND YB>
5) THEN 1630
1590 IF (YA>5 AND YA-YB<1) OR (YB>5 AND
YB-YA>1) THEN 1630
1600 IF (ZA>5 AND ZB<5) OR (ZA<5 AND ZB>
5) THEN 1680
1610 IF (ZA>5 AND ZA-ZB>1) OR (ZB>5 AND
ZB-ZA>1) THEN 1680
1620 GOTO 1640
1630 S=S+1
```

```
1640 AA=1:BB=1
1650 IF P$=A$ THEN R$=A$:P$=B$:GOTO 1320

1660 P$=A$:R$=B$:GOTO 1320
1670 REM ********************************
1680 T=1
1690 GOTO 1320
1700 REM ********************************
1710 REM DELAY
1720 FOR M=1 TO 1000:NEXT M
1730 RETURN
1740 DATA "0","15","30","40"
```

21

Driving a Racing Car

Now you have the chance to drive a simulated racing car around your choice of four of the world's greatest Grand Prix circuits. You, too, can be a hero on the British course known as "The Whale," at Germany's "The Key," on the Italian track called "The Shoe," or on the 3100-meter track at Monaco.

The program begins by asking your name, wishing you luck, and asking you which track you wish to try and how many laps the race will be over:

```
WHAT IS YOUR NAME, DRIVER? HARTNELL

    OK, GOOD LUCK, HARTNELL
        OK, GOOD LUCK, HARTNELL
            OK, GOOD LUCK, HARTNELL
****************************************
WHICH RACE DO YOU WANT TO TAKE PART IN:

        BRITISH GRAND PRIX   2650MT   :1
        GERMAN  GRAND PRIX   1700MT   :2
        ITALIAN GRAND PRIX   2200MT   :3
        MONACO  GRAND PRIX   3100MT   :4

        ENTER A NUMBER (1 TO 4)
```

```
****************************************
        OK, THE BRITISH RACE
****************************************

OVER HOW MANY LAPS?
? 1
```

The aim of the simulation, naturally enough, is to complete the race as quickly as possible, without crashing and without overheating either your engine or your brakes. The race begins as follows:

You start the race, as the fifth line down indicates, in the sixth position. On the British circuit, you start the simulation at 140 kilometers an hour, just under the speed recommended for the approaching corner. To increase your speed, you hit the "M" key. The "Z" key will slow you down, and the space bar allows you to maintain the same speed.

A few seconds after the above "snapshot" of the simulation, the screen looked like this:

```
ENGINE TEMPERATURE 100 C.  (MAX. 200)
BRAKE TEMPERATURE: 10 C.  (MAX. 500)
 DISTANCE COVERED: 0 METERS
                 : 0 LAPS
YOU'RE IN POSITION 6
-------------------------------------
    CURRENT SPEED: 140 KPH
                 : 77.7 METERS PER MOVE
-------------------------------------
CORNER APPROACHING 800 METERS
RECOMMENDED SPEED: 150 KPH
-------------------------------------
```

The simulation run began with the first corner 800 meters away. This has now shrunk to just 57 meters, and I've increased my speed to 148 kph, just below the recommended speed for taking that corner of 150 kph. The engine has warmed up slightly, but still a long, long way away from the maximum of 200 C., and the temperature of the brakes has gone up from 10 degrees to nearly 55.

```
ENGINE TEMPERATURE 104.6 C.  (MAX. 200)
BRAKE TEMPERATURE: 54.7 C.  (MAX. 500)
```

```
 DISTANCE COVERED: 742.2 METERS
                 : .28 LAPS
YOU'RE IN POSITION 6
-------------------------------------
     CURRENT SPEED: 148 KPH
                 : 82.2 METERS PER MOVE
-------------------------------------
CORNER APPROACHING 57 METERS
RECOMMENDED SPEED: 150 KPH
-------------------------------------
```

I safely negotiate that corner, but find that I have perhaps been a bit too cautious: with just under half of the one-lap race completed I have fallen back to the seventh position after starting in position six:

```
ENGINE TEMPERATURE 87.1 C.  (MAX. 200)
BRAKE TEMPERATURE: 157.3 C.  (MAX. 500)
 DISTANCE COVERED: 1102 METERS
                 : .41 LAPS
YOU'RE IN POSITION 7
-------------------------------------
     CURRENT SPEED: 112.3 KPH
                 : 62.3 METERS PER MOVE
-------------------------------------
CORNER APPROACHING 97 METERS
RECOMMENDED SPEED: 90 KPH
-------------------------------------
```

I am just 97 meters from the next corner, where the recommended cornering speed is 90 kph. I'm doing just over 112 kph. Frantically, I slam on the brakes, punching at the "Z" key. But it is too late:

```
YOU CORNERED AT 104.8 KPH
AND THE MAXIMUM SPEED WAS JUST 90
YOU SPIN OFF THE TRACK...
..........AND CRASH!!!!!
-------------------------------------
YOU ONLY COMPLETED 1218.4 METERS,
OR .45 LAPS AND AT THAT
STAGE WERE IN POSITION 7
-------------------------------------
```

```
YOUR AVERAGE SPEED WAS 137.07 KPH
YOU WERE 2 TH FASTEST ON STRAIGHTS,
AND 12 TH FASTEST ON CORNERS.

PRESS 'S' FOR SAME RACE, 'N' FOR NEW
 RACE, 'E' TO END
```

I was in seventh place when my race ended. The final screen tells me my average speed was a shade over 137 kph, I was second fastest on the straights, and only twelfth fastest on the corners.

As you can see, you are given the choice of running the same race again (by pressing "S"), choosing a new race ("N"), or ending the simulation ("E").

I press "N" and decide on the German circuit:

```
****************************************
WHICH RACE DO YOU WANT TO TAKE PART IN:

       BRITISH GRAND PRIX  2650MT  :1
       GERMAN  GRAND PRIX  1700MT  :2
       ITALIAN GRAND PRIX  2200MT  :3
       MONACO  GRAND PRIX  3100MT  :4

       ENTER A NUMBER (1 TO 4)
****************************************
        OK, THE GERMAN RACE
****************************************

OVER HOW MANY LAPS?
? 1
```

This time, I take fewer risks, and am soon on my way to completing the circuit without mishap:

```
ENGINE TEMPERATURE 117.5 C.  (MAX. 200)
BRAKE TEMPERATURE: 34.5 C.  (MAX. 500)
 DISTANCE COVERED: 1424.3 METERS
                 : .83 LAPS
YOU'RE IN POSITION 27
-------------------------------------
```

```
     CURRENT SPEED: 116.3 KPH
                  : 64.6 METERS PER MOVE
-------------------------------------
CORNER APPROACHING 75 METERS
RECOMMENDED SPEED: 200 KPH
-------------------------------------
```

A few careful moments later, and I've done it:

```
WELL DONE, HARTNELL!!
-------------------------------------
YOU MANAGED TO LAST OUT THE FULL
          1 LAP RACE...
-------------------------------------
```

The main value of this simulation, apart from that of its high entertainment potential, is showing how the facts of "real life" (such as the engine speed maximum, and the data on each track) can be encoded into a program. You can also see how the formulas link the various outputs together in a realistic way—for example, how lines 370 and 380 work out how far you have traveled, by converting your speed in kilometers per hour into meters.

Note also that lines 320 and 330, which act on your attempts to speed up or slow down, add or subtract a value that is related to the actual speed you are traveling. This means you can brake more dramatically when you are moving quickly than you can while moving slowly. Using a value that is related to current speed also overcomes the realism-destroying practice of just changing the current speed by a fixed value each time a key is pressed.

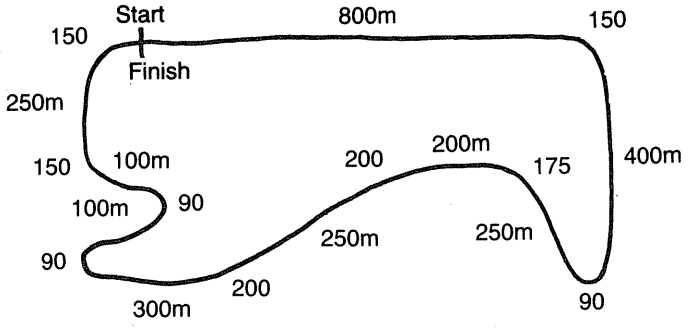
```
YOU FINISHED IN 30 POSITION,
AFTER STARTING IN 6TH POSITION...
YOUR AVERAGE SPEED WAS 100.38 KPH
YOU WERE 14 TH FASTEST ON STRAIGHTS,
AND 47 TH FASTEST ON CORNERS.

PRESS 'S' FOR SAME RACE, 'N' FOR NEW
 RACE, 'E' TO END
```

The Tracks

Here are the four Grand Prix circuits that are encoded within the program.

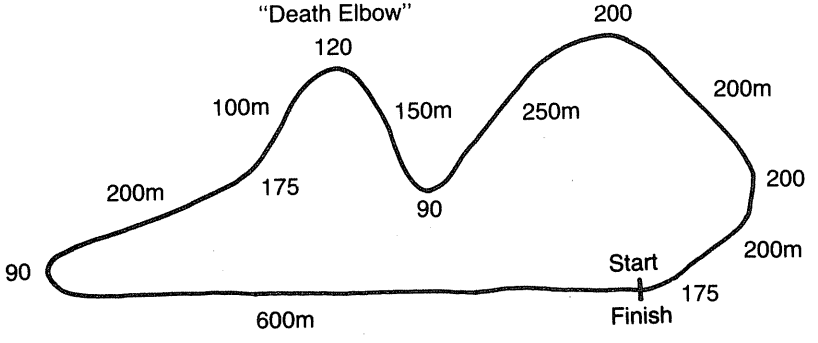
British Grand Prix

"The Whale," 2650 meters:



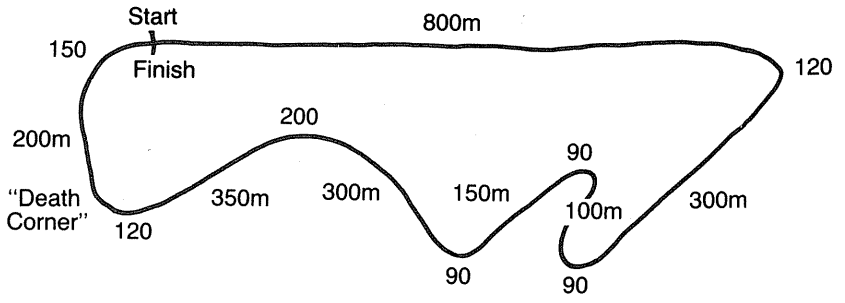
German Grand Prix

"The Key," 1700 meters:



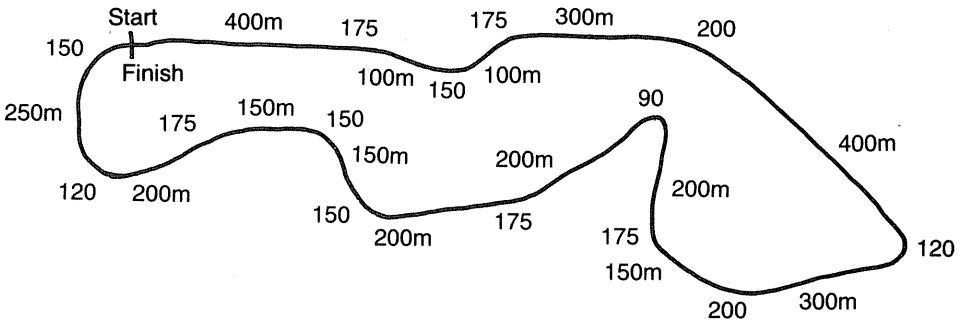
Italian Grand Prix

"The Shoe," 2200 meters:



Monaco Grand Prix

3100 meters:



Numbers *not* followed by "m" indicate maximum cornering speeds.

Numbers followed by "m" (for meters) indicate distances between corners.

22

The GRAND PRIX Listing

Take a firm grip on the wheel, and tackle the GRAND PRIX circuits with this listing:

```
10 REM GRAND PRIX
20 GOSUB 2200:REM INITIALIZE
30 GOSUB 1190:REM CHOOSE TRACK
40 REM ************************
50 REM MAJOR LOOP
60 GOSUB 120:REM PRINTOUT
70 GOSUB 280:REM ACCELERATION/CHECK
80 GOSUB 450:REM ENGINE/BRAKES
90 GOSUB 500:REM CORNER/POSITION
100 GOTO 60
110 REM ************************
120 REM PRINTOUT
130 CLS
140 PRINT "ENGINE TEMPERATURE"INT(ENG*10
)/10"C.  (MAX. 200)"
150 PRINT "BRAKE TEMPERATURE:"INT(BRAK*1
0)/10"C.  (MAX. 500)"
160 PRINT " DISTANCE COVERED:"INT(DIST*1
0)/10"METERS"
```

```
170 PRINT "                    :"INT(DIST*1
00/RR)/100"LAPS"
180 PRINT "YOU'RE IN POSITION"INT(FP)
190 PRINT "-----------------------------
-------"
200 PRINT "    CURRENT SPEED:"INT(SPEED*
10)/10"KPH"
210 PRINT "                    :"INT(SPEED*
5.555)/10"METERS PER MOVE"
220 PRINT "-----------------------------
-------"
230 PRINT "CORNER APPROACHING"INT(APP)"M
ETERS"
240 PRINT "RECOMMENDED SPEED:"C(C)"KPH"
250 PRINT "-----------------------------
-------"
260 RETURN
270 REM ************************
280 REM CHECK ACCELERATION AND FACTORS
290 X$=INKEY$:IF X$<>"Z" AND X$<>"M" AND
 X$<>" " THEN 290
300 PRINT TAB(12);"OK"
310 X=0
320 IF X$="M" THEN X=SPEED/15
330 IF X$="Z" THEN X=-SPEED/15
340 NUM=NUM+1:REM NUMBER OF MOVES
350 SPEED=SPEED+X
360 IF SPEED<0 THEN SPEED=0
370 TRAV=SPEED*.5555:REM DISTANCE
                        TRAVELLED
380 DIST=DIST+TRAV:REM TOTAL DISTANCE
                        TRAVELLED
390 ENG=ENG+(X/2)+.07:IF ENG<70 THEN ENG
=70+RND(1)*8:REM ENGINE TEMP
400 IF X>0 THEN BRAK=BRAK*.9:REM BRAKE
  TEMP FALLING; ACCELERATING
410 IF X<1 THEN BRAK=BRAK-(3*X)-RND(1)*3
:REM BRAKE TEMP INCREASING; BRAKING
420 IF BRAK<8 THEN BRAK=8+RND(1)*8
430 RETURN
440 REM ************************
450 REM CHECK ENGINE/BRAKE TEMP
460 IF ENG>200 THEN PRINT "YOUR ENGINE H
AS OVERHEATED":GOTO 830
```

```
470 IF BRAK>500 THEN PRINT "YOUR BRAKES
HAVE OVERHEATED":GOTO 830
480 RETURN
490 REM **************************
500 REM CHECK CORNERING SPEED
            AND FIELD POSITION
510 APP=APP-TRAV
520 IF APP>0 THEN RETURN
530 CRASH=0
540 IF SPEED>(C(C)*1.125) THEN CRASH=1:G
OTO 690
550 IF SPEED>(C(C)*1.1) THEN GOTO 690
560 PNT=PNT+100-((C(C)*1.1)-SPEED):REM C
ORNERING POINTS
570 NC=NC+1:REM NUMBER OF CORNERS
580 CP=96-(PNT/NC):REM CORNERING
                          POSITION
590 AM=AM+A(C):REM AVERAGE NUMBER
                   OF MOVES ALLOWED
600 RP=NUM-AM:REM RACING POSITION: YOUR
          MOVES MINUS AVERAGE MOVES
610 FP=(CP+RP)/2:REM FIELD POSITION IS
AVERAGE OF CORNER & RACE POSITIONS
620 IF FP<1 THEN FP=1
630 C=C+1
640 IF C=WW THEN C=1:REM LAP OVER
650 APP=APP+D(C)
660 IF LAP*QQ=AM THEN 910:REM RACE OVER
670 RETURN
680 REM **************************
690 REM CRASHED
700 CLS
710 PRINT "YOU CORNERED AT"INT(10*SPEED)
/10"KPH"
720 PRINT "AND THE MAXIMUM SPEED WAS JUS
T"C(C)
730 GOSUB 2330
740 PRINT "YOU SPIN OFF THE TRACK...
750 GOSUB 2330
760 IF CRASH=1 THEN 830
770 PRINT "YOU'VE LOST 20 SECONDS, BUT Y
OU'RE       ABLE TO REJOIN THE RACE"
780 NUM=NUM+10:SPEED=INT(2*C(C)/3)
790 PNT=PNT+50
```

```
800 GOSUB 2330
810 GOTO 570
820 REM ************************
830 PRINT "..........AND CRASH!!!!!"
840 PRINT "-----------------------------
-------"
850 PRINT "YOU ONLY COMPLETED"INT(10*DIS
T)/10"METERS,"
860 PRINT "OR"INT(DIST*100/RR)/100"LAPS
AND AT THAT"
870 PRINT "STAGE WERE IN POSITION"INT(FP)
880 PRINT "-----------------------------
-------"
890 GOTO 1050
900 REM ************************
910 REM RACE OVER
920 CLS
930 EFLAG=1
940 FOR X=1 TO 20
950 PRINT TAB(X);"WELL DONE, ";A$;"!!"
960 PRINT TAB(21-X);"WELL DONE, ";A$;"!!
"
970 NEXT X
980 PRINT "-----------------------------
-------"
990 PRINT "YOU MANAGED TO LAST OUT THE F
ULL                "LAP"LAP RACE..."
1000 PRINT "----------------------------
--------"
1010 GOSUB 2330
1020 PRINT "YOU FINISHED IN POSITION"INT
(FP)
1030 PRINT "AFTER STARTING IN 6TH POSITI
ON..."
1040 GOSUB 2330
1050 PRINT "YOUR AVERAGE SPEED WAS"INT(D
IST*180/NUM)/100"KPH"
1060 GOSUB 2330
1070 IF RP<1 THEN RP=1
1080 IF CP<1 THEN CP=1
1090 PRINT "YOU WERE"INT(ABS(RP))"TH FAS
TEST ON STRAIGHTS,"
1100 PRINT "AND"INT(ABS(CP))"TH FASTEST
ON CORNERS."
```

```
1110 PRINT:PRINT "PRESS 'S' FOR SAME RAC
E, 'N' FOR NEW      RACE, 'E' TO END"
1120 I$=INKEY$:IF I$<>"S" AND I$<>"N" AN
D I$<>"E" THEN 1120
1130 IF I$="E" THEN END
1140 GOSUB 2240
1150 RESTORE
1160 IF I$="S" THEN GOSUB 1490:LAP=L2AP:
GOTO 60
1170 IF I$="N" THEN CLS:GOSUB 1250:GOTO
60
1180 REM ************************
1190 REM NAME AND TRACK DATA
1200 INPUT "WHAT IS YOUR NAME, DRIVER";A
$
1210 PRINT
1220 FOR X=1 TO 3
1230 PRINT TAB(4*X);"OK, GOOD LUCK, ";A$

1240 GOSUB 2330:NEXT X
1250 PRINT "******************************
*********"
1260 PRINT "WHICH RACE DO YOU WANT TO TA
KE PART IN:"
1270 PRINT
1280 PRINT TAB(7);"BRITISH GRAND PRIX  2
650MT  :1"
1290 PRINT TAB(7);"GERMAN  GRAND PRIX  1
700MT  :2"
1300 PRINT TAB(7);"ITALIAN GRAND PRIX  2
200MT  :3"
1310 PRINT TAB(7);"MONACO  GRAND PRIX  3
100MT  :4"
1320 PRINT
1330 PRINT TAB(7);"ENTER A NUMBER (1 TO
4)"
1340 K$=INKEY$
1350 IF K$<"1" OR K$>"4" THEN 1340
1360 GP=VAL(K$)
1370 PRINT "******************************
*********"
1380 PRINT TAB(8);"OK, THE ";
1390 IF GP=1 THEN PRINT "BRITISH";
1400 IF GP=2 THEN PRINT "GERMAN";
```

```
1410 IF GP=3 THEN PRINT "ITALIAN";
1420 IF GP=4 THEN PRINT "MONACO";
1430 PRINT " RACE"
1440 PRINT "*****************************
*********"
1450 PRINT:PRINT "OVER HOW MANY LAPS?"
1460 INPUT LAP:IF LAP<1 THEN 1460
1470 LAP=INT(LAP+.5):L2AP=LAP
1480 REM ************************
1490 REM BRITISH DATA
1500 SPEED=140
1510 FOR X=1 TO 9
1520 READ D(X):REM DISTANCE BETWEEN
                        CORNERS
1530 NEXT X
1540 DATA 800,400,250,200,250,300,100,10
0,250
1550 FOR X=1 TO 9
1560 READ C(X):REM RECOMMENDED
               MAXIMUM CORNERING SPEED
1570 NEXT X
1580 DATA 150,90,175,200,200,90,90,150,1
50
1590 FOR X=1 TO 9
1600 READ A(X):REM AVERAGE NUMBER OF
       MOVES ALLOWED BETWEEN CORNERS
1610 NEXT X
1620 DATA 8,4,2,2,2,2,1,1,2
1630 APP=800:WW=10:QQ=24:RR=2650
1640 IF GP=1 THEN RETURN
1650 REM ************************
1660 REM GERMAN DATA
1670 SPEED=85
1680 FOR X=1 TO 7
1690 READ D(X)
1700 NEXT X
1710 DATA 600,200,100,150,250,200,200
1720 FOR X=1 TO 7
1730 READ C(X)
1740 NEXT X
1750 DATA 90,175,120,90,200,200,175
1760 FOR X=1 TO 7
1770 READ A(X)
1780 NEXT X
```

```
1790 DATA 6,2,1,2,2,2,2
1800 APP=600:WW=8:QQ=17:RR=1700
1810 IF GP=2 THEN RETURN
1820 REM ************************
1830 REM ITALIAN DATA
1840 SPEED=108
1850 FOR X=1 TO 7
1860 READ D[X]
1870 NEXT X
1880 DATA 800,300,100,150,300,350,200
1890 FOR X=1 TO 7
1900 READ C[X]
1910 NEXT X
1920 DATA 120,90,90,150,200,120,150
1930 FOR X=1 TO 7
1940 READ A[X]
1950 NEXT X
1960 DATA 8,3,2,1,3,3,2
1970 APP=800:WW=8:QQ=22:RR=2200
1980 IF GP=3 THEN RETURN
1990 REM ************************
2000 REM MONACO DATA
2010 SPEED=162.5
2020 FOR X=1 TO 14
2030 READ D[X]
2040 NEXT X
2050 DATA 400,100,100,300,400,300,150,20
0,200,200
2060 DATA 150,150,200,250
2070 FOR X=1 TO 14
2080 READ C[X]
2090 NEXT X
2100 DATA 175,150,175,200,120,200,175,90
,175,150
2110 DATA 150,175,120,150
2120 FOR X=1 TO 14
2130 READ A[X]
2140 NEXT X
2150 DATA 4,1,1,3,4,3,1,2,2,2
2160 DATA 1,2,2,2
2170 APP=400:WW=15:QQ=30:RR=3100
2180 RETURN
2190 REM ************************
2200 REM INITIALIZATION
```

```
2210 CLS
2220 RANDOMIZE VAL(RIGHT$(TIME$,2))
2230 DIM A(14),C(14),D(14)
2240 C=1:FP=6:PNT=0:NC=0:CP=0
2250 AM=0:RP=0:APP=0
2260 NUM=0:REM NUMBER OF MOVES
2270 ENG=100:BRAK=10:TRAV=0:DIST=0
2280 EFLAG=0
2290 X=0
2300 RETURN
2310 REM **************************
2320 REM DELAY
2330 FOR O=1 TO 1000:NEXT O
2340 RETURN
```

23

Up, Up and Away

Flight simulators are probably the most entertaining type of simulation programs. Most of us will never learn to fly, but would somehow like to enjoy the experience. A flight simulation program gives you a chance to find out a little of how it feels to fly without ever leaving the ground.

The main challenge facing a pilot is to keep on top of a number of different elements that are changing all at once. Ignore any one of them—like the angle at which the plane is flying, or the amount of fuel you have left—for too long, and your plane may well drop out of the sky. Although this program does *not* occur in real time, so you'll have a chance to think about the choices facing you before you act, you'll still find it a fairly challenging and frustrating simulation to master.

Even getting the plane off the ground is not particularly easy the first few times you run the program. Get it in the air, and you'll have to fight every second to keep it there.

And once you try to land . . .

Crashing during a landing attempt is a trifle inconvenient in a real plane. The moment you try and land 150 feet above the ground, you'll give thanks that you are only flying your computer.

Mastering the Controls

This simulation is the most complex in the book. It will take you

a little longer to learn than the others. This longer learning time will, however, be amply repaid as you're sure to find this program by far the most satisfying to run. FLIGHT SIMULATION contains another bonus that makes it very worthwhile to run. Your flight is automatically recorded, so that at any moment, while you're still in the air, you can tell the computer you want to see the whole of the current flight over from the beginning. It is very entertaining to watch your flight quickly unfolding again. The controls are handed back to you once you reach the point in the original flight where you asked the computer for a replay.

Think of the flight as having three parts, each of which requires a different approach to the controls. Part one is the takeoff, part two is the actual flight, and part three is the landing. You'll become an ace pilot fairly quickly if you concentrate on mastering each flight section in turn.

Whatever you do, don't give up, even after your twentieth attempt at landing has ended in disaster. The satisfaction you'll feel when you make your first perfect landing will more than compensate for all the frustration you've encountered in the learning process.

This is what you'll see when you first run the program:

```
   HORIZON            HEADING
:-----------------:----------:
:                 :    .N.   :
:                 :  ..@..   :
:                 : .. : .. :
: ***************  : W--X--E :
:                 : .. : .. :
:                 :  ..:..   :
:                 :    .S.   :
:-------------------------:
:RANGE 0 : TIME .1 : 226
:-------------------------:
:AIRSPEED : 0
: >
:ALTIMETER: 0       0 DEG.
: >
:FUEL     : 750
:-----------------> 
:-------------------------:
:ELEVATION: 0 : -------
:    > UNDERCARRIAGE DOWN < :
```

The line of asterisks in the top left corner shows the horizon line. This can tilt rather alarmingly from side to side as you turn the plane, or go to the bottom of the "windshield" as you climb, or to the top as you descend. It may take a short while in order for you to be

able to see this line as the horizon, but once you do, you'll find it conveys a much better impression of being in the air than you might imagine.

To the right of the horizon is your compass. The "@" shows the direction your plane is heading. You always start a flight facing due north, and must take off more or less in this direction. Your exact heading is shown further down the instrument cluster, on the same line as ALTIMETER, where you'll see "0 DEG.".

The line of readings underneath the horizon and compass shows the distance you've covered so far (the "range"), the elapsed time of the flight, and the direction in which you must be flying in order to land—assuming that you get this baby up in the air, and keep it there for more than a few seconds! You need to be within 12 degrees of this heading for a successful landing. The required heading changes from run to run, but does not change during a flight.

Shown underneath this is your airspeed, height above the ground (altimeter), and remaining fuel. The line of dashes ending in a "greater than" sign (---->) indicates the magnitude of each of these readings. That is, the line gets longer as you go faster or climb higher.

The elevation is the angle of your plane relative to the ground. When you enter a command, by touching a single key, a full-word version of the command appears in the position currently occupied by the series of dashes you can see after the elevation angle in the sample run above. Finally, you are told whether or not your undercarriage is down.

After a few inputs, the screen looks like this:

```
   HORIZON            HEADING
:-----------------:---------:
:                 :    .N.    :
:                 :   ..@..   :
:                 :  ..  :  .. :
: ***************  : W--X--E  :
:                 :  ..  :  .. :
:                 :   ..:..   :
:                 :    .S.    :
:---------------------------:
:RANGE .6  : TIME 1.3  : 226
:---------------------------:
:AIRSPEED  : 30
:->
:ALTIMETER: 0        0 DEG.
:>
:FUEL      : 692
:-------------------->
:---------------------------:
:ELEVATION: 20  : NOSE UP
:    > UNDERCARRIAGE DOWN <  :
```

Your fuel has gone down slightly, your airspeed is up to 30, and the nose of the plane is pointed 20 degrees into the air. You can see, from the line down near the bottom right-hand corner of the screen, that NOSE UP is the full equivalent of the most recent command you entered.

A little later, and we are in the air:

```
   HORIZON          HEADING
:----------------:---------:
:                :    .N.  :
:                :  ..@..  :
:                : .. : .. :
:                : W--X--E :
: **************** : .. : .. :
:                :  ..:..  :
:                :    .S.  :
:--------------------------:
:RANGE 1 : TIME 2 : 226
:--------------------------:
:AIRSPEED : 51
:-->
:ALTIMETER: 66      359 DEG.
:-->
:FUEL      : 660
:------------------->
:--------------------------:
:ELEVATION: 19 : THROTTLE ON
:    > UNDERCARRIAGE DOWN < :
```

You need an airspeed of between 45 and 60, and an elevation greater than 10, in order to get off the ground. Let's try turning:

```
   HORIZON          HEADING
:----------------:---------:
:                :    .N.  :
:                :  .@:..  :
:                : .. : .. :
: ****           : W--X--E :
:     ******     : .. : .. :
:           ***** :  ..:..  :
:                :    .S.  :
:--------------------------:
:RANGE 1.2 : TIME 2.3 : 226
:--------------------------:
:AIRSPEED : 40
:-->
:ALTIMETER: 143     344 DEG.
:---->
:FUEL      : 648
:------------------->
:--------------------------:
:ELEVATION: 15 : BANK LEFT
:     > UNDERCARRIAGE UP <   :
```

Note that the undercarriage is now up (which saves on fuel by decreasing drag on the plane) and the "horizon" is now sloping to down to the right, as the plane banks left. It is now heading at 344 degrees, and the @ symbol on the compass has moved to show the approximate direction in which the plane is flying.

```
   HORIZON          HEADING
:----------------:---------:
:                :    .N.    :
:              **:   ..@..   :
:           ***  :  .. : ..  :
:        ***     : W--X--E   :
:     ***        :  .. : ..  :
:  ***           :   ..:..   :
:                :    .S.    :
:--------------------------:
:RANGE 3.1 : TIME 3.7 : 226
:--------------------------:
:AIRSPEED : 59
:-->
:ALTIMETER: 353     3 DEG.
:---------->
:FUEL      : 590
:------------------->
:--------------------------:
:ELEVATION: 7 : BANK RIGHT
:     > UNDERCARRIAGE UP <    :
```

In this "snapshot," taken a few moments later, we have started to bank to the right. Our airspeed is up to 59, and we've continued to climb. However, the elevation has fallen, so the rate of climb will decrease. As we level off, the horizon gradually tilts back to the horizontal:

```
   HORIZON          HEADING
:----------------:---------:
:                :    .N.    :
:                :   ..:@.   :
:                :  .. : ..  :
:            *****: W--X--E   :
:     ******      :  .. : ..  :
:  ****           :   ..:..   :
:                :    .S.    :
:--------------------------:
:RANGE 3.6 : TIME 5.3 : 226
:--------------------------:
:AIRSPEED : 76
:--->
:ALTIMETER: 475     15 DEG.
:--------------->
:FUEL      : 525
:------------------->
:--------------------------:
:ELEVATION: 12 : THROTTLE ON
:     > UNDERCARRIAGE UP <    :
```

As I said, there are an awful lot of things to keep track of. While concentrating on the direction in which I'm flying, I've been neglecting the plane's elevation—which has been slowly falling:

```
   HORIZON            HEADING
:-----------------:----------:
:                 :    .N.   :
:                 :   ..:@.  :
:           *****   : ..  :.. :
:     ******        : W--X--E :
:  ****             : ..  :.. :
:                   :   ..:..  :
:                   :    .S.   :
:---------------------------:
:RANGE 7.4  : TIME 6.9  : 226
:---------------------------:
:AIRSPEED  : 152
:-------->
:ALTIMETER: 593      31 DEG.
:------------------->
:FUEL       : 457
:--------------------->
:---------------------------:
:ELEVATION: 0  : THROTTLE ON
:     > UNDERCARRIAGE UP <
```

Suddenly I notice the nose is pointing downward—note how the horizon is now right at the top. I frantically try to climb:

```
   HORIZON            HEADING
:-----------------:----------:
:     ******      :    .N.   :
:  ****           :   ..:..  :
:                 : ..  :@.  :
:                 : W--X--E  :
:                 : ..  :..  :
:                 :   ..:..  :
:                 :    .S.   :
:---------------------------:
:RANGE 11.3 : TIME 8.1  : 226
:---------------------------:
:AIRSPEED  : 245
:------------>
:ALTIMETER: 250      47 DEG.
:-------->
:FUEL       : 403
:--------------------->
:---------------------------:
:ELEVATION:-11  : CLIMB
:     > UNDERCARRIAGE UP <    :
```

However, too much is happening at once, with the inevitable result:

```
CRASH!
                                CRASH!
 CRASH!
                                CRASH!
  CRASH!
                                CRASH!
   CRASH!
                                CRASH!
    CRASH!
                                CRASH!
     CRASH!
                                CRASH!
      CRASH!
                                CRASH!
       CRASH!
                                CRASH!
        CRASH!
                                CRASH!
         CRASH!
                                CRASH!
          CRASH!
                                CRASH!
           CRASH!
                                CRASH!
            CRASH!
                                CRASH!
             CRASH!
                                CRASH!
              CRASH!
                                CRASH!
               CRASH!
                                CRASH!
```

The final picture is pretty bleak:

```
    HORIZON              HEADING
:-----------------:----------:
: C R**   A **  S* :     .N.    :
: *   A ** S* H*  :    ..:..   :
: R**   A ** S* H  : .. : .. :
: R**   A ** S* H  : W--X-@E :
:    A ** S* H* I  : .. : .. :
: **   A ** S* H* :    ..:..   :
: * *C R**   A ** :     .S.    :
:---------------------------:
:RANGE 14.1 : TIME 9.2 : 226
:---------------------------:
:AIRSPEED : 273
:------------->
:ALTIMETER: 0        84 DEG.
: >
:FUEL      : 366
:--------------------->
:---------------------------:
:ELEVATION:-16 : THROTTLE ON
:     > UNDERCARRIAGE UP <    :
```

The commands you have at your disposal are:

R This allows you to repeat the current flight from the beginning up to that point.
Space bar This is used for "throttle on," and increases your speed.
. Use this to throttle back.
Q To increase elevation.
A To decrease elevation.
Z To turn left.
M To turn right.
1 To change undercarriage from up to down, or from down to up.

Remember, to take off your speed must be between 45 and 60, and your elevation must be greater than 10. To land, your undercarriage must be down (!), your heading must be within 12 degrees of the setting shown beneath the compass, you must be at 15 or below on your altimeter, and your speed must not be greater than 20. You'll find that, as in real life, landing is even harder than taking off.

The complete FLIGHT SIMULATION listing is given in the next chapter.

24

The FLIGHT SIMULATION Listing

Now it's time to earn your wings with this listing:

```
10 REM FLIGHT SIMULATION
20 RPT=0
30 LD=INT(RND(1)*360)
40 DIM E$(1000):REM THIS HOLDS FLIGHT
                              RECORD
50 DIM A$(7),C$(7):REM THESE ARRAYS
 HOLD HORIZON AND COMPASS OUTPUT
60 REM ***************************
70 GOSUB 2320:REM INITIALIZE
80 IF CRASH=0 THEN GOSUB 820:REM HORIZON
                                /COMPASS

90 GOSUB 500:REM PRINTOUT
100 IF CRASH=1 THEN END
110 IF LAND=1 AND UFLAG=1 THEN PRINT "WE
LL DONE. A PERFECT LANDING!!":END
120 IF LAND=1 AND UFLAG=0 THEN PRINT "YO
UR WHEELS ARE UP":GOSUB 1780:GOTO 90
130 T=AIRSPEED:STALL=0
```

```
140 X$=INKEY$
150 IF X$="R" THEN RPT=1:GOTO 70
160 IF RPT=1 AND E$(CLOCK+1)="" THEN RPT
=0:GOTO 140
170 IF RPT=1 THEN X$=E$(CLOCK+1)
180 IF X$="" THEN 140
190 IF CLOCK<999 THEN E$(CLOCK+1)=X$
200 IF TAKEOV=1 THEN ELEVATE=INT(ELEVATE
+RND(1)*2-RND(1)*3)
210 IF AIRSPEED<3 THEN 290
220 IF X$="Q" THEN ELEVATE=ELEVATE+5:EFL
AG=5:IF ELEVATE>60 THEN STALL=1
230 IF X$="A" THEN ELEVATE=ELEVATE-5:EFL
AG=-5:IF ELEVATE<-70 THEN STALL=-1
240 IF STALL<>0 THEN GOSUB 1640
250 IF ALTIMETER<1 THEN 290:REM PREVENTS
      DRAMATIC TURNS ON THE GROUND
260 IF X$="Z" THEN WA=WA-.5:ANG=ANG-6:IF
 WA<-3 THEN WA=-3
270 IF X$="M" THEN WA=WA+.5:ANG=ANG+6:IF
 WA>3 THEN WA=3
280 ANG=INT(ANG+RND(1)*2-RND(1)*2)
290 IF X$=" " THEN AIRSPEED=AIRSPEED+8.5

300 IF X$="." THEN AIRSPEED=AIRSPEED-7
310 AIRSPEED=AIRSPEED-ELEVATE/5
320 IF UFLAG=1 THEN AIRSPEED=AIRSPEED-1.
5:FUEL=FUEL-.5
330 IF AIRSPEED<0 THEN AIRSPEED=0
340 IF AIRSPEED>400 THEN AIRSPEED=400
350 IF X$="1" AND UFLAG=0 THEN UFLAG=1:G
OTO 370
360 IF X$="1" AND UFLAG=1 THEN UFLAG=0
370 FUEL=FUEL-(ABS(T-AIRSPEED)/10)-3.75
380 IF FUEL<1 THEN GOSUB 1780
390 IF TAKEOV=1 THEN 420
400 IF ELEVATE>10 AND AIRSPEED>45 AND AI
RSPEED<60 AND UFLAG=1 THEN TAKEOV=1
410 IF TAKEOV=0 THEN ALTIMETER=0:GOTO 45
0
420 IF LAND=0 AND AIRSPEED<30 THEN ELEVA
TE=ELEVATE-5:ALTIMETER=9*ALTIMETER/10
430 ALTIMETER=ALTIMETER+INT(((ELEVATE+.1
)*AIRSPEED)+EFLAG*AIRSPEED/1000)/80
```

```
440 IF ALTIMETER<300 AND TAKEOV=1 THEN A
LTIMETER=ALTIMETER+AIRSPEED/30+ELEVATE
450 IF ALTIMETER<0 THEN GOSUB 1780:REM
     CRASH
460 REM CHANGE NEXT TWO LINES TO MAKE IT
       EASIER (OR EVEN HARDER) TO LAND
470 IF ALTIMETER>15 AND AIRSPEED>20 OR T
AKEOV=0 THEN 80
480 IF ABS(ANG-LD)<13 OR ABS(ANG+360-LD)
<13 THEN LAND=1:GOTO 80
490 REM ***************************
500 REM PRINTOUT
510 CLS
520 PRINT "   HORIZON";TAB(20);"HEADING"

530 EV=INT(ELEVATE/10)
540 IF EV>2 THEN EV=2
550 IF EV<-2 THEN EV=-2
560 IF EV<>0 AND TAKEOV=1 AND CRASH=0 TH
EN GOSUB 1920
570 PRINT ":----------------:---------:"

580 FOR J=1 TO 7
590 PRINT ": ";A$(J);" :";C$(J);" :"
600 A$(J)=""
610 NEXT J
620 PRINT ":-------------------------:"

630 DIST=DIST+ABS((COS(ELEVATE))*AIRSPEE
D)/360
640 CLOCK=CLOCK+1
650 PRINT ":RANGE"INT(DIST*10)/10": TIME
"INT(CLOCK)/10;":"LD
660 PRINT ":-------------------------:"
670 PRINT ":AIRSPEED :"INT(AIRSPEED)
680 PRINT ":";LEFT$(Q$,INT(AIRSPEED/20))
;">"
690 PRINT ":ALTIMETER:"INT(ALTIMETER);
700 IF ANG<0 THEN PRINT TAB(19);360+ANG"
DEG."
710 IF ANG>=0 THEN PRINT TAB(19);ANG"DEG
."
720 MR=INT(ALTIMETER/30):IF MR>20 THEN M
R=20
```

```
730 PRINT ":";LEFT$(Q$,MR);">"
740 PRINT ":FUEL      :"INT(FUEL)
750 PRINT ":";LEFT$(Q$,20-INT(FUEL/750))
;">"
760 PRINT ":-------------------------:"

770 PRINT ":ELEVATION:"ELEVATE": ";:GOSU
B 2210:PRINT U$
780 IF UFLAG=1 THEN PRINT ":";TAB(5);">
UNDERCARRIAGE DOWN < :"
790 IF UFLAG=0 THEN PRINT ":";TAB(6);">
UNDERCARRIAGE UP <    :"
800 RETURN
810 REM ************************
820 REM ASSIGN HORIZON/COMPASS
830 IF ABS(INT(WA+.5))=3 THEN GOSUB 980
840 IF ABS(INT(WA+.5))=2 THEN GOSUB 1070

850 IF ABS(INT(WA+.5))=1 THEN GOSUB 1160

860 IF INT(WA+.5)=0 THEN GOSUB 1250
870 REM NEXT TWO LINES USED TO
   GRADUALLY STRAIGHTEN UP WINGS
880 IF WA>0 THEN WA=WA-.2
890 IF WA<0 THEN WA=WA+.2
900 IF WA>.2 THEN 1350
910 FOR Z=1 TO 7
920 M$(8-Z)=A$(Z)
930 NEXT Z
940 FOR Z=1 TO 7
950 A$(Z)=M$(Z)
960 NEXT Z
970 GOTO 1350
980 REM WA=3 OR -3
990 A$(1)="               *  "
1000 A$(2)="             **   "
1010 A$(3)="          **      "
1020 A$(4)="       **         "
1030 A$(5)="     **           "
1040 A$(6)="  **              "
1050 A$(7)="**                "
1060 RETURN
1070 REM WA=2 OR -2
1080 A$(1)="                  "
```

```
1090 A$[2]="              **  "
1100 A$[3]="          ***     "
1110 A$[4]="       ***        "
1120 A$[5]="   ***            "
1130 A$[6]="***               "
1140 A$[7]="                  "
1150 RETURN
1160 REM WA=1 OR -1
1170 A$[1]="                  "
1180 A$[2]="                  "
1190 A$[3]="            *****"
1200 A$[4]="    ******        "
1210 A$[5]="****              "
1220 A$[6]="                  "
1230 A$[7]="                  "
1240 RETURN
1250 REM WA=0
1260 A$[1]="                  "
1270 A$[2]="                  "
1280 A$[3]="                  "
1290 A$[4]="***************"
1300 A$[5]="                  "
1310 A$[6]="                  "
1320 A$[7]="                  "
1330 RETURN
1340 REM ************************
1350 REM ASSIGN COMPASS STRINGS
1360 F2=ANG-F1
1370 IF F2<0 THEN FA=INT[[F2+375]/30]
1380 IF F2>=0 THEN FA=INT[[F2+15]/30]
1390 IF FA=12 THEN FA=0
1400 C$[1]="    .N.   "
1410 IF FA=11 THEN C$[2]="   .@:.. ":GOTO
 1450
1420 IF FA=0 THEN C$[2]="   ..@.. ":GOTO
1450
1430 IF FA=1 THEN C$[2]="   ..:@. ":GOTO
1450
1440 C$[2]="   ..:.. "
1450 IF FA=10 THEN C$[3]= " .@ : ..":GOT
O 1480
1460 IF FA=2 THEN C$[3]= " .. : @.":GOTO
 1480
1470 C$[3]=" .. : .."
```

```
1480 IF FA=9 THEN C$(4)=" W@-X--E":GOTO
1510
1490 IF FA=3 THEN C$(4)=" W--X-@E":GOTO
1510
1500 C$(4)=" W--X--E"
1510 IF FA=8 THEN C$(5)=" .@ : ..":GOTO
1540
1520 IF FA=4 THEN C$(5)=" .. : @.":GOTO
1540
1530 C$(5)=" .. : .."
1540 IF FA=7 THEN C$(6)="  .@:.. ":GOTO
1580
1550 IF FA=6 THEN C$(6)="  ..@.. ":GOTO
1580
1560 IF FA=5 THEN C$(6)="  ..:@. ":GOTO
1580
1570 C$(6)="  ..:.. "
1580 C$(7)="   .S.  "
1590 IF ANG>360 THEN ANG=ANG-360
1600 F2=ANG
1610 IF W>0 THEN W=W-.4
1620 IF W<0 THEN W=W+.4
1630 RETURN
1640 REM STALL/FALL
1650 IF STALL=-1 THEN 1710
1660 FOR J=1 TO 10
1670 PRINT TAB(J);"YOU HAVE STALLED!"
1680 NEXT J
1690 AIRSPEED=AIRSPEED/4
1700 RETURN
1710 FOR J=1 TO 10
1720 PRINT TAB(J);"UNCONTROLLED DIVE!!"
1730 PRINT TAB(21-J);"PULL UP!!"
1740 NEXT J
1750 ALTIMETER=4*ALTIMETER/5
1760 RETURN
1770 REM **************************
1780 REM CRASH
1790 CRASH=1
1800 ALTIMETER=0
1810 M$="** *C R**  A ** S* H* !!*":REM
     25 CHARACTERS LONG
1820 FOR J=1 TO 20
1830 PRINT TAB(J);"CRASH!"
```

```
1840 PRINT TAB(21-J);"CRASHI"
1850 NEXT J
1860 FOR J=1 TO 7
1870 G=INT(RND(1)*11)+1
1880 A$(J)=MID$(M$,G,14)
1890 NEXT J
1900 RETURN
1910 REM ***************************
1920 REM ADJUST HORIZON
1930 G$="                ":REM 14 SPACES
1940 ON EV+3 GOSUB 1960,2020,2070,2080,2
140
1950 RETURN
1960 REM EV=-2
1970 FOR J=1 TO 4
1980 A$(J)=A$(J+3)
1990 NEXT J
2000 A$(5)=G$:A$(6)=G$:A$(7)=G$
2010 RETURN
2020 REM EV=-1
2030 FOR J=1 TO 6
2040 A$(J)=A$(J+1)
2050 NEXT J
2060 A$(7)=G$
2070 RETURN:REM EV=0
2080 REM EV=1
2090 FOR J=6 TO 1 STEP -1
2100 A$(J+1)=A$(J)
2110 NEXT J
2120 A$(1)=G$
2130 RETURN
2140 REM EV=2
2150 FOR J=4 TO 1 STEP -1
2160 A$(J+3)=A$(J)
2170 NEXT J
2180 A$(1)=G$:A$(2)=G$:A$(3)=G$
2190 RETURN
2200 REM ***************************
2210 REM INPUT INTO COMMAND NAME
2220 U$="--------"
2230 IF X$=" " THEN U$="THROTTLE ON"
2240 IF X$="." THEN U$="THROTTLE OFF"
2250 IF X$="Q" AND ALTIMETER>0 THEN U$="
CLIMB"
```

```
2260 IF X$="Q" AND ALTIMETER=0 THEN U$="
NOSE UP"
2270 IF X$="A" THEN U$="NOSE DOWN"
2280 IF X$="Z" THEN U$="BANK LEFT"
2290 IF X$="M" THEN U$="BANK RIGHT"
2300 RETURN
2310 REM **************************
2320 REM INITIALIZATION
2330 CLS
2340 RANDOMIZE VAL(RIGHT$(TIME$,2))
2350 Q$="----------------------";REM
   21 CHARACTERS IN STRING
2360 UFLAG=1:REM UNDERCARRIAGE -
                1 - DOWN, 0 - UP
2370 EFLAG=0:REM CLIMB RATE
2380 ANG=0:TAKEOV=0:LAND=0
2390 AIRSPEED=0
2400 DIST=0:REM DISTANCE COVERED 'RANGE'

2410 ALTIMETER=0
2420 ELEVATE=0:REM ANGLE OF ELEVATION
2430 WA=0:REM 'WING ANGLE; USED IN
                      HORIZON PRINTOUT
2440 FUEL=750:CRASH=0:F2=0:F1=0:REM
 FOR DIRECTION CHANGE/COMPASS ROUTINE
2450 CLOCK=0:REM TIME
2460 X$=""
2470 RETURN
2480 REM ALL TAKE-OFFS ARE INTO THE
  NORTH (SPEED 45-60; ELEVATION >10)
2490 REM LANDING DIRECTION SHOWN
           BELOW COMPASS
2500 REM YOU MUST BE WITHIN 12 DEGREES
     OF THIS FOR A SUCCESSFUL LANDING
```

Appendix

Additional Listings for APPLE IIe and COMMODORE 64

SPECIAL INSTRUCTIONS FOR COMMODORE PROGRAMMERS: You'll note that many of the PRINT statements in the Commodore 64 listings begin with three-letter codes within brackets, like this: [RED].

Do not type these in directly. These indicate the use of the Commodore's number keys to control screen colors. (Note that each of the number keys also has a color marked on it.)

For example, when you see [RED] in the listing, you should press the "CTRL" and the "RED" key—which is also the "3" key—at the same time.

APPLE IIe

SPACE LANDING SIMULATION / Apple IIe version

```
 10  REM  SPACE LANDING SIMULATION I
 15  REM  APPLE IIE/IIC VERSION
 20  GOSUB 8020
 30  REM  **********************
 40  REM  STARTING VALUES
 50 FUEL = 200 +  RND (1) * 40
 60 VELOCITY =  RND (1) * 20 - 6
 70 HEIGHT = 500 -  RND (1) * 10
 80  HOME
 90  PRINT " FUEL"; TAB( 12)" VELOCITY"; T
AB( 24)" HEIGHT"
 100  REM  **********************
 110  REM  MAJOR CYCLE
 120  GOSUB 430
 130  IF FUEL <  = 0 THEN FUEL = 0:THRUST
= 0: GOTO 170
 140  GET A$
 150  IF A$ < "0" OR A$ > "9" THEN 140
 152 P =  INT (HEIGHT / 2 * 1.25)
 155  IF P < 1 THEN P = 1
 157  IF P > 255 THEN P = 255
 159 D = 150: GOSUB 8000
 160 THRUST =  VAL (A$) + .1
 170 FUEL = FUEL - THRUST
 180 FLAG = THRUST - 2
 190 THRUST = 0
 200 HEIGHT = HEIGHT + VELOCITY + FLAG / 4
 210 VELOCITY = VELOCITY + FLAG
 220  IF HEIGHT <  = 10 THEN 240
 230  IF HEIGHT > 10 THEN 120
 240  IF VELOCITY >  - 9 AND VELOCITY < 5
THEN 290
```

```
 250  GOSUB 410
 260  GOSUB 5000: PRINT "YOU HAVE CRASHED
INTO THE SURFACE..."
 270  IF HEIGHT > 0 THEN HEIGHT =  - HEIGH
T
 280  GOTO 320
 290  GOSUB 5500: PRINT "YOU HAVE LANDED S
AFELY!"
 300  FLASH : PRINT "YOUR SKILL RATING IS
"; INT ( - 1000 * FUEL / (VELOC
     ITY - HEIGHT))
 305  NORMAL
 310 HEIGHT = 0
 320  GOSUB 410
 330  PRINT "FINAL INSTRUMENT READINGS WER
E:"
 340  PRINT " FUEL"; TAB( 12)" VELOCITY";
TAB( 24)" HEIGHT"
 350  GOSUB 430
 360  GOSUB 410
 370  IF HEIGHT >  = 0 THEN  END
 380  IF HEIGHT < 0 THEN  PRINT "NEW CRATE
R ON MOON "; INT ( ABS (100 * (
     HEIGHT + .2) / 3)) / 100;" METERS DEE
P!"
 390  PRINT "YOUR SKILL RATING IS "; INT (
100 * FUEL / (VELOCITY - HEIGHT
     ))
 400  END
 410  PRINT "-----------------------------
---------"
 415  GOSUB 5200
 420  RETURN
 430  PRINT  INT (100 * FUEL) / 100;
 440  PRINT  TAB( 12) -  INT (100 * VELOCI
TY) / 100;
 450  IF HEIGHT >  = 0 THEN  PRINT  TAB( 2
4) INT (100 * HEIGHT) / 100
 460  IF HEIGHT < 0 THEN  PRINT
 470  RETURN
 5000 P = 250:D = 255
 5010  GOSUB 8000
 5020  RETURN
```

```
 5200 P = 150:D = 100
 5210  GOSUB 8000
 5220  RETURN
 5500 P = 5:D = 10
 5510  GOSUB 8000
 5520 P = P + 15
 5530  IF P < 250 THEN  GOTO 5510
 5540  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

MONTE CARLO DEMONSTRATION / Apple IIe version

```
 10  REM  MONTE CARLO DEMONSTRATION
 15  REM  APPLE IIE/IIC VERSION
 20  GOSUB 370: REM  INITIALISE
 30  REM  ********************
 40  REM  MAJOR CYCLE
 50  GOSUB 100: REM  PRINT
 60  IF P = EP AND Q = EQ THEN  PRINT : PR
INT "DEMONSTRATION OVER": END
 70  GOSUB 230: REM  GENERATE MOVE
 80  GOTO 50
 90  REM  ********************
 100  REM  PRINTOUT
 110 A$(P,Q) = "O"
 120 M = M + 1
 130  VTAB 5
 140  PRINT "MOVE: ";M
 150  FOR X = 1 TO 10
 160  FOR Y = 1 TO 10
 170  PRINT A$(X,Y);" ";
 180  NEXT Y
 190  PRINT
 200  NEXT X
 210  RETURN
 220  REM  *************
 230  REM  GENERATE MOVE
 240 A$(P,Q) = "."
 250 G = 0
 260 T =  INT ( RND (1) * 4) + 1
 270  ON T GOSUB 310,320,330,340
 280  IF G = 0 THEN 260
 290  IF G = 1 AND  RND (1) > .5 THEN 260
 300  RETURN
 310  IF P > 1 THEN P = P - 1:G = G + 1: R
ETURN
 320  IF P < 10 THEN P = P + 1:G = G + 1:
RETURN
 330  IF Q > 1 THEN Q = Q - 1:G = G + 1: R
ETURN
 340  IF Q < 10 THEN Q = Q + 1:G = G + 1:
RETURN
 350  RETURN
```

```
 360  REM  **********
 370  REM  INITIALISE
 380  HOME
 400  DIM A$(10,10)
 410  FOR X = 1 TO 10
 420  FOR Y = 1 TO 10
 430 A$(X,Y) = "."
 440  NEXT Y
 450  NEXT X
 460  PRINT : PRINT
 470  PRINT "ENTER FIRST START CO-ORDINATE
(LESS     THAN 10)"
 480  INPUT P
 490  IF P < 1 OR P > 10 THEN 480
 500  PRINT "ENTER SECOND START CO-ORDINAT
E (LESS    THAN 10)"
 510  INPUT Q
 520  IF Q < 1 OR Q > 10 THEN 510
 530  PRINT : PRINT
 540  PRINT "ENTER FIRST END CO-ORDINATE (
LESS       THAN 10)"
 550  INPUT EP
 560  IF EP = P OR EP < 1 OR EP > 10 THEN
550
 570  PRINT "ENTER SECOND END CO-ORDINATE
(LESS      THAN 10)"
 580  INPUT EQ
 590  IF EQ = Q OR EQ < 1 OR EQ > 10 THEN
580
 600 A$(P,Q) = "O"
 610 A$(EP,EQ) = "X"
 615  HOME
 620  RETURN
```

CELL CLASH SIMULATION / Apple IIe version

```
 10  REM  SIMULTANEOUS EQUATIONS
 12  REM  APPLE IIE/IIC VERSION
 20  HOME
 30  GOSUB 8020
 40 HS = 0
 45 SD =  RND (1)
 50 FD =  RND (0)
 60  PRINT : PRINT "DECAY FACTOR IS ";FD
 70  GOSUB 550
 80  HOME
 90  PRINT : PRINT
 100  PRINT "ENTER NUMBER OF CELL X TO
           START (LESS THAN 40)
     "
 110  INPUT CP: IF CP < 1 OR CP > 39 THEN
110
 120  PRINT : PRINT
 130  PRINT "WE HAVE ";CP;" X CELLS"
 140  PRINT : PRINT
 150  PRINT "ENTER NUMBER OF CELL Y TO
           START (LESS THAN 40)
     "
 160  INPUT EP: IF EP < 1 OR EP > 39 THEN
160
 170  HOME : VTAB 5: PRINT "PLEASE STAND B
Y..."
 180  GOSUB 550: HOME
 190 DA = 1
 200  IF CP > EP / FD THEN CP = EP / FD
 210  PRINT "---------------"
 220  PRINT "TIME ELAPSED: ";DA
 230  PRINT  INT (CP);" CELL X"
 240  PRINT  INT (EP);" CELL Y"
 250  REM  **********************
 260  REM  MAJOR CYCLE
 270  GOSUB 550
 280 DA = DA + 1
 290  PRINT "---------------"
 300  PRINT "TIME ELAPSED: ";DA
 305 P = 100:D = 50: GOSUB 8000
 310  IF CP > EP / FD THEN CP = EP / FD
```

```
 320  REM  EQUATIONS FOLLOW; MODIFY PARTS
OF THEM TO SEE WHAT HAPPENS
 330 CP = CP + ((8 * CP - CP * EP / 3) * F
D)
 340 EP = EP + ((4 * EP - EP * CP) * .01)
 350  PRINT  INT (CP);" CELL X"
 360  PRINT  INT (EP);" CELL Y"
 370  IF EP < 2 OR CP < 2 THEN 410
 380  GOSUB 550
 390  GOTO 280
 400  REM  **********************
 410  IF DA > HS THEN HS = DA
 420  PRINT : PRINT
 430  PRINT "YOUR CELL CLASH SIMULATION SU
RVIVED"
 440  PRINT "FOR ";DA;" TIME PERIODS"
 450  PRINT "----------------------------
---------"
 460  PRINT "THE BEST SURVIVAL TIME SO FAR
 IS ";HS
 470  GOSUB 550
 480  PRINT "----------------------------
---------"
 490  PRINT "DO YOU WANT A NEW RUN (Y OR N
)?"
 500  GET A$
 510  IF A$ <  > "Y" AND A$ <  > "N" THEN
500
 520  IF A$ = "Y" THEN  HOME : GOTO 60
 530  PRINT "OK": PRINT : PRINT :P = 200:D
 = 250: GOSUB 8000: END
 540  REM  **********************
 550  FOR J = 1 TO 2000: NEXT J
 560  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
       POKE 779,208: POKE 780,246
```

```
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

LIFE / Apple IIe version

```
 10  REM  CONWAY'S LIFE SIMULATION
 15  REM  APPLE IIE/IIC VERSION
 20  REM  DEFINED INITIAL COLONY
 30  GOSUB 460: REM  INITIALISE
 40  REM  ********************
 50  REM  MAJOR CYCLE
 60 GE = GE + 1
 70  GOSUB 290: REM  PRINTOUT
 80  GOSUB 110 REM  EVOLVE
 90  GOTO 60
 100  REM  ********************
 110  REM  EVOLVE
 120  FOR X = 2 TO 12
 130  FOR Y = 2 TO 12
 140 C = 0
 150  IF A$(X - 1,Y - 1) = "X" THEN C = C
+ 1
 160  IF A$(X - 1,Y) = "X" THEN C = C + 1
 170  IF A$(X - 1,Y + 1) = "X" THEN C = C
+ 1
 180  IF A$(X,Y - 1) = "X" THEN C = C + 1
 190  IF A$(X,Y + 1) = "X" THEN C = C + 1
 200  IF A$(X + 1,Y - 1) = "X" THEN C = C
+ 1
 210  IF A$(X + 1,Y) = "X" THEN C = C + 1
 220  IF A$(X + 1,Y + 1) = "X" THEN C = C
+ 1
 230  IF A$(X,Y) = "X" AND C <  > 2 AND C
<  > 3 THEN B$(X,Y) = " "
 240  IF A$(X,Y) = " " AND C = 3 THEN B$(X
,Y) = "X"
 250  NEXT Y
 260  NEXT X
 270  RETURN
 280  REM  ********************
 290  REM  PRINTOUT
 300  HOME
 305 PZ = 200:DZ = 150: GOSUB 8000
 310  PRINT
 320  PRINT  TAB( 4)"GENERATION ";GE
 330  PRINT
```

```
 340  FOR X = 2 TO 12
 350  FOR Y = 2 TO 12
 360 A$(X,Y) = B$(X,Y)
 370  PRINT A$(X,Y);
 380  NEXT Y
 390  FOR Y = 12 TO 2 STEP  - 1
 400  PRINT A$(X,Y);
 410  NEXT Y
 420  PRINT
 430  NEXT X
 440  RETURN
 450  REM  ********************
 460  REM  INITIALISATION
 470  HOME
 480  GOSUB 8020
 500  DIM A$(13,13),B$(13,13)
 510  VTAB 4: PRINT  TAB( 11)"PLEASE STAND
BY..."
 520  FOR X = 1 TO 13
 530  PRINT 14 - X;" ";
 540  FOR Y = 1 TO 13
 550  REM  FILL ARRAY WITH BLANKS
 560 A$(X,Y) = " "
 570 B$(X,Y) = " "
 580  NEXT Y
 590  NEXT X
 600  READ D: IF D = 99 THEN 630
 610  READ E:A$(D,E) = "X":B$(D,E) = "X"
 620  GOTO 600
 630 GE = 0
 640  RETURN
 650  DATA  5,5,5,9,6,6,6,8
 660  DATA  7,7
 670  DATA  8,6,8,8,9,5,9,9
 700  DATA  99
 8000  REM   SOUND ROUTINE
 8010  POKE 10,PZ: POKE 11,DZ: CALL 768: R
ETURN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
```

```
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

ROBOT LOGO / Apple IIe version

```
 100  REM  ROBOT LOGO
 105  REM  APPLE IIE/IIC VERSION
 110  GOSUB 1730: REM  INITIALISE
 120  GOTO 490
 130  REM  ********************
 140  REM
 150  REM
 160  REM
 170  REM
 180  REM
 190  REM
 200  REM
 210  REM
 220  REM
 230  REM
 240  REM
 250  REM
 260  REM
 270  REM
 280  REM
 290  REM
 300  REM
 310  REM
 320  DATA  "*"
 330  REM  ************************
 340  REM  INT UX,AX
 350 UX =  INT (UX + .5):AX =  INT (AX + .
5)
 360  RETURN
 370  REM  ************************
 380  REM         PRINT OUT
 390  HOME
 400  PRINT "STEP ";PSN;" > ";A$(PSN): PRI
NT
 410  FOR J = 1 TO DE
 420  FOR K = 1 TO BR
 430  PRINT Z$(J,K);
 440  NEXT K
 450  PRINT
 460  NEXT J
 470  RETURN
```

```
 480  REM  **********************
 490  REM  READ PROGRAM
 500 COUNT = COUNT + 1
 510  READ A$(COUNT)
 520  IF A$(COUNT) = "*" THEN 550
 530  IF COUNT < 20 THEN 500
 540  REM  **********************
 550  REM  EXECUTE PROGRAM
 560 PSN = 0: REM  PRIGRAM STEP NUMBER
 570 PSN = PSN + 1
 580  IF PSN = 21 THEN 580: REM  END
 590 FLAG = 0
 600 M$ = A$(PSN)
 610  IF M$ = "*" THEN 610: REM  END
 620 N$ =  LEFT$ (M$,2)
 630  IF N$ = "ST" THEN 560: REM  START AG
AIN
 640  IF N$ = "PR" THEN  GOSUB 380: REM  P
RINTOUT
 650  IF N$ = "FO" THEN FLAG = 1
 660  IF N$ = "BA" THEN FLAG = 2
 670  IF N$ = "TU" THEN FLAG = 3
 680  IF N$ = "HO" THEN FLAG = 4
 690  IF N$ = "CL" THEN FLAG = 5
 700  IF N$ = "GO" THEN FLAG = 6
 710  IF N$ = "RA" THEN FLAG = 7
 720  IF N$ = "RE" THEN FLAG = 8
 730  IF N$ = "EN" THEN FLAG = 9
 740  IF N$ = "FA" THEN FLAG = 10
 750  ON FLAG GOSUB 780,940,1000,1160,1220
,1260,1400,1460,1530,1580
 760  GOTO 570
 770  REM  ********************
 780  REM        FORWARD
 790 M$ =  MID$ (M$,4)
 800  IF  ASC (M$) = 87 THEN M$ =  MID$ (M
$,6)
 810 F$ = "F"
 820 NUM =  VAL (M$)
 830  FOR E = 1 TO NUM
 840  IF UX < 1 OR UX > DE THEN 880
 850  IF AX < 1 OR AX > BR THEN 880
 860 Z$(UX,AX) = T$
```

```
 870  REM  DELETE THE '*2' AT THE END OF T
HE NEXT TWO LINES IF BETTER ON
     YOUR SYSTEM
 880  IF F$ = "F" THEN UX = UX + UP:AX = A
X + AC * 2
 890  IF F$ = "B" THEN UX = UX - UP:AX = A
X - AC * 2
 900  GOSUB 340
 910  NEXT E
 920  RETURN
 930  REM  ********************
 940  REM          BACK
 950 M$ =  MID$ (M$,4)
 960  IF  ASC (M$) = 75 THEN M$ =  MID$ (M
$,3)
 970 F$ = "B"
 980  GOTO 820
 990  REM  ********************
 1000  REM          TURN
 1010 M$ =  MID$ (M$,4)
 1020  IF  ASC (M$) = 78 THEN M$ =  MID$ (
M$,3)
 1030 NUM =  VAL (M$)
 1040 Y =  INT ((NUM + 17.5) / 45)
 1050  IF Y = 0 OR Y = 8 THEN  RETURN
 1060  FOR J = 1 TO Y
 1070  IF UP =  - 1 AND AC = 0 THEN AC = 1
: GOTO 1130
 1080  IF UP = 0 AND AC = 1 THEN UP = 1: G
OTO 1130
 1090  IF UP = 1 AND AC = 0 THEN AC =  - 1
: GOTO 1130
 1100  IF UP = 0 AND AC =  - 1 THEN UP =
- 1: GOTO 1130
 1120  IF UP =  - 1 AND AC = 1 OR UP = 1 A
ND AC =  - 1 THEN UP = 0
 1130  NEXT J
 1140  RETURN
 1150  REM  ********************
 1160  REM          HOME
 1170 AX =  INT ((BR + .5) / 2)
 1180 UX =  INT ((DE + .5) / 2)
 1190 UP =  - 1:AC = 0: REM  FACES UP
```

```
 1200  RETURN
 1210  REM  ******************
 1220  REM         CLEAN
 1230  GOSUB 1870
 1240  RETURN
 1250  REM  ******************
 1260  REM         GO X,Y
 1270 P = 0
 1280 P = P + 1
 1290  IF  MID$ (M$,P,1) = "," THEN 1320
 1300  IF P <  LEN (M$) THEN 1280
 1310  RETURN : REM  ERROR
 1320 UX =  VAL ( MID$ (M$,4,P - 1))
 1330 AX =  VAL ( RIGHT$ (M$, LEN (M$) - P
))
 1340  GOSUB 340
 1350  IF UX < 1 OR UX > DE THEN 1380
 1360  IF AC < 1 OR AC > BR THEN 1380
 1370 Z$(UX,AX) = R$
 1380  RETURN
 1390  REM  ******************
 1400  REM         RANDOM
 1410 AX =  INT ( RND (1) * BR)
 1420 UX =  INT ( RND (1) * DE)
 1430 Z$(UX,AX) = R$
 1440  RETURN
 1450  REM  ******************
 1460  REM         REPEAT
 1470 M$ =  MID$ (M$,4)
 1480  IF  ASC (M$) = 69 THEN M$ =  MID$ (
M$,5)
 1490 RECOUNT =  VAL (M$)
 1500 MARKER = PSN
 1510  RETURN
 1520  REM  ******************
 1530  REM       END REPEAT
 1540 RECOUNT = RECOUNT - 1
 1550  IF RECOUNT > 0 THEN PSN = MARKER
 1560  RETURN
 1570  REM  ******************
 1580  REM          FACE
 1590 M$ =  MID$ (M$,4)
 1600  ASC (M$) = 69 THEN M$ = MID$ (M$,3)
```

```
 1610 NUM =  VAL (M$)
 1620 Y =  INT ((NUM + 17.5) / 45) * 45
 1630  IF Y = 0 OR Y = 360 THEN UP =  - 1:
AC = 0
 1640  IF Y = 45 THEN UP =  - 1:AC = 1
 1650  IF Y = 90 THEN UP = 0:AC = 1
 1660  IF Y = 135 THEN UP = 1:AC = 1
 1670  IF Y = 180 THEN UP = 1:AC = 0
 1680  IF Y = 225 THEN UP = 1:AC =  - 1
 1690  IF Y = 270 THEN UP = 0:AC =  - 1
 1700  IF Y = 315 THEN UP =  - 1:AC =  - 1
 1710  RETURN
 1720  REM  ********************
 1730  REM  INITIALISE
 1740  HOME
 1770 BR = 40
 1780 DE = 24
 1790 BR = BR - 1
 1800 DE = DE - 3
 1810 UP =  - 1:AC = 0: REM  STARTS FACING
 UP
 1820  DIM A$(20): REM  FOR ROBOT PROGRAM
 1830  DIM Z$(DE,BR): REM            DISPL
AY
 1840 T$ = "X": REM  PUT SYMBOL FOR ROBOT'
S TRAIL HERE, CHANGE IF YOU WIS
     H
 1850 AX = 0:UX = 0
 1860  REM  FILL ARRAY WITH SPACES
 1870  FOR J = 1 TO DE
 1880  FOR K = 1 TO BR
 1890 Z$(J,K) = " "
 1900  NEXT K
 1910  NEXT J
 1920  RETURN
```

POINT-DUTY ROBOT / Apple IIe version

```
100  REM  POINT-DUTY ROBOT
105  REM  APPLE IIE/IIC VERSION
106  REM  EXAMPLES IN TEXT MAY HAVE TO BE
MODIFIED TO PRODUCE REQUIRED R
    ESULTS
110  GOSUB 1730: REM  INITIALISE
120  GOTO 490
130  REM  **********************
140  REM
150  REM
160  REM
170  REM
180  REM
190  REM
200  REM
210  REM
220  REM
230  REM
240  REM
250  REM
260  REM
270  REM
280  REM
290  REM
300  REM
310  REM
320  DATA  "*"
330  REM  ************************
340  REM  INT UX,AX
350 UX =  INT (UX + .5):AX =  INT (AX + .
5)
360  RETURN
480  REM  ************************
490  REM  READ PROGRAM
500 COUNT = COUNT + 1
510  READ A$(COUNT)
520  IF A$(COUNT) = "*" THEN 550
530  IF COUNT < 20 THEN 500
540  REM  ************************
550  REM  EXECUTE PROGRAM
560 PSN = 0: REM  PRIGRAM STEP NUMBER
```

```
 570 PSN = PSN + 1
 580  IF PSN = 21 THEN 580: REM  END
 590 FLAG = 0
 600 M$ = A$(PSN)
 610  IF M$ = "*" THEN 610: REM  END
 620 N$ =  LEFT$ (M$,2)
 630  IF N$ = "ST" THEN 560: REM  START AG
AIN
 650  IF N$ = "FO" THEN FLAG = 1
 660  IF N$ = "BA" THEN FLAG = 2
 670  IF N$ = "TU" THEN FLAG = 3
 680  IF N$ = "HO" THEN FLAG = 4
 700  IF N$ = "GO" THEN FLAG = 5
 710  IF N$ = "RA" THEN FLAG = 6
 720  IF N$ = "RE" THEN FLAG = 7
 730  IF N$ = "EN" THEN FLAG = 8
 740  IF N$ = "FA" THEN FLAG = 9
 750  ON FLAG GOSUB 780,940,1000,1160,1260
,1400,1460,1530,1580
 760  GOTO 570
 770  REM  ********************
 780  REM        FORWARD
 790 M$ =  MID$ (M$,4)
 800  IF  ASC (M$) = 87 THEN M$ =  MID$ (M
$,6)
 810 F$ = "F"
 820 NUM =  VAL (M$)
 830  FOR E = 1 TO NUM
 840  IF UX < 1 OR UX > DE THEN 880
 850  IF AX < 1 OR AX > BR THEN 880
 860  HPLOT AX,UX
 880  IF F$ = "F" THEN UX = UX + UP:AX = A
X + AC
 890  IF F$ = "B" THEN UX = UX - UP:AX = A
X - AC
 900  GOSUB 340
 910  NEXT E
 915  HCOLOR= FC
 920  RETURN
 930  REM  ********************
 940  REM          BACK
 945  HCOLOR= BC
 950 M$ =  MID$ (M$,4)
```

```
 960  IF  ASC (M$) = 75 THEN M$ =  MID$ (M
$,3)
 970 F$ = "B"
 980  GOTO 820
 990  REM  ********************
 1000  REM         TURN
 1010 M$ =  MID$ (M$,4)
 1020  IF  ASC (M$) = 78 THEN M$ =  MID$ (
M$,3)
 1030 NUM =  VAL (M$)
 1040 Y =  INT ((NUM + 11.25) / 22.5)
 1050  IF Y = 0 OR Y = 16 THEN  RETURN
 1060  FOR J = 1 TO Y
 1065  IF UP =  - 2 AND AC = 0 OR UP = 2 A
ND AC = 2 THEN AC = 1: GOTO 113
     0
 1070  IF UP =  - 2 AND AC = 1 THEN AC = 2
: GOTO 1130
 1075  IF UP =  - 2 AND AC = 2 OR UP = 0 A
ND AC =  - 2 THEN UP =  - 1: GOTO
     1130
 1080  IF UP =  - 1 AND AC = 2 OR UP = 1 A
ND AC =  - 2 THEN UP = 0: GOTO
     1130
 1085  IF UP = 0 AND AC = 2 OR UP = 2 AND
AC =  - 2 THEN UP = 1: GOTO 113
     0
 1090  IF UP = 1 AND AC = 2 THEN UP = 2: G
OTO 1130
 1095  IF UP = 2 AND AC = 1 THEN AC = 0: G
OTO 1130
 1100  IF UP = 2 AND AC = 0 THEN AC =  - 1
: GOTO 1130
 1105  IF UP = 2 AND AC =  - 1 THEN AC =
- 2: GOTO 1130
 1110  IF UP =  - 1 AND AC =  - 2 THEN UP
=  - 2: GOTO 1130
 1115  IF UP =  - 2 AND AC =  - 2 THEN AC
=  - 1: GOTO 1130
 1120  IF UP =  - 2 AND AC =  - 1 THEN AC
= 0
 1130  NEXT J
 1140  RETURN
```

```
 1150  REM  ******************
 1160  REM         HOME
 1170 AX =  INT ((BR + .5) / 2)
 1180 UX =  INT ((DE + .5) / 2)
 1190 UP =  - 2:AC = 0: REM   FACES UP
 1200  RETURN
 1210  REM  ******************
 1220  REM         CLEAN
 1230  GOSUB 1870
 1240  RETURN
 1250  REM  ******************
 1260  REM         GO X,Y
 1270 P = 0
 1280 P = P + 1
 1290  IF  MID$ (M$,P,1) = "," THEN 1320
 1300  IF P <  LEN (M$) THEN 1280
 1310  RETURN : REM  ERROR
 1320 UX =  VAL ( MID$ (M$,4,P - 1))
 1330 AX =  VAL ( RIGHT$ (M$, LEN (M$) - P
))
 1340  GOSUB 340
 1350  IF UX < 1 OR UX > DE THEN 1380
 1360  IF AC < 1 OR AC > BR THEN 1380
 1370  HPLOT AX,UX
 1380  RETURN
 1390  REM  ******************
 1400  REM         RANDOM
 1410 AX =  INT ( RND (1) * BR)
 1420 UX =  INT ( RND (1) * DE)
 1430  HPLOT AX,UX
 1440  RETURN
 1450  REM  ******************
 1460  REM         REPEAT
 1470 M$ =  MID$ (M$,4)
 1480  IF  ASC (M$) = 69 THEN M$ =  MID$ (
M$,5)
 1490 RECOUNT =  VAL (M$)
 1500 MARKER = PSN
 1510  RETURN
 1520  REM  ******************
 1530  REM       END REPEAT
 1540 RECOUNT = RECOUNT - 1
 1550  IF RECOUNT > 0 THEN PSN = MARKER
```

```
 1560  RETURN
 1570  REM  ********************
 1580  REM          FACE
 1590 M$ =  MID$ (M$,4)
 1600  IF  ASC (M$) = 69 THEN M$ =  MID$ (
M$,3)
 1610 NUM =  VAL (M$)
 1620 Y =  INT ((NUM + 11.25) / 22.5) * 22
.5
 1630  IF Y = 0 OR Y = 360 THEN UP =  - 2:
AC = 0
 1635  IF Y = 22.5 THEN UP =  - 2:AC = 1
 1640  IF Y = 45 THEN UP =  - 2:AC = 2
 1645  IF Y = 67.5 THEN UP =  - 1:AC = 2
 1650  IF Y = 90 THEN UP = 0:AC = 2
 1655  IF Y = 112 THEN UP = 1:AC = 2
 1660  IF Y = 135 THEN UP = 2:AC = 2
 1665  IF Y = 157.5 THEN UP = 2:AC = 1
 1670  IF Y = 180 THEN UP = 2:AC = 0
 1675  IF Y = 202.5 THEN UP = 2:AC =  - 1
 1680  IF Y = 225 THEN UP = 2:AC =  - 2
 1685  IF Y = 247.5 THEN UP = 1:AC =  - 2
 1690  IF Y = 270 THEN UP = 0:AC =  - 2
 1695  IF Y = 292.5 THEN UP =  - 1:AC =  -
2
 1700  IF Y = 315 THEN UP =  - 2:AC =  - 2
 1705  IF Y = 337.5 THEN UP =  - 2:AC =  -
1
 1710  RETURN
 1720  REM  ********************
 1730  REM  INITIALISE
 1735  HGR :BC = 0:FC = 3
 1740  HOME
 1750  COLOR= 3
 1770 BR = 279
 1780 DE = 191
 1790 BR = BR - 1
 1800 DE = DE - 3
 1810 UP =  - 2:AC = 0: REM   STARTS FACIN
G UP
 1820  DIM A$(20): REM  FOR ROBOT PROGRAM
 1830  FOR XP = 1 TO 20: PRINT : NEXT XP
 1920  RETURN
```

CONNECT FOUR / Apple IIe version

```
 10  REM  CONNECT FOUR
 12  REM  APPLE IIE/IIC VERSION
 15  REM  A. W. PEARSON
 20  GOSUB 8020
 30  HOME
 40  VTAB 8: HTAB 14: PRINT "CONNECT FOUR"
 50  GOSUB 5000
 70  VTAB 12
 80  PRINT "ENTER YOUR MOVE AS A NUMBER BE
TWEEN"
 90  PRINT "1 AND 8, ENTER 0 FOR A NEW GAM
E..."
 100  FOR F = 1 TO 1000: NEXT F
 110  DIM A$(10,10),B(10,2)
 120 FLAG = 0
 140 C$ = "*":H$ = "@": REM  *=COMPUTER, @
=PLAYER
 150  FOR F = 1 TO 8
 160 B(F,1) = 6
 170  NEXT F
 180  FOR F = 1 TO 6
 190  FOR G = 1 TO 8
 200 A$(F,G) = "."
 210  NEXT G
 220  NEXT F
 230  REM  ************************
 240  REM  ACCEPT HUMAN MOVE
 250  GOSUB 430
 260  PRINT : PRINT "YOUR MOVE..."
 270  INPUT A
 280  IF A = 0 THEN  RUN
 290  IF A < 1 OR A > 8 THEN 270
 300 L = 0
 310  IF A$(L + 1,A) <  > "." OR L = 6 THE
N 340
 320 L = L + 1
 330  GOTO 310
 340  IF L = 0 THEN 270
 350 A$(L,A) = H$
 360 B(A,1) = B(A,1) - 1
 370  GOSUB 430
```

```
380  GOSUB 560
390  GOSUB 430
400  GOTO 260
410  REM  ************************
420  REM  PRINT BOARD
430  HOME
435 P = 200:D = 50: GOSUB 8000
440  FOR F = 1 TO 6
450  FOR G = 1 TO 8
460  PRINT A$(F,G);
470  NEXT G
480  PRINT
490  NEXT F
500  PRINT "12345678"
510  PRINT
520  IF FLAG = 1 THEN  PRINT "I
  HAVE WON!!": GOSUB 5200: END

530  RETURN
540  REM  ************************
550  REM  COMPUTER MOVES
560  PRINT "MY MOVE..."
570 MV = 0
580  FOR F = 1 TO 8
590 B(F,2) = 0
600  NEXT F
610  FOR F = 1 TO 8
620  FOR X =  - 1 TO 1
630  FOR Y =  - 1 TO 1
640  IF B(F,1) = 0 THEN 680
650  IF A$(B(F,1) + X,F + Y) = "" OR A$(B
(F,1) + X,F + Y) = "." THEN 680
660  IF A$(B(F,1) + X,F + Y) = H$ THEN  G
OSUB 810
670  IF A$(B(F,1) + X,F + Y) = C$ THEN  G
OSUB 910
680  NEXT Y
690  NEXT X
700  NEXT F
710 PC = 0
720  FOR F = 1 TO 8
730  IF B(F,2) > PC THEN PC = B(F,2):N =
F
```

```
 740  NEXT F
 750 A$(B(N,1),N) = C$
 760 B(N,1) = B(N,1) - 1
 770 N = 0
 780 PC = 0
 790  RETURN
 800  REM  ************************
 810 MV = 2
 820 M1 = MV
 830  IF A$(B(F,1) + (X * 2),F + (Y * 2))
= H$ THEN MV = MV + 10
 840  IF A$(B(F,1) - X,F - Y) = H$ THEN MV
 = MV + 20
 850  IF MV <  > M1 + 10 THEN 870
 860  IF A$(B(F,1) + (X * 3),F + (Y * 3))
= H$ THEN MV = MV + 1000
 870 B(F,2) = B(F,2) + MV
 880 M1 = 0
 890  RETURN
 900  REM  ************************
 910 MV = 2
 920 M1 = MV
 930  IF A$(B(F,1) + (X * 2),F + (Y * 2))
= C$ THEN MV = MV + 9
 940  IF A$(B(F,1) - X,F - Y) = C$ THEN MV
 = MV + 20
 950  IF MV <  > M1 + 9 THEN 970
 960  IF A$(B(F,1) + (X * 3),F + (Y * 3))
= C$ THEN MV = MV + 2000:FLAG =
     1
 970 B(F,2) = B(F,2) + MV
 980  RETURN
5000 P = 10:D = 25
5010  GOSUB 8000
5020 P = P + 10
5030  IF P < 250 THEN  GOTO 5010
5040  GOSUB 8000
5050 P = P - 10
5060  IF P > 10 THEN  GOTO 5040
5070  RETURN
5200 P = 200:D = 25
5210  FOR TD = 1 TO 5
5220  GOSUB 8000
```

```
 5230  NEXT TD
 5240  RETURN
 5250  NEXT TL
 5260  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

QUEVEDO CHESS MACHINE / Apple IIe version

```
 10  REM  QUEVEDO CHESS MACHINE
 15  REM   APPLE IIE/IIC VERSION
 20  GOSUB 1510: REM  INITIALISE
 30  GOTO 60
 40  GOSUB 1320: REM  PRINT BOARD
 50  GOSUB 110: REM  COMPUTER MOVES
 60  GOSUB 1320
 70  GOSUB 1120: REM  ACCEPT HUMAN MOVE
 80  GOTO 40
 90  END
 100  REM  **************
 110  REM  COMPUTER MOVES
 120  IF QUIT = 1 THEN 1080
 130 W1 = WK
 140  REM  ********
 150  REM  MOVE ONE
 160 MOVE = 1
 170 KM =  INT (BK / 10)
 180 RM =  INT (R / 10)
 190  IF  ABS (KM - RM) > 3 THEN 330
 200 A(R) = 46
 210 X =  INT (BK / 10):Y =  INT (R / 10)
 220  IF X > Y THEN 270
 230  IF A(R - 10) <  > 46 THEN 270
 240  IF A(R - 19) = BK OR A(R - 21) = BK
OR A(R - 20) = BK THEN 270
 250  IF A(R - 11) = BK OR A(R - 9) = BK T
HEN 270
 260 R = R - 10: GOTO 300
 270  IF A(R + 10) <  > 46 THEN A(R) = R:
GOTO 330
 280  IF A(R + 19) = BK OR A(R + 21) = BK
OR A(R + 20) = BK THEN A(R) = R
     : GOTO 330
 290 R = R + 10
 300 A(R) =  ASC ("R")
 310  RETURN
 320  REM  ********
 330  REM  MOVE TWO
 340 MOVE = 2
 350 KM = BK - 10 * KM
```

```
 360 RM = R - 10 * RM
 370  IF  ABS (KM - RM) < 2 THEN 480
 380 A(R) = 46
 390  IF R > 11 THEN  IF (A(R - 12) = BK O
R A(R - 2) = BK OR A(R + 8) = B
     K) THEN A(R) = R: GOTO 480
 400  IF R > 11 THEN  IF (A(R - 1) = BK OR
 A(R - 11) = BK OR A(R + 9) = B
     K) THEN A(R) = R: GOTO 480
 410 Y = BK - 10 *  INT (BK / 10)
 420 Z = R - 10 *  INT (R / 10)
 430  IF (Z = 1 OR Y > Z) AND A(R + 1) = 4
6 THEN R = R + 1: GOTO 450
 440 R = R - 1
 450 A(R) =  ASC ("R")
 460  RETURN
 470  REM  **********
 480  REM  MOVE THREE
 490 MOVE = 3
 500 WM = WK - 10 *  INT (WK / 10)
 510 BM = BK - 10 *  INT (BK / 10)
 520  IF  ABS (WM - BM) < 3 THEN 600
 530  IF A(WK - 1) <  > 46 OR A(WK - 18) =
 BK OR A(WK - 2) = BK OR A(WK +
     8) = BK THEN 610
 540  IF A(WK - 11) = BK OR A(WK + 9) = BK
 OR A(WK - 22) = BK THEN 610
 550 A(WK) = 46
 560 WK = WK - 1
 570 A(WK) =  ASC ("K")
 580  RETURN
 590  REM  ************************
 600  REM  MOVES FOUR, FIVE AND SIX
 610 Z =  ABS ( INT (BK / 10) -  INT (WK /
 10))
 620  IF Z = 0 THEN 950
 630  IF 2 *  INT (Z / 2) = Z THEN 790
 640  REM  *********
 650  REM  MOVE FOUR
 660 MOVE = 4
 670 A(R) = 46
 680  IF A(R - 10) <  > 46 THEN 720
```

```
 690  IF A(R - 9) = BK OR A(R - 11) = BK T
HEN 720
 700  IF A(R - 19) = BK OR A(R - 21) = BK
OR A(R - 20) = BK THEN 720
 710 R = R - 10: GOTO 760
 720  IF A(R + 10) <  > 46 THEN A(R) = R:
GOTO 790
 730  IF A(R + 19) = BK OR A(R + 21) = BK
OR A(R + 20) = BK THEN A(R) =  ASC
     ("R"): GOTO 790
 740  IF A(R + 11) = BK OR A(R + 9) = BK T
HEN A(R) =  ASC ("R"): GOTO 790

 750 R = R + 10
 760 A(R) =  ASC ("R")
 770  RETURN
 780  REM  *********
 790  REM  MOVE FIVE
 800 MOVE = 5
 810 J =  INT (BK / 10)
 820 K = BK - 10 * J
 830 L =  INT (WK / 10)
 840 M = WK - 10 * L
 850 Z = 10: IF J < L THEN Z =  - 10
 860 X = 1: IF K < M THEN X =  - 1
 870 A(WK) = 46
 880 W1 = WK
 890 WK = WK + Z + X
 900 G =  ABS (WK - BK)
 910  IF G = 1 OR G = 9 OR G = 10 OR G = 1
1 THEN WK = W1:A(WK) = 75: GOTO
     950
 920 A(WK) =  ASC ("K")
 930  RETURN
 940  REM  ********
 950  REM  MOVE SIX
 960 MOVE = 6
 970 A(R) = 46
 980  IF R > 11 THEN  IF A(R - 12) = BK OR
 A(R - 2) = BK OR A(R + 8) = BK
      OR A(R - 1) <  > 46 THEN 1070
 990  IF R > 11 THEN  IF (A(R - 1) = BK OR
```

```
   A(R - 11) = BK OR A(R + 9) = B
       K) THEN 1070
   1000 Y = BK - 10 *  INT (BK / 10)
   1010 Z = R - 10 *  INT (R / 10)
   1020  IF (Z = 1 OR Y > Z) AND A(R + 1) =
  46 THEN R = R + 1: GOTO 1040
   1030 R = R - 1
   1040 A(R) =  ASC ("R")
   1050  RETURN
   1060  REM  ******
   1070  GOSUB 1320
   1080  PRINT : PRINT
   1085  FLASH
   1090  PRINT "I CONCEDE TO THE MASTER"
   1095  NORMAL
   1100  GOSUB 5000: END
   1110  REM  ****************
   1120  REM  ACCEPT HUMAN MOVE
   1130  REM  ENTER 'Q' TO QUIT
   1140 MOVE = 0
   1145 P = 100:D = 100: GOSUB 8000
   1150  PRINT ">> MOVE TO (LETTER, NO.) ";
   1160  INPUT G$
   1170  IF G$ = "Q" THEN 1280
   1180  IF  LEN (G$) <  > 2 THEN 1160
   1190 Z =  ASC (G$)
   1200  IF Z < 65 OR Z > 72 THEN 1160
   1210 X =  VAL ( RIGHT$ (G$,1))
   1220  IF X < 1 OR X > 8 THEN 1160
   1230 A(BK) = 46
   1240 BK = 10 * (Z - 64) + X
   1250  IF A(BK) =  ASC ("R") THEN QUIT = 1
   1260 A(BK) =  ASC ("$")
   1270  RETURN
   1280  PRINT : PRINT
   1290  INVERSE : PRINT "THANKS FOR THE GAM
  E"
   1295 P = 75:D = 150: GOSUB 8000
   1300  END
   1310  REM  **********
   1320  REM  PRINT BOARD
   1325 P = 200:D = 50: GOSUB 8000
   1330  HOME
```

```
 1340  PRINT : PRINT
 1350  IF MOVE > 0 THEN  PRINT "I USED MOV
E ";MOVE
 1360  IF MOVE = 0 THEN  PRINT
 1370  PRINT : PRINT
 1380  PRINT  TAB( 10)"ABCDEFGH"
 1390  FOR J = 8 TO 1 STEP  - 1
 1400  PRINT  TAB( 8)J;" ";
 1410  FOR K = 10 TO 80 STEP 10
 1420  PRINT  CHR$ (A(J + K));
 1430  NEXT K
 1440  PRINT " ";J
 1450  NEXT J
 1460  PRINT
 1470  PRINT  TAB( 10)"ABCDEFGH"
 1480  PRINT : PRINT
 1490  RETURN
 1500  REM  **************
 1510  REM  INITIALISATION
 1520  HOME
 1530  GOSUB 8020: REM  INITIALISE SOUND
 1540 MOVE = 0
 1550 QUIT = 0
 1560  DIM A(130)
 1570  FOR J = 10 TO 80 STEP 10
 1580  FOR K = 1 TO 8
 1590 A(J + K) = 46: REM  ASCII OF "."
 1600  NEXT K
 1610  NEXT J
 1620  REM  ** PLACE PIECES **
 1630  REM  BLACK KING - HUMAN
 1640 BK =  INT ( RND (1) * 3) + 1
 1650 BK = 10 * BK + BK +  INT ( RND (1) *
5)
 1660 A(BK) =  ASC ("$")
 1670  REM  WHITE KING - COMPUTER
 1680 WK =  INT ( RND (1) * 4) + 4
 1690 WK = 10 * WK + WK +  INT ( RND (1) *
2)
 1700  IF WK = BK THEN 1680
 1710 A(WK) =  ASC ("K")
 1720  REM  WHITE ROOK - COMPUTER
 1730 R =  INT ( RND (1) * 4) + 4
```

```
 1740 R = 10 * R + R +  INT ( RND (1) * 2)
 1750  IF R = WK OR R = BK THEN 1730
 1760  IF  ABS (R - BK) < 12 THEN 1730
 1770 A(R) =  ASC ("R")
 1780  RETURN
 5000 P = 175:D = 50
 5010  FOR TL = 1 TO 5
 5020  GOSUB 8000
 5030  FOR TD = 1 TO 50: NEXT TD
 5040  NEXT TL
 5050  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

WASHINGTON D.C. / Apple IIe version

```
 10  REM  WASHINGTON D.C.
 15  REM  APPLE IIE/IIC VERSION
 20  GOSUB 1160: REM  INITIALISE
 30  REM  ********************
 40  REM  MAJOR CYCLE
 50 P =  INT (P + (P * 273 / ML))
 60  GOSUB 160: REM  PRINTOUT
 70  GOSUB 510: REM  CALCULATE
 80  REM  NOW CHECK END GAME
 90  GOSUB 710: REM  STANDARD OF LIVING
 100  GOSUB 780: REM  INFLATION RATE
 110  GOSUB 840: REM  UNEMPLOYMENT
 120  IF GAME = 1 THEN  HOME : GOTO 890
 130  GOTO 50
 140  REM  ********************
 150  REM  PRINTOUT
 160  HOME :PZ = 50:DZ = 150: GOSUB 8000
 170  PRINT "PRESIDENT ";A$;":"
 180  PRINT "YOUR ADMINISTRATION HAS BEEN
IN          POWER FOR ";Y + Z /
     4;" YEARS"
 190  PRINT "------------------------------
---------"
 200  PRINT "-----STATE OF THE NATION-----
"
 210  PRINT "------------------------------
---------"
 220  PRINT "POPULATION ";P
 230  PRINT "NO. UNEMPLOYED "; INT (U);"
"; INT (100 * U / P);"%"
 240  PRINT "CURRENT WAGES $ ";WO;"  INFLA
TION "; INT (IP);"%"
 250  PRINT "GOVT. EXPENDITURE LAST QTR. $
M ";GE
 260  PRINT "UNEMPLOYMENT COST $M "; INT (
10 * GU) / 10
 270  PRINT "INCOME FROM TAXES $M "; INT (
GI * 10) / 10
 280  PRINT "BUDGET SURPLUS(+)/DEFICIT(-)
$M "; INT (BD * 10) / 10
```

```
 290  PRINT "GROSS DOMESTIC PRODUCT $M ";
INT (GDP * 10) / 10
 300  IF Y + Z / 4 > .5 THEN  PRINT "CHANG
E IN LIVING STANDARD "; INT ((2
      * ((RGDP / AGDP) * 100) - 100) / 3);
"%"
 310  PRINT "-----------------------------
---------"
 320  PRINT "PUBLIC INVESTMENT ";Y;" Q ";Z
;" $M "; INT (IV * 10) / 10
 330  PRINT "-----------------------------
---------"
 340  PRINT "OK, PRESIDENT ";A$;"..."
 350  INPUT "ENTER GOVERNMENT SPENDING $M
";GE
 360  INPUT "ENTER COST OF WAGES $M ";WN
 370  PRINT "IS YOUR ADMINISTRATION IN FAV
OR OF "
 380  PRINT : PRINT "IMMIGRATION THIS QUAR
TER (Y/N)?"
 390  GET X$
 400  IF X$ <  > "Y" AND X$ <  > "N" THEN
390
 410  PRINT  TAB( 20)"OK...";X$
 420  FOR H = 1 TO 1000: NEXT H
 430  IF X$ <  > "Y" THEN  RETURN
 440  PRINT "HOW MANY IMMIGRANTS WILL YOU
ALLOW      INTO THE US?"
 450  INPUT M
 460  IF M < 0 THEN 450
 470 P = P + M
 480  RETURN
 490  REM  ************************
 500  REM  CALCULATIONS
 510 CN = CN + (CN * IP / 100)
 520 U = P * (GE + IV) / (CN * 10) + P * (
IP / 1000)
 530 GU = U * WN / ML: REM  UNEMPLOYMENT C
OST
 540 GI = (((P - U) * WN * .4) / ML): REM
 INCOME FROM TAXES
 550 BD = BD + GI - GU - GE: REM  BUDGET D
EFICIT
```

```
 560 AGDP = AGDP * (1 + (IP / 100))
 570 GDP = GE + IV + ((P - U) * WN / ML)
 580 RGDP = GDP * 440 / AGDP
 590 IP = ((GE + IV) / CN * .1 + (WN / WO)
 / 100) * 100
 600 IV = (CN * 67) / (IP * IP)
 610 WO = WN
 620 Z = Z + 1: IF Z > 4 THEN Z = 1:Y =  +
 1
 630  RETURN
 640  REM  *************************
 650  REM  CHECK BUDGET DEFICIT
 660  IF BD >  - 1000 THEN  RETURN
 670 GAME = 1
 680 FLAG = 1
 690  RETURN
 700  REM  *************************
 710  REM  CHECK STANDARD OF LIVING
 720  IF Y < .75 THEN  RETURN
 730  IF  INT ((2 * ((RGDP / AGDP) * 100)
- 100) / 3) >  - 15 THEN  RETURN

 740 GAME = 1
 750 FLAG = 2
 760  RETURN
 770  REM  *************************
 780  REM  CHECK INFLATION RATE
 790  IF IP < 15 THEN  RETURN
 800 GAME = 1
 810 FLAG = 3
 820  RETURN
 830  REM  *************************
 840  REM  CHECK UNEMPLOYMENT
 850  IF  INT (U * 100 / P) < 15 THEN  RET
URN
 860 GAME = 1
 870 FLAG = 4
 880  RETURN
 890  REM  *************************
 900  REM  END OF THE GAME
 905 PZ = 200:DZ = 100: GOSUB 8000
 907 PZ = 100:DZ = 75: GOSUB 8000
 910  PRINT "PRESIDENT ";A$;", YOUR"
```

```
 920  PRINT "ADMINISTRATION'S POOR ECONOMI
C"
 930  PRINT "PERFORMANCE HAS LED TO AN UNA
CCEPTABLE"
 940  IF FLAG = 1 THEN  PRINT "BUDGET DEFI
CIT"
 950  IF FLAG = 2 THEN  PRINT "DROP IN THE
 STANDARD OF LIVING"
 960  IF FLAG = 3 THEN  PRINT "RISE IN THE
 INFLATION RATE"
 970  IF FLAG = 4 THEN  PRINT "RISE IN UNE
MPLOYMENT"
 980  PRINT "             AMONG OTHER THING
S..."
 990  PRINT "-----------------------------
---------"
 1000  PRINT "THE LACK OF CONFIDENCE IN YO
UR"
 1010  PRINT "ADMINISTRATION IS SO BAD THE
RE ARE"
 1020  PRINT "CALLS FOR YOU TO RESIGN...YO
U STEP"
 1030  PRINT "ASIDE TO ALLOW THE VICE-PRES
IDENT TO"
 1040  PRINT "      OCCUPY THE OVAL OFFICE
"
 1050  FOR H = 1 TO 1000: NEXT H
 1060  PRINT "-----------------------------
----------"
 1070  PRINT "YOU WERE PRESIDENT FOR ";Y +
 (Z * .25);" YEARS"
 1080  PRINT "DURING YOUR TERM OF OFFICE,
THE"
 1090  PRINT "POPULATION ROSE BY ";P - 3 *
 ML
 1100  PRINT "THE UNEMPLOYMENT RATE BECAME
 "; INT (U * 1000 / P) / 10;"%"

 1110  PRINT "AND THE INFLATION RATE BECAM
E "; INT (10 * IP) / 10;"%"
 1120  PRINT "STANDARD OF LIVING CHANGED B
Y "; INT ((2 * ((RGDP / AGDP) *
      100) - 100) / 3);"%"
```

```
 1130  PRINT "AND THE BUDGET SURPLUS/DEFIC
IT           WAS $M"; INT (10 *
     BD) / 10
 1140  END
 1150  REM  ************************
 1160  REM  INITIALIZATION
 1170  HOME
 1180  GOSUB 8020
 1190 ML = 1000 * 1000
 1200 P = 3 * ML
 1210 U = P / 10: REM  UNEMPLOYMENT
 1220 IV = 236: REM  INVESTMENT
 1230 GE = 118: REM  GOVERNMENT EXPENDITUR
E
 1240 GU = 0: REM  COST OF UNEMPLOYMENT
 1250 GI = 0: REM  INCOME FROM TAXES
 1260 WN = 100: REM  NEW WAGES
 1270 WO = 100: REM  OLD WAGES
 1280 IP = 5: REM  INFLATION PERCENT
 1290 GDP = 440: REM  GROSS DOMESTIC PRODU
CT
 1300 AGDP = 440: REM  BASE YEAR GDP
 1310 RGDP = 440: REM  REAL GDP
 1320 CN = 354: REM  ECONOMIC CONSTANT (US
ED THROUGHOUT SIMULATION)
 1330 Z = 1:GAME = 0:FLAG = 0
 1340 Y = 0: REM  YEAR
 1350  PRINT "ENTER YOUR LAST NAME"
 1360  INPUT A$
 1370  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,PZ: POKE 11,DZ: CALL 768: R
ETURN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

STOCK MARKET / Apple IIe version

```
 10  REM  STOCKMARKET
 15  REM  APPLE IIE/IIC VERSION
 20  HOME
 30  GOSUB 8020
 40  DIM S(5),N(5),P(5),D(5)
 50 S(1) = 1.49:S(2) = 1.99:S(3) = 2.49:S(
4) = 2.99:S(5) = 3.49
 60 N(1) = 2000:N(2) = 1500:N(3) = 1200:N(
4) = 1000:N(5) = 800
 70 BB = 265:TV = 15000:QQ = 15000:DAY = 1
 80  PRINT : PRINT "ENTER YOUR GOAL FOR TH
IS SIMULATION,"
 90  PRINT  TAB( 8)"$16,000 TO $100,000"
 100  INPUT GOAL
 110  IF GOAL < 16000 THEN  PRINT "TOO LOW
!": GOSUB 5000: GOTO 80
 120  IF GOAL > 100 * 1000 THEN  PRINT "TO
O HIGH!": GOSUB 5000: GOTO 80
 130  REM  ********************
 140  REM  MAJOR LOOP
 150  FOR C = 1 TO 5
 160  REM  ADJUST THE 55 IN THE NEXT LINE
TO MODIFY THE GAME; 80 VERY HAR
      D, 30 VERY EASY
 170 D(C) =  INT ( RND (1) * 55) + 1
 180 P(C) =  INT ( RND (1) * (100 - D(C)))
 + 1
 190  NEXT C
 200  GOSUB 230
 210  GOTO 460
 220  REM  ********************
 230  REM  PRINT OUT
 240  HOME
 250  PRINT "-----------------------------
---------"
 255  GOSUB 5200
 260  PRINT "DAY "DAY"        YOUR GOAL IS
$"GOAL
 270  PRINT "-----------------------------
---------"
 280  PRINT "COMPANY NUMBER:"
```

```
 290  PRINT  TAB( 2)1; TAB( 9)2; TAB( 16)3
; TAB( 25)4; TAB( 32)5
 295  PRINT
 300  PRINT "CHANCE OF INCREASE (%):"
 310  PRINT  TAB( 2)P(1); TAB( 9)P(2); TAB
( 16)P(3); TAB( 25)P(4); TAB( 3
     2)P(5)
 315  PRINT
 320  PRINT "CHANCE OF DECREASE (%):"
 330  PRINT  TAB( 2)D(1); TAB( 9)D(2); TAB
( 16)D(3); TAB( 25)D(4); TAB( 3
     2)D(5)
 335  PRINT
 340  PRINT "CURRENT VALUE PER SHARE:"
 350  PRINT "$"; INT (S(1) * 100) / 100; T
AB( 8)"$"; INT (S(2) * 100) / 1
     00;
 360  PRINT  TAB( 15)"$"; INT (S(3) * 100)
 / 100; TAB( 23)"$"; INT (S(4) *
     100) / 100;
 370  PRINT  TAB( 30)"$"; INT (S(5) * 100)
 / 100
 375  PRINT
 380  PRINT "NO. OF SHARES HELD:"
 390  PRINT  TAB( 2)N(1); TAB( 9)N(2); TAB
( 16)N(3); TAB( 24)N(4); TAB( 3
     1)N(5)
 395  PRINT
 400  PRINT "BANK $"; INT (BB)" TOTAL WORT
H $"; INT (TV)
 410  PRINT "-----------------------------
---------"
 420  IF TV > GOAL THEN  PRINT "YOU'VE HIT
 YOUR FINACAIL GOAL!": GOSUB 55
     00: END
 430  RETURN
 440  REM  ************************
 450  REM          ** SELL **
 460  PRINT "DO YOU WANT TO SELL ANY SHARE
S (Y/N)?"
 470  GET A$
 480  IF A$ <  > "Y" AND A$ <  > "N" THEN
470
```

```
 490  IF A$ = "N" THEN 690
 500  GOSUB 230
 510  PRINT "WHICH ONES TO SELL? ";
 520  GET A$
 530  IF A$ < "1" OR A$ > "5" THEN 520
 540 C =  VAL (A$)
 550  PRINT "    OK ";C
 560  PRINT "HOW MANY OF ";C;" TO SELL ";
 570  INPUT N
 580  IF N > N(C) THEN  PRINT "YOU DON'T H
AVE THAT MANY!": GOSUB 5000: GOTO
     570
 590  REM  ************************
 600  REM  ADJUST FIGURES AFTER SALE
 610 BB = BB + S(C) * N: REM  ADD VALUE TO
 BANK
 620 N(C) = N(C) - N: REM  SUBTRACT NO. SO
LD
 630 TV = 0: REM  SET TOTAL WORTH TO ZERO
 640  REM  NOW DETERMINE CURRENT WORTH
 650  FOR C = 1 TO 5
 660 TV = TV + N(C) * S(C)
 670  NEXT C
 680 TV = TV + BB: REM  ADD IN BANK BALANC
E
 690  GOSUB 230
 700  REM  ************************
 710  REM          ** BUY **
 720  PRINT "DO YOU WANT TO BUY ANY SHARES
 (Y/N)?"
 730  GET A$
 740  IF A$ <  > "Y" AND A$ <  > "N" THEN
730
 750  IF A$ = "N" THEN 890
 760  GOSUB 230
 770  PRINT "WHICH COMPANY TO BUY? ";
 780  GET A$
 790  IF A$ < "1" OR A$ > "5" THEN 780
 800 C =  VAL (A$)
 810  PRINT "    OK ";C
 820  PRINT "HOW MANY OF ";C;" TO BUY ";
 830  INPUT N
 840  IF N * S(C) > BB THEN  PRINT "YOU DO
```

```
N'T HAVE ENOUGH MONEY!": GOSUB
     5000: GOTO 830
 850  REM  ************************
 860  REM  ADJUST FIGURES AFTER BUY
 870 BB = BB - S(C) * N
 880 N(C) = N(C) + N
 890 TV = 0
 900  FOR C = 1 TO 5
 910 TV = TV + N(C) * S(C)
 920  NEXT C
 930 TV = TV + BB
 940  GOSUB 230
 950  REM  ************************
 960  REM  MODIFY ALL INDICATORS
 970 TV = 0
 980  FOR C = 1 TO 5
 990 K =  INT ( RND (1) * 100) + 1
1000  IF K < P(C) THEN S(C) = S(C) * (1 +
(P(C) / 1000))
1010 K =  INT ( RND (1) * 100) + 1
1020  IF K < D(C) THEN S(C) = S(C) / (1 +
(D(C) / 1000))
1030 TV = TV + (S(C) * N(C))
1040  NEXT C
1050 TV = TV + BB
1060 QQ = QQ * 1.005
1070 W = (TV * 100 / QQ) - 100
1080  IF W = 0 THEN W = .1
1090 W = W + 6
1100  IF W < 1 THEN W = 1
1110  IF W > 15 THEN W = 15
1120  RESTORE
1130  FOR T = 1 TO W
1140  READ A$
1150  NEXT T
1160  PRINT
1170  REM  ********************
1180  REM  GIVE RATING, START NEW ROUND
1190  PRINT "YOUR RATING AFTER THAT ROUND
OF"
1200  PRINT "TRADING IS '";A$;"'"
1210  PRINT : PRINT  TAB( 5)"<PRESS SPACE
BAR TO CONTINUE>"
```

```
 1220  GET A$: IF A$ <  > " " THEN 1220: R
EM  NOTE SPACE BETWEEN QUOTE MA
     RKS
 1230 DAY = DAY + 1
 1240  GOTO 150
 1250  DATA  "HOPELESS","VERY, VERY, POOR"
 1260  DATA  "TERRIBLE","AWFUL","BAD"
 1270  DATA  "VERY ORDINARY","AVERAGE"
 1280  DATA  "REASONABLE","A LITTLE ABOVE
AVERAGE"
 1290  DATA   "FAIRLY GOOD","GOOD","VERY G
OOD"
 1300  DATA  "GREAT","EXCELLENT","SUPERLAT
IVE"
 5000 P = 50:D = 100
 5010  GOSUB 8000
 5020  RETURN
 5200 P = 150:D = 200
 5210  GOSUB 8000
 5220  RETURN
 5500 P = 250:D = 5
 5510  GOSUB 8000
 5520 P = P - 10
 5530  IF P > 10 THEN  GOTO 5510
 5540  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

DETROIT CITY / Apple IIe version

```
 10  REM  DETROIT CITY
 15  REM  APPLE IIE/IIC VERSION
 20  GOSUB 1640: REM  INITIALIZE
 30  GOTO 110
 40 MT = MT + 1: REM  COUNTS MONTHS
 50  GOSUB 650
 60  IF TP > 200 THEN 1560
 70  PRINT "DO YOU WANT TO RESIGN (Y/N)?"
 80  GOSUB 1010
 90  IF A$ = "Y" THEN  PRINT "OK, CHIEF":P
Z = 50:D = 250: GOSUB 8000: END
 100  GOSUB 1380
 110  GOSUB 650
 120  FOR T = 1 TO 1000: NEXT T
 130  GOSUB 850
 140  PRINT "DO YOU WANT TO EXPAND OUTPUT
(Y/N)?"
 150  GOSUB 1010
 160  IF A$ = "Y" THEN 1080
 170  IF SF = 1 THEN 210
 180  PRINT "DO YOU WANT TO SELL FACTORY 4
 (Y/N)?"
 190  GOSUB 1010
 200  IF A$ = "Y" THEN 1250
 210  GOSUB 650
 220  INPUT "HOW MANY EMPLOYEES TO HIRE ";
HE
 230 NE = NE + HE: IF HE > 0 THEN 260
 240  INPUT "HOW MANY EMPLOYEES TO FIRE ";
HE
 250 N = NE - HE
 260  GOSUB 650
 270 P1 = AS: REM  SET P1 EQUAL TO OLD PRI
CE
 280  INPUT "WHAT IS YOUR SELLING PRICE ";
AS
 290  REM  NEXT LINE REJECTS TOO BIG A CHA
NGE IN SELLING PRICE
 300  IF  ABS (P1 - AS) > 2500 THEN  PRINT
 "TOO BIG A CHANGE FOR THE MARK
     ET": GOTO 280
```

```
 310  HOME
 320  PRINT : PRINT : PRINT
 330 MI =  INT ( RND (1) * 4000) + 48 * 10
00: REM  THIS MONTH'S SALES BY
     INDUSTRY
 340 C = C + 1: REM  COUNTS NUMBER OF MONT
HS
 350  IF C < 3 THEN 470
 360 M =  INT ( RND (1) * 10 + 1) / 4: REM
  INFLATION
 370  HOME
 380  PRINT "INFLATION RATE THIS QUARTER I
S ";M;"%"
 390  PRINT "AVERAGE WAGES BILL WILL NOW R
ISE TO"
 400 AW = (AW * M / 100) + AW
 410  PRINT  TAB( 8)"$"; INT (AW)" PER EMP
LOYEE"
 430  PRINT : PRINT  TAB( 12)"ANY KEY TO C
ONTINUE"
 440  GET V$
 450 FA = (FA * M / 100) + FA
 460 C = 0
 470 Y(1) = NE * 15 / 12: REM  SALES BASED
 ON NUMBER OF EMPLOYEES
 480 Y(2) = (100 - AS / FA) * MI / 100: RE
M  SALES BASED ON INDUSTRY SALE
     S
 490  REM  NEXT LINES SET LOWEST FIGURE FR
OM Y(1),Y(2),M(5) EQUAL TO Y(3)
 500  IF Y(1) < Y(2) AND Y(1) < M(5) THEN
Y(3) = Y(1): GOTO 540
 510  IF Y(2) < Y(1) AND Y(2) < M(5) THEN
Y(3) = Y(2): GOTO 540
 520 Y(3) = M(5)
 530  REM  NEXT LINES DETERMINE MONTHLY SA
LES
 540  IF  ABS (P1 - AS) < 501 THEN Y(3) =
3.6 * Y(3) / 3
 550  IF Y(3) > M(5) THEN Y(3) = Y(3) - 19
75: GOTO 550
 560 MC = (MC * M / 100) + MC
 570 EF = Y(3) / M(5) * 100: REM  EFFICIEN
```

```
CY % AS SALES DIVIDED BY TOTAL
     OUTPUT
 580 AC = (MC * ( ABS (85 - EF) / 3) / 100
) + MC: REM  AVERAGE COST PER V
     EHICLE
 590 MP = ((Y(3) * (AS - AC)) - (NE * AW /
 12)): REM   MONTHLY PROFIT
 600 MP =  INT (MP / (100 * 1000))
 610 TP = TP + MP / 10: REM  TOTAL PROFIT
IN MILLIONS
 620 M = 0
 630  GOTO 40
 640  REM  **********************
 650  REM  REPORT PRINTOUT
 660  HOME
 665 PZ = 100:DZ = 100: GOSUB 8000
 670  PRINT "INDUSTRY SALES ";MI;" IN MONT
H ";MT
 680  IF MT > 0 THEN  PRINT "YOUR SALES: "
; INT (Y(3));" (";  INT (Y(3) *
     1000 / MI) / 10;"% OF TOTAL)"
 690  PRINT "-----------------------------
---------"
 700  PRINT "YOU HAVE ";NE;" EMPLOYEES"
 710  PRINT "AVERAGE WAGES ARE $"; INT (AW
)
 720  PRINT " OR $M "; INT (AW * NE / (100
 * 1000) / 12) / 10;" PER MONTH
     "
 730  PRINT "-----------------------------
---------"
 740  IF MT = 0 THEN  RETURN
 750  PRINT "AVERAGE COST PER VEHICLE IS $
"; INT (AC)
 760  PRINT "AND AVERAGE SELLING PRICE IS
$"; INT (AS)
 770  PRINT "SO THE AVERAGE PROFIT IS $";
INT (AS - AC)
 780  PRINT "OR $M "; INT ((AS - AC) * Y(3
) / (100 * 1000)) / 10;" PER MO
     NTH"
 790  PRINT "-----------------------------
---------"
```

```
 800  PRINT "PROFIT FOR THE MONTH IS $M ";
MP / 10
 810  PRINT "& TOTAL PROFIT TO DATE IS $M
"; INT (TP * 10) / 10
 820  PRINT "----------------------------
---------"
 830  RETURN
 840  REM  ********************
 850  REM  MONTH REPORT
 860  HOME
 865 PZ = 150:DZ = 100: GOSUB 8000
 880  PRINT "----------------------------
---------"
 890  PRINT "MAXIMUM MONTHLY OUTPUT:"
 900  PRINT  TAB( 3)"FACTORY 1: "; INT (M(
1))
 910  PRINT  TAB( 3)"FACTORY 2: "; INT (M(
2))
 920  PRINT  TAB( 3)"FACTORY 3: "; INT (M(
3))
 930  IF SF = 1 THEN 960
 940  PRINT  TAB( 3)"FACTORY 4: "; INT (M(
4))
 950  PRINT "----------------------------
---------"
 960  PRINT "TOTAL OUTPUT IS "; INT (M(5))
 970  PRINT "----------------------------
---------"
 980  PRINT "EFFICIENCY LEVEL IS "; INT (E
F);"%"
 990  RETURN
 1000  REM  ********************
 1010  REM  GET REPLIES
 1020  GET A$
 1030  IF A$ <  > "Y" AND A$ <  > "N" THEN
 1020
 1040  PRINT  TAB( 22)A$
 1050  FOR J = 1 TO 500: NEXT J
 1060  RETURN
 1070  REM  ********************
 1080  REM  INCREASE OUTPUT?
 1090  IF M(4) = 0 THEN X = 15: GOTO 1110
 1100 X = 18
```

```
 1110  PRINT "IT WILL COST $M ";X;" TO EXP
AND"
 1120  PRINT  TAB( 8)"OUTPUT BY 1%"
 1130  PRINT "----------------------------
----------"
 1140  PRINT "HOW MANY % DO YOU WISH TO RA
ISE OUTPUT?"
 1150  INPUT EP: IF EP < 0 OR EP > 100 THE
N 1150
 1160 M(5) = 0
 1170  FOR T = 1 TO 4
 1180 M(T) = M(T) + M(T) * EP / 100
 1190 M(5) = M(5) + M(T)
 1200  NEXT T
 1210 TP = TP - EX * X
 1220  FOR T = 1 TO 500: NEXT T
 1230  GOTO 170
 1240  REM  **********************
 1250  REM  SALE OF FACTORY FOUR
 1260  PRINT "FACTORY FOUR IS VALUED FOR S
ALE AT $M 104"
 1270  PRINT "YOU CAN'T REBUY IT LATER IF
YOU          SELL IT..."
 1280  PRINT "DO YOU WANT TO SELL (Y/N)?"
 1290  GOSUB 1010
 1300  IF A$ = "N" THEN 210
 1310 TP = TP + 104
 1320 SF = 1
 1330 M(5) = M(1) + M(2) + M(3)
 1340 M(4) = 0
 1350  GOTO 170
 1360  REM  **********************
 1370  REM  CHECK ON LOSSES
 1380  IF MP > 0 THEN SA = 0: GOTO 1480
 1390 SA = SA + 1
 1400  IF SA > 11 THEN 1420
 1410  GOTO 1480
 1420  HOME :PZ = 150:D = 250: GOSUB 8000:
PZ = 150:DZ = 250: GOSUB 8000
 1430  PRINT : PRINT "YOU JUST MADE YOUR T
WELFTH MONTHLY"
 1440  PRINT "LOSS IN A ROW........."
 1450  PRINT  TAB( 6)"YOUR EMPLOYMENT"
```

```
 1460  PRINT  TAB( 6)"IS HEREBY TERMINATED
!!"
 1470  END
 1480  IF TP >  =  - 250 THEN 1530
 1490  HOME :PZ = 200:DZ = 250: GOSUB 8000
 1500  PRINT : PRINT "UNDER YOUR MANAGEMEN
T, THE COMPANY HAS"
 1510  PRINT "LOST MORE THAN $M 250!!"
 1520  GOTO 1450
 1530  IF TP > 200 THEN 1570
 1540  RETURN
 1550  REM  **********************
 1560  REM  SWEET SWEET SUCCESS!!!
 1570  HOME : GOSUB 5000
 1580  PRINT : PRINT "WELL DONE! THE COMPA
NY HAS MADE MORE"
 1590  PRINT "  THAN $M 200.   YOU'VE BEEN
 MADE"
 1600  PRINT "          A MEMBER OF THE BOA
RD"
 1610  FOR T = 1 TO 2000: NEXT T
 1620  END
 1630  REM  **********************
 1640  REM  INITIALIZATION
 1650  HOME
 1660  GOSUB 8020
 1670  DIM M(5),Y(5)
 1680 NE = 12000: REM  STARTING NO. OF EMP
LOYEES
 1690 AW = 22995: REM  STARTING AVERAGE WA
GE
 1700 AC = 11100: REM  COST PRICE/VEHICLE
 1710 AS = 12000: REM  SELLING PRICE
 1720 MI = 50 * 1000:MC = 10100
 1730 Y(3) = 12500
 1740 MS = 25:EF = 77:FA = 160:SF = 0:MT =
 0
 1750  FOR J = 1 TO 5
 1760  READ M(J)
 1770  NEXT J
 1780  RETURN
 1790  DATA  8900,3250,2500,1625,16275
 5000 PZ = 200:DZ = 50
```

```
 5010  FOR TL = 1 TO 5
 5020  GOSUB 8000
 5030  FOR TH = 1 TO 50: NEXT TH
 5040  NEXT TL
 5050  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,PZ: POKE 11,DZ: CALL 768: R
ETURN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

GRIDIRON/ Apple IIe version

```
 10  REM  GRIDIRON
 15  REM  APPLE IIE/IIC VERSION
 20  HOME
 30  GOSUB 8020
 40  GOSUB 70
 50  GOTO 220
 60  REM  ******************
 70  FOR X = 1 TO 2000: NEXT X
 80  RETURN
 100  PRINT A$;SA
 110  PRINT B$;SB
 120  RETURN
 130  REM  **********************
 140  IF Z$ = A$ THEN Z$ = B$: RETURN
 150 Z$ = A$: RETURN
 170  PRINT "     >PRESS ANY KEY<"
 180  GET M$
 200 P = 100:D = 50: GOSUB 8000: PRINT  TA
B( 18)"OK": RETURN
 210  REM  *********
 220  REM  INTIALISE
 230  DEF  FN A(X) =  INT ( RND (1) * X) +
 1
 240  PRINT "ONE PLAYER OR TWO"
 250  INPUT X
 260  IF X < 1 OR X > 2 THEN 250
 270  IF X = 1 THEN VC = 1:A$ = "SILICON C
OWBOYS ": GOTO 300
 280  PRINT "WHAT IS THE NAME OF THE HOME
TEAM?"
 290  INPUT A$: IF A$ = "" THEN 290
 295 A$ = A$ + " "
 300  PRINT "AND THE NAME OF THE VISITING
TEAM?"
 310  INPUT B$: IF B$ = "" THEN 310
 315 B$ = B$ + " "
 320 Z$ = A$:NU = 35
 330  HOME
 340  PRINT "THERE ARE "; INT (10 * (60 -
(W / 4))) / 10;" MINUTES TO GO"
 350  PRINT  TAB( 8)Z$;"TO KICK OFF"
```

```
 360  PRINT "YOU ARE ON YOUR OWN ";NU;" YA
RD LINE"
 370  IF VC = 1 AND Z$ = A$ THEN  GOSUB 70
: GOTO 400
 380  PRINT "TO KICK OFF..."
 390  GOSUB 170
 400 A =  FN A(20) + 40
 410  PRINT Z$;"HAVE..."
 415  GOSUB 70
 420  FOR X = 1 TO A
 425 PX =  INT (X / 3): IF PX < 1 THEN PX
= 1
 430  PRINT  TAB( PX)"KICKED ";X;" YARDS"
 440  NEXT X
 450 NU = NU + X
 460  GOSUB 70
 470  PRINT "THE BALL IS CAUGHT!"
 480  GOSUB 70
 490 A =  FN A(30) + 10
 500  FOR X = 1 TO A
 505 PX = X / 5: IF PX < 1 THEN PX = 1
 510  PRINT  TAB( PX)"AND RETURNED ";X;" Y
ARDS"
 520  NEXT X
 530 NU =  ABS (100 - NU + X)
 540  GOSUB 140
 550  PRINT "-----------------------------
---------"
 560  PRINT "THE BALL IS DOWN ON"
 570  PRINT Z$"'S ";NU;" YARD LINE"
 580  IF Z$ = A$ AND VC = 1 THEN  GOSUB 70
: GOTO 600
 590  GOSUB 170
 600 TG = 10:DN = 0:SL = NU
 610  IF W = 60 OR W = 180 THEN 2010
 620  IF W = 120 THEN 2070
 630  IF W = 240 THEN 2140
 640  HOME
 650  PRINT  LEFT$ (A$,6);" ";SA;" "; LEFT
$ (B$,6);" ";SB
 660  PRINT  INT (10 * (60 - (W / 4))) / 1
0;" MINUTES TO GO"
 670  GOSUB 70
```

```
 680  PRINT "-----------------------------
---------"
 690  PRINT Z$;"IN POSSESSION"
 700  PRINT  TAB( 4)DN;" DOWN"
 710  PRINT  TAB( 4)TG;" YARDS TO GO"
 720  PRINT "-----------------------------
---------"
 730  PRINT "START AT ";SL;" YARD LINE"
 740  PRINT "NOW ON ";NU;" YARD LINE"
 750  PRINT 100 - NU;" YARDS TO TOUCHDOWN"
 760  PRINT "-----------------------------
---------"
 770  PRINT "ON THIS PLAY ";
 780  IF Z$ = A$ THEN  PRINT A$;"CAN": GOT
O 800
 790  PRINT B$;"CAN"
 800  PRINT "EITHER 1 - THROW"
 810  PRINT "       2 - CARRY"
 829  PRINT "    OR 3 - PUNT"
 830 PT = 0
 840  IF Z$ = A$ AND VC = 1 AND DN < 3 THE
N PT = 2: GOTO 900
 850  IF Z$ = A$ AND VC = 1 AND TG < 7 THE
N PT = 2: GOTO 900
 855  IF Z$ = A$ AND VC = 1 AND DN > 2 THE
N PT = 3: GOTO 900
 860  IF Z$ = A$ AND VC = 1 AND (100 - NU)
 < 31 THEN PT = 3: GOTO 900
 870  IF Z$ = A$ AND VC = 1 THEN PT = 1: G
OTO 900
 880  GET K$: IF K$ < "1" OR K$ > "3" THEN
 880
 890 PT =  VAL (K$): PRINT  TAB( 10)"OK ";
PT
 900  GOSUB 70
 910 W = W + 1
 920  HOME
 930  PRINT Z$;", YOUR QUARTERBACK HAS"
 940  PRINT  TAB( 8)"GOT THE BALL"
 950  PRINT "-----------------------------
---------"
 960  PRINT "WAIT FOR THE COUNT, ";Z$;","
 970  PRINT  TAB( 8)"THEN HIT ANY KEY..."
```

```
 980 I$ = ""
 990  GOSUB 70
 1000  GOSUB 2200
 1010  IF E = 11 THEN 2340
 1020  PRINT "----------------------------
----------"
 1030  ON PT GOTO 1050,1310,1590
 1040  REM  ************************
 1050  PRINT "YOU'VE THROWN ";E * 5;" YARD
S"
 1060  PRINT  TAB( 4);"AND THE PLAY IS..."
 1070 A =  FN A(8)
 1080  IF A = 1 THEN 1520
 1090 A =  FN A(E + 1)
 1100  IF A = 1 THEN  PRINT  TAB( 20)"...C
OMPLETE": GOTO 1220
 1110  PRINT  TAB( 20)"...INCOMPLETE":DN =
 DN + 1
 1120  GOSUB 170
 1130  PRINT "----------------------------
----------"
 1140  IF DN > 3 THEN 1160
 1150  GOTO 610
 1160  PRINT "THAT WAS YOUR FOURTH DOWN"
 1170  PRINT "AND YOU'VE LOST POSSESSION!!
"
 1180 DN = 0:TG = 10:NU =  ABS (100 - NU):
SL = NU
 1190  GOSUB 70
 1200  GOSUB 140
 1210  GOTO 610
 1220  GOSUB 170
 1230 NU = NU + (E * 5):TG = TG - (E * 5)
 1240  IF NU > 100 THEN 1800
 1250  IF TG < 1 THEN 1280
 1260 DN = DN + 1: IF DN > 3 THEN 1160
 1270  GOTO 610
 1280 DN = 0:TG = 10:SL = NU
 1290  GOTO 610
 1300  REM  ********************
 1310 A =  FN A(15)
 1320  IF A = 1 THEN 1510
 1330 E = A - 5
```

```
 1340  IF E < 0 THEN 1440
 1350  IF E = 0 THEN E = 1: GOTO 1370
 1360  PRINT "GOOD SNAP, PASS AND RUN"
 1370  PRINT "YOU'VE GAINED ";E;" YARDS"
 1380  GOSUB 170
 1390 TG = TG - E:NU =  ABS (NU + E):DN =
DN + 1
 1400  IF NU > 100 THEN 1800
 1410  IF TG < 1 THEN 1280
 1420  IF DN > 3 THEN 1160
 1430  GOTO 610
 1440  PRINT "GREAT RUNNING BY THE OPPOSIT
ION HAS"
 1450  PRINT "CAUSED YOU TO LOSE "; ABS (E
);" YARDS"
 1460 TG = TG - E:NU = NU + E:DN = DN + 1
 1470  GOSUB 170
 1480  IF DN > 3 THEN 1160
 1490  GOTO 610
 1500  REM  ************************
 1510  PRINT "BAD SNAP...YOU'VE"
 1520  PRINT "FUMBLED...AND"
 1530  PRINT "YOU'VE LOST POSSESSION..."
 1540 NU = 100 - NU:DN = 0:TG = 10:SL = NU
 1560  GOSUB 170
 1570  GOTO 460
 1580  REM  ************************
 1590  PRINT "NICE PUNT..."
 1600  PRINT "YOU'VE KICKED ";E * 4;" YARD
S"
 1610 NU = NU + E * E
 1620  IF NU > 100 THEN 1650
 1630  PRINT "-----------------------------
----------"
 1640  GOTO 460
 1650 A =  FN A(3)
 1660  IF A > 1 THEN 1740
 1670  PRINT "BUT YOU'VE MISSED THE GOAL"
 1680  IF NU - E * 4 < 80 THEN NU =  ABS (
100 - (NU - E * 4)): GOTO 1700
 1690 NU = 20
 1700 DN = 0:TG = 10:SL = NU
 1710  GOSUB 140
```

```
 1720  GOSUB 170
 1730  GOTO 610
 1740  PRINT "...AND SCORED!"
 1745 P = 50:D = 150: GOSUB 8000
 1750  IF Z$ = B$ THEN SB = SB + 3: GOTO 1
770
 1760 SA = SA + 3
 1770  GOSUB 100
 1780  GOSUB 170
 1790 NU = 35: GOTO 330
 1800  HOME
 1810  FOR X = 1 TO 5
 1820  PRINT  TAB( X * 2)"TOUCHDOWN!!"
 1825 P = 25:D = 25: GOSUB 8000
 1830  NEXT X
 1840  IF Z$ = A$ THEN SA = SA + 6: GOTO 1
860
 1850 SB = SB + 6
 1860  GOSUB 100
 1870  PRINT "TO PLAY FOR EXTRA POINT"
 1880  GOSUB 170
 1890  PRINT "--------------------------
----------"
 1900  PRINT "THE BALL IS SNAPPED...PREPAR
E TO KICK!"
 1910  GOSUB 70
 1920  GOSUB 2200
 1930  IF E > 9 THEN  PRINT "YOU MISSED":N
U = 20: GOTO 1970
 1940  PRINT "YOU SCORED...":NU = 35
 1950  IF Z$ = A$ THEN SA = SA + 1: GOTO 1
980
 1960 SB = SB + 1
 1970  GOSUB 140
 1980  GOSUB 100
 1990  GOSUB 170
 2000  GOTO 330
 2010  FOR X = 1 TO 10
 2015 P = 200:D = 100: GOSUB 8000
 2020  PRINT  TAB( 2 * X)"PERIOD OVER"
 2030  NEXT X
 2040  GOSUB 100
 2050  GOSUB 170
```

```
 2060  GOTO 660
 2070  FOR X = 1 TO 10
 2080  PRINT  TAB( X * 2)"HALF TIME"
 2090  NEXT X
 2100  GOSUB 100
 2110 Z$ = B$
 2120  GOSUB 170
 2130 NU = 35:W = W + 2: GOTO 330
 2140  FOR X = 1 TO 10
 2150  PRINT  TAB( X * 2)"GAME OVER"
 2160  NEXT X
 2170  GOSUB 100
 2180  END
 2190  REM  **********************
 2200 E = 0:X = 10
 2210  IF Z$ = A$ AND VC = 1 THEN  PRINT "
THIS ONE FOR ";A$: GOTO 2290
 2220 E = E + 1:X = X - 1
 2230  PRINT  TAB( E);E
 2240  FOR Y = 1 TO X * 1.5
 2250 I =  PEEK ( - 16384) - 128: IF I > 0
 THEN I$ =  CHR$ (I)
 2252  POKE  - 16368,0
 2255  IF I$ <  > "" THEN Y = X * 1.5 + 1:
 RETURN
 2260  NEXT Y
 2270  IF E = 11 THEN  RETURN
 2280  GOTO 2220
 2290  FOR E = 1 TO  FN A(7) + 2
 2300  FOR J = 1 TO 60: NEXT J
 2310  PRINT  TAB( E);E
 2320  NEXT E
 2330  RETURN
 2340  PRINT "TOO LATE!!"
 2350  PRINT "YOU'VE BEEN SACKED!!"
 2360 E =  FN A(4)
 2370  IF E = 3 THEN 2430
 2380  PRINT "AND LOST FIVE YARDS!"
 2390 TG = TG + 5:DN = DN + 1:NU = NU - 5
 2400  GOSUB 170
 2410  IF DN > 3 THEN 1160
 2420  GOTO 610
 2430  PRINT "AND LOST POSSESSION!"
```

```
 2440 DN = 0:NU =  ABS (100 - NU + 5):SL =
 NU:TG = 10
 2450  GOSUB 170
 2460  GOSUB 140
 2470  GOTO 610
 8000  REM   SOUND ROUTINE
 8010  POKE 10,P: POKE 11,D: CALL 768: RET
URN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

TENNIS / Apple IIe version

```
 10  REM  TENNIS
 15  REM  APPLE IIE/IIC VERSION
 20  HOME
 30  GOSUB 8020
 40 AA = 0:BB = 0:T = 0:KA = 0
 50 XA = 0:YA = 0:ZA = 0
 60 XB = 0:YB = 0:ZB = 0
 70  DEF  FN A(X) =  INT ( RND (1) * X) +
1
 80  INPUT "ONE HUMAN PLAYER OR TWO ";A
 90  IF A < 1 OR A > 2 THEN 80
 100  IF A = 1 THEN A$ = "BJORNX":VC = 1
 110  IF VC = 1 THEN 160
 120  PRINT "PLEASE ENTER A SIX-LETTER NAM
E"
 130  INPUT "NAME OF FIRST PLAYER ";A$
 140  IF  LEN (A$) < 6 THEN A$ = A$ + " ":
 GOTO 140
 150 A$ =  LEFT$ (A$,6)
 160  INPUT "NAME OF SECOND PLAYER ";B$
 170  IF  LEN (B$) < 6 THEN B$ = B$ + " ":
 GOTO 170
 180 B$ =  LEFT$ (B$,6)
 190 S = 1:AA = 1:BB = 1
 200  HOME
 210 P$ = A$:R$ = B$
 220  REM  **********************
 230  IF P$ = A$ THEN R$ = B$
 240  IF P$ = B$ THEN R$ = A$
 250  PRINT P$;" SERVING"
 260  PRINT "DO YOU WANT TO SERVE 1 - FAST
"
 270  PRINT "                    OR 2 - SLOW
"
 280  IF P$ = A$ AND VC = 1 AND SC = 0 THE
N KB = 1: GOSUB 1720: GOTO 330
 290  IF P$ = A$ AND VC = 1 AND SC = 1 THE
N KB = 2: GOSUB 1720: GOTO 330
 300 K$ = "":K =  PEEK ( - 16384) - 128: I
F K > 0 THEN K$ =  CHR$ (K): POKE
      - 16368,0
```

```
 310  IF K$ < "1" OR K$ > "2" THEN 300
 320 KB =  VAL (K$)
 330  PRINT : PRINT  TAB( 6)KB; TAB( 10)">
 IT'S A ";
 340  IF KB = 1 THEN  PRINT "FAST";
 350  IF KB = 2 THEN  PRINT "SLOW";
 360  PRINT " SERVE..."
 370  GOSUB 1720
 380  IF KB = 1 THEN EB =  FN A(3): GOTO 4
00
 390 EB =  FN A(8)
 400  IF EB = 1 THEN 450
 410  IF EB = 3 AND SC = 0 THEN 520
 420  IF EB = 3 AND SC = 1 THEN 590
 430  GOTO 670
 440  REM  *************************
 450  HOME : PRINT
 460  PRINT  TAB( 8)"....ACE..."
 470  GOSUB 1720
 480 SC = 0
 490  IF P$ = A$ THEN 1140
 500  GOTO 1150
 510  REM  *************************
 520  HOME : PRINT
 530  PRINT  TAB( 12)"....OUT...."
 540  PRINT  TAB( 8)"...SECOND SERVE..."
 550  GOSUB 1720
 560 SC = 1
 570  GOTO 230
 580  REM  *************************
 590  HOME : PRINT
 600  PRINT  TAB( 12)"....OUT...."
 610  PRINT  TAB( 9)"....DOUBLE FAULT...."
 620  GOSUB 1720
 630 SC = 0
 640  IF P$ = A$ THEN 1150
 650  GOTO 1140
 660  REM  *************************
 670 SC = 0
 680  HOME : PRINT
 690  POKE  - 16368,0
 700  PRINT R$;", THE BALL IS": PRINT "IN
YOUR COURT"
```

```
 710  PRINT "----------------------"
 720  IF R$ = A$ AND VC = 1 THEN 750
 730  PRINT "HIT ANY KEY, WHEN YOU SEE THE
 ZERO,     TO RETURN THE BALL..
      "
 750 X = 4 *  FN A(3):Y = X
 760  GOSUB 1720
 770 E = 5
 780  PRINT  TAB( 2 * (11 - E));E
 790 Y = Y - 1
 800 S$ = "":S1 =  PEEK ( - 16384) - 128:
IF S1 > 0 THEN S$ =  CHR$ (S): POKE
      - 16368,0
 810  IF S$ <  > "" AND E = 0 THEN 890
 820  IF S$ <  > "" THEN 990
 830  IF Y > 0 THEN 790
 840 E = E - 1:Y = X
 850  IF E <  - 1 THEN 990
 860  IF E =  - 1 AND R$ = A$ AND VC = 1 T
HEN 890
 870  GOTO 780
 880  IF KB = 1 THEN EA =  FN A(2): GOTO 1
000
 890 EA =  FN A(4): GOSUB 5000
 900  IF E = 0 AND R$ = A$ AND VC = 1 THEN
 EA =  FN A(8)
 910  IF EA = 1 THEN 940
 920  IF R$ = A$ THEN R$ = B$: GOTO 670
 930 R$ = A$: GOTO 670
 940  PRINT R$;", YOU,VE HIT THE BALL"
 950  PRINT  TAB( 8)"OUT OF PLAY..."
 960  GOSUB 1720
 970  IF R$ = A$ THEN R$ = B$: GOTO 1150
 980  GOTO 1140
 990 EA =  FN A(4)
 1000  IF EA = 1 THEN 1070
 1010  PRINT "YOU MISSED THE BALL, AND..."
 1020  GOSUB 1720
 1030  PRINT "IT WAS IN...BAD MISTAKE"
 1040  GOSUB 1720
 1050  IF R$ = A$ THEN R$ = B$: GOTO 1150
 1060  GOTO 1140
 1070  PRINT "YOU MISSED THE BALL AND..."
```

```
 1080  GOSUB 1720
 1090  PRINT "   IT WAS OUT..WELL LEFT"
 1100  GOSUB 1720
 1110  IF R$ = A$ THEN R$ = B$: GOTO 1140
 1120  GOTO 1150
 1130  REM  ************************
 1140 AA = AA + 1: GOTO 1160
 1150 BB = BB + 1
 1160  IF AA < 5 AND BB < 5 THEN 1230
 1170  IF (BB > 4 AND AA < 4) OR (BB > 4 A
ND BB - AA > 1) THEN AA = 1:BB =
     1: GOTO 1500
 1180  IF (AA > 4 AND BB < 4) OR (AA > 4 A
ND AA - BB > 1) THEN AA = 1:BB =
     1: GOTO 1440
 1190  IF AA > 4 AND AA > BB THEN C$ = "AD
V":D$ = "---": GOTO 1320
 1200  IF (BB > 4 AND BB > AA) THEN D$ = "
ADV":C$ = "---": GOTO 1320
 1210 C$ = "{DEUCE":D$ = "{DEUCE": GOTO 13
20
 1220  REM  ************************
 1230  RESTORE
 1240  FOR D = 1 TO AA
 1250  READ C$
 1260  NEXT D
 1270  RESTORE
 1280  FOR D = 1 TO BB
 1290  READ D$
 1300  NEXT D
 1310  REM  ************************
 1320  HOME
 1330  PRINT "----------------------"
 1340  PRINT "           SET SET SET"
 1350  PRINT "----------------------"
 1360  PRINT "             1   2   3  GAME"
 1370  PRINT A$;"      ";XA;"   ";YA;"   "
;ZA;"   ";C$
 1380  PRINT B$;"      ";XB;"   ";YB;"   "
;ZB;"   ";D$
 1390  PRINT "----------------------"
 1400  GOSUB 1720
 1410  IF T <  > 1 THEN 230
```

```
 1420  END
 1430  REM  ************************
 1440  HOME
 1445  GOSUB 5500
 1450  PRINT "GAME TO ";A$
 1460  GOSUB 1720
 1470  IF S = 1 THEN XA = XA + 1:C$ = "O":
D$ = "O": GOTO 1560
 1480  IF S = 2 THEN YA = YA + 1:C$ = "O":
D$ = "O": GOTO 1580
 1490  IF S = 3 THEN ZA = ZA + 1:C$ = "O":
D$ = "O": GOTO 1600
 1500  HOME
 1505  GOSUB 5500
 1510  PRINT "GAME TO ";B$
 1520  GOSUB 1720
 1530  IF S = 1 THEN XB = XB + 1:C$ = "O":
D$ = "O": GOTO 1560
 1540  IF S = 2 THEN YB = YB + 1:C$ = "O":
D$ = "O": GOTO 1580
 1550  IF S = 3 THEN ZB = ZB + 1:C$ = "O":
D$ = "O": GOTO 1600
 1560  IF (XA > 5 AND XB < 5) OR (XA < 5 A
ND XB > 5) THEN 1630
 1570  IF (XA > 5 AND XA - XB > 1) OR (XB
> 5 AND XB - XA > 1) THEN 1630
 1580  IF (YA > 5 AND YB < 5) OR (YA < 5 A
ND YB > 5) THEN 1630
 1590  IF (YA > 5 AND YA - YB < 1) OR (YB
> 5 AND YB - YA > 1) THEN 1630
 1600  IF (ZA > 5 AND ZB < 5) OR (ZA < 5 A
ND ZB > 5) THEN 1680
 1610  IF (ZA > 5 AND ZA - ZB > 1) OR (ZB
> 5 AND ZB - ZA > 1) THEN 1680
 1620  GOTO 1640
 1630 S = S + 1
 1640 AA = 1:BB = 1
 1650  IF P$ = A$ THEN R$ = A$:P$ = B$: GO
TO 1320
 1660 P$ = A$:R$ = B$: GOTO 1320
 1670  REM  **********************
 1680 T = 1
 1690  GOTO 1320
```

```
 1700  REM  **********************
 1710  REM  DELAY
 1720  FOR M = 1 TO 1000: NEXT M
 1730  RETURN
 1740  DATA  "0","15","30","40"
 5000 PZ = 200:DZ = 50
 5010  GOSUB 8000
 5020  RETURN
 5500 PZ = 100:DZ = 50
 5510  FOR TL = 1 TO 3
 5520  GOSUB 8000
 5530  FOR TD = 1 TO 50: NEXT TD
 5540  NEXT TL
 5550  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,PZ: POKE 11,DZ: CALL 768: R
ETURN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
 14580  IF S = 2 THEN YA = YA + 1:C$ = "0"
:D$ = "0": GOTO 1580
```

GRAND PRIX / Apple IIe version

```
 10  REM  GRAND PRIX
 15  REM  APPLE IIE/IIC VERSION
 20  GOSUB 2200: REM  INITIALIZE
 30  GOSUB 1190: REM  CHOOSE TRACK
 40  REM  ************************
 50  REM  MAJOR LOOP
 60  GOSUB 120: REM  PRINTOUT
 70  GOSUB 280: REM  ACCELERATION/CHECK
 80  GOSUB 450: REM  ENGINE/BRAKES
 90  GOSUB 500: REM  CORNER/POSITION
 100  GOTO 60
 110  REM  ************************
 120  REM  PRINTOUT
 130  HOME
 140  PRINT "ENGINE TEMPERATURE "; INT (EN
G * 10) / 10;" C.  (MAX. 200)"
 150  PRINT "BRAKE TEMPERATURE: "; INT (BR
AK * 10) / 10;" C.  (MAX. 500)"
 160  PRINT " DISTANCE COVERED: "; INT (DI
ST * 10) / 10;" METERS"
 170  PRINT "                  : "; INT (DI
ST * 100 / RR) / 100;" LAPS"
 180  PRINT "YOU'RE IN POSITION "; INT (FP
)
 190  PRINT "-----------------------------
---------"
 200  PRINT "    CURRENT SPEED: "; INT (SP
 * 10) / 10;" KPH"
 210  PRINT "                   : "; INT (SP
 * 5.555) / 10;" METERS PER MOV
     E"
 220  PRINT "-----------------------------
---------"
 230  PRINT "CORNER APPROACHING "; INT (AP
P);" METERS"
 240  PRINT "RECOMMENDED SPEED: ";C(C);" K
PH"
 250  PRINT "-----------------------------
---------"
 260  RETURN
 270  REM  ************************
```

```
 280  REM  CHECK ACCELERATION AND FACTORS
 290  GET X$: IF X$ <  > "Z" AND X$ <  > "
M" AND X$ <  > " " THEN 290
 300  PRINT  TAB( 12)"OK"
 310 X = 0
 320  IF X$ = "M" THEN X = SP / 15
 330  IF X$ = "Z" THEN X =  - SP / 15
 340 NUM = NUM + 1: REM  NUMBER OF MOVES
 350 SP = SP + X
 360  IF SP < 0 THEN SP = 0
 370 TRAV = SP * .5555: REM   DISTANCE TRA
VELLED
 380 DIST = DIST + TRAV: REM  TOTAL DISTAN
CE TRAVELLED
 390 ENG = ENG + (X / 2) + .07: IF ENG < 7
0 THEN ENG = 70 +  RND (1) * 8:
      REM  ENGINE TEMP
 400  IF X > 0 THEN BRAK = BRAK * .9: REM
 BRAKE EMP FALLING; ACCELERATIN
     G
 410  IF X < 1 THEN BRAK = BRAK - (3 * X)
-  RND (1) * 3: REM  BRAKE TEMP
      INCREASING; BRAKING
 420  IF BRAK < 8 THEN BRAK = 8 +  RND (1)
 * 8
 430  RETURN
 440  REM  **********************
 450  REM  CHECK ENGINE/BRAKE TEMP
 460  IF ENG > 200 THEN  PRINT "YOUR ENGIN
E HAS OVERHEATED": GOSUB 5000: GOTO
     830
 470  IF BRAK > 500 THEN  PRINT "YOUR BRAK
ES HAVE OVERHEATED": GOSUB 5000
     : GOTO 830
 480  RETURN
 490  REM  **********************
 500  REM  CHECK CORNERING SPEED AND FIELD
 POSITION
 510 APP = APP - TRAV
 520  IF APP > 0 THEN  RETURN
 530 CRASH = 0
 540  IF SP > (C(C) * 1.125) THEN CRASH =
1: GOTO 690
```

```
 550  IF SP > (C(C) * 1.1) THEN  GOTO 690
 560 PNT = PNT + 100 - ((C(C) * 1.1) - SP)
: REM    CORNERING POINTS
 570 NC = NC + 1: REM  NUMBER OF CORNERS
 580 CP = 96 - (PNT / NC): REM  CORNERING
POSITION
 590 AM = AM + A(C): REM  AVERAGE NUMBER O
F MOVES ALLOWED
 600 RP = NUM - AM: REM  RACING POSITION.
YOUR MOVES MINUS AVERAGE MOVES
 610 FP = (CP + RP) / 2: REM  FIELD POSITI
ON IS AVERAGE OF CORNER & RACE
     POSITIONS
 620  IF FP < 1 THEN FP = 1
 630 C = C + 1
 640  IF C = WW THEN C = 1: REM  LAP OVER
 650 APP = APP + D(C)
 660  IF LAP * QQ = AM THEN 910: REM  RACE
 OVER
 670  RETURN
 680  REM  ************************
 690  REM  CRASHED
 700  HOME
 710  PRINT "YOU CORNERED AT "; INT (10 *
SPEED) / 10;" KPH"
 720  PRINT "AND THE MAXIMUM SPEED WAS JUS
T ";C(C)
 730  GOSUB 2330
 740  PRINT "YOU SPIN OFF THE TRACK..."
 750  GOSUB 2330
 760  IF CRASH = 1 THEN  GOSUB 5200: GOTO
830
 770  PRINT "YOU'VE LOST 20 SECONDS, BUT Y
OU'RE      ABLE TO REJOIN THE R
     ACE"
 780 NUM = NUM + 10:SP =  INT (2 * (C(C) /
 3)
 790 PNT = PNT + 50
 800  GOSUB 2330
 810  GOTO 570
 820  REM  ************************
 830  PRINT ".....AND CRASH!!!!!!"
```

```
 840  PRINT "-----------------------------
---------"
 850  PRINT "YOU ONLY COMPLETED "; INT (10
 * DIST) / 10;" METERS"
 860  PRINT "OR "; INT (DIST * 100 / RR) /
 100;" LAPS AND AT THAT"
 870  PRINT "STAGE WERE IN POSITION "; INT
 (FP)
 880  PRINT "-----------------------------
---------"
 890  GOTO 1050
 900  REM  ************************
 910  REM  RACE OVER
 920  HOME
 930 EFLAG = 1
 940  FOR X = 1 TO 20
 950  PRINT  TAB( X)"WELL DONE, ";A$;" !!"
 960  PRINT  TAB( 21 - X)"WELL DONE ";A$;"
 !!"
 970  NEXT X
 980  PRINT "-----------------------------
---------"
 990  PRINT "YOU MANAGED TO LAST OUT THE F
ULL        ";LAP;" LAP RACE..."
 1000  PRINT "----------------------------
----------"
 1010  GOSUB 2330
 1020  PRINT "YOU FINISHED IN POSITION ";
INT (FP)
 1030  PRINT "AFTER STARTING IN 6TH POSITI
ON..."
 1040  GOSUB 2330
 1050  PRINT "YOUR AVERAGE SPEED WAS "; IN
T (DIST * 180 / NUM) / 100;" KP
     H"
 1060  GOSUB 2330
 1070  IF RP < 1 THEN RP = 1
 1080  IF CP < 1 THEN CP = 1
 1090  PRINT "YOU WERE "; INT ( ABS (RP));
"TH FASTEST ON STRAIGHTS,"
 1100  PRINT "AND "; INT ( ABS (CP));"TH F
ASTEST ON CORNERS."
```

```
 1110  PRINT : PRINT "PRESS 'S' FOR SAME R
ACE, 'N' FOR NEW    RACE, 'E' T
     O END"
 1120  GET I$: IF I$ <  > "S" AND I$ <  >
"N" AND I$ <  > "E" THEN 1120
 1130  IF I$ = "E" THEN  END
 1140  GOSUB 2240
 1150  RESTORE
 1160  IF I$ = "S" THEN  GOSUB 1490:LAP =
L2AP: GOTO 60
 1170  IF I$ = "N" THEN  HOME : GOSUB 1250
: GOTO 60
 1180  REM  **********************
 1190  REM  NAME AND TRACK DATA
 1200  INPUT "WHAT IS YOUR NAME, DRIVER ";
A$
 1210  PRINT
 1220  FOR X = 1 TO 3
 1230  PRINT  TAB( 4 * X)"OK, GOOD LUCK, "
;A$
 1240  GOSUB 2330: NEXT X
 1250  PRINT "****************************
**********"
 1260  PRINT "WHICH RACE DO YOU WANT TO TA
KE PART IN:"
 1270  PRINT
 1280  PRINT  TAB( 7)"BRITISH GRAND PRIX
2650MT   :1"
 1290  PRINT  TAB( 7)"GERMAN  GRAND PRIX
1700MT   :2"
 1300  PRINT  TAB( 7)"ITALIAN GRAND PRIX
2200MT   :3"
 1310  PRINT  TAB( 7)"MONACO  GRAND PRIX
3100MT   :4"
 1320  PRINT
 1330  PRINT  TAB( 7)"ENTER A NUMBER (1 TO
 4)"
 1340  GET K$
 1350  IF K$ < "1" OR K$ > "4" THEN 1340
 1360 GP =  VAL (K$)
 1370  PRINT "****************************
**********"
 1380  PRINT  TAB( 8)"OK, THE ";
```

```
 1390  IF GP = 1 THEN  PRINT "BRITISH";
 1400  IF GP = 2 THEN  PRINT "GERMAN";
 1410  IF GP = 3 THEN  PRINT "ITALIAN";
 1420  IF GP = 4 THEN  PRINT "MONACO";
 1430  PRINT " RACE"
 1440  PRINT "**************************
**********"
 1450  PRINT : PRINT "OVER HOW MANY LAPS?"
 1460  INPUT LAP: IF LAP < 1 THEN 1460
 1470 LAP =  INT (LAP + .5):L2AP = LAP
 1480  REM  ****************
 1490  REM  BRITISH DATA
 1500 SP = 140
 1510  FOR X = 1 TO 9
 1520  READ D(X): REM  DISTANCE BETWEEN CO
RNERS
 1530  NEXT X
 1540  DATA  800,400,250,200,250,300,100,1
00,250
 1550  FOR X = 1 TO 9
 1560  READ C(X): REM  RECOMMENDED MAXIMUM
 CORNERING SPEED
 1570  NEXT X
 1580  DATA  150,90,175,200,200,90,90,150,
150
 1590  FOR X = 1 TO 9
 1600  READ A(X): REM  AVERAGE NUMBER OF M
OVES ALLOWED BETWEEN CORNERS
 1610  NEXT X
 1620  DATA  8,4,2,2,2,2,1,1,2
 1630 APP = 800:WW = 10:QQ = 24:RR = 2650
 1640  IF GP = 1 THEN  RETURN
 1650  REM  ***********************
 1660  REM  GERMAN DATA
 1670 SP = 85
 1680  FOR X = 1 TO 7
 1690  READ D(X)
 1700  NEXT X
 1710  DATA  600,200,100,150,250,200,200
 1720  FOR X = 1 TO 7
 1730  READ C(X)
 1740  NEXT X
 1750  DATA  90,175,120,90,200,200,175
```

```
 1760  FOR X = 1 TO 7
 1770  READ A(X)
 1780  NEXT X
 1790  DATA  6,2,1,2,2,2,2
 1800 APP = 600:WW = 8:QQ = 17:RR = 1700
 1810  IF GP = 2 THEN  RETURN
 1820  REM  ************************
 1830  REM  ITALIAN DATA
 1840 SP = 108
 1850  FOR X = 1 TO 7
 1860  READ D(X)
 1870  NEXT X
 1880  DATA  800,300,100,150,300,350,200
 1890  FOR X = 1 TO 7
 1900  READ C(X)
 1910  NEXT X
 1920  DATA  120,90,90,150,200,120,150
 1930  FOR X = 1 TO 7
 1940  READ A(X)
 1950  NEXT X
 1960  DATA  8,3,2,1,3,3,2
 1970 APP = 800:WW = 8:QQ = 22:RR = 2200
 1980  IF GP = 3 THEN  RETURN
 1990  REM  ************************
 2000  REM  MONACO DATA
 2010 SP = 162.5
 2020  FOR X = 1 TO 14
 2030  READ D(X)
 2040  NEXT X
 2050  DATA  400,100,100,300,400,300,150,2
00,200,200
 2060  DATA   150,150,200,250
 2070  FOR X = 1 TO 14
 2080  READ C(X)
 2090  NEXT X
 2100  DATA  175,150,175,200,120,200,175,9
0,175,150
 2110  DATA  150,175,120,150
 2120  FOR X = 1 TO 14
 2130  READ A(X)
 2140  NEXT X
 2150  DATA  4,1,1,3,4,3,1,2,2,2
 2160  DATA  1,2,2,2
```

```
 2170 APP = 400:WW = 15:QQ = 30:RR = 3100
 2180  RETURN
 2190  REM  ************************
 2200  REM  INITIALIZATION
 2210  HOME
 2220  GOSUB 8020
 2230  DIM A(14),C(14),D(14)
 2240 C = 1:FP = 6:PNT = 0:NC = 0:CP = 0:
 2250 AM = 0:RP = 0:APP = 0
 2260 NUM = 0: REM  NUMBER OF MOVES
 2270 ENG = 100:BRAK = 10:TRAV = 0:DIST =
0
 2280 EFLAG = 0
 2290 X = 0
 2300  RETURN
 2310  REM  ************************
 2320  REM  DELAY
 2330  FOR O = 1 TO 1000: NEXT O
 2340  RETURN
 5000 PZ = 200:DZ = 75
 5010  FOR TL = 1 TO 3
 5020  GOSUB 8000
 5030  NEXT TL
 5040  RETURN
 5200 PZ = 100:DZ = 255
 5210  GOSUB 8000
 5220  RETURN
 8000  REM   SOUND ROUTINE
 8010  POKE 10,PZ: POKE 11,DZ: CALL 768: R
ETURN
 8020  POKE 768,173: POKE 769,48: POKE 770
,192: POKE 771,136: POKE 772,20
     8: POKE 773,4
 8030  POKE 774,198: POKE 775,11: POKE 776
,240: POKE 777,8: POKE 778,202:
      POKE 779,208: POKE 780,246
 8040  POKE 781,166: POKE 782,10: POKE 783
,76: POKE 784,0: POKE 785,3: POKE
     786,96
 8050  RETURN
```

FLIGHT SIMULATION / Apple IIe version

```
 10  REM  FLIGHT SIMULATION
 15  REM  APPLE IIE/IIC VERSION
 20 RPT = 0
 30 LD =  INT ( RND (1) * 360)
 40  DIM E$(1000): REM  THIS HOLDS FLIGHT
RECORD
 50  DIM A$(7),C$(7): REM  THESE ARRAYS HO
LD HORIZON AND COMPASS OUTPUT
 60  REM  ********************
 70  GOSUB 2320: REM  INITIALIZE
 80  IF CRASH = 0 THEN  GOSUB 820: REM   H
ORIZON/COMPASS
 90  GOSUB 500: REM   PRINTOUT
 100  IF CRASH = 1 THEN  END
 110  IF LA = 1 AND UFLAG = 1 THEN  PRINT
"WELL DONE. A PERFECT LANDING!!
     ": END
 120  IF LA = 1 AND UFLAG = 0 THEN  PRINT
"YOUR WHEELS ARE UP": GOSUB 178
     0: GOTO 90
 130 T = AI:STALL = 0
 140 X$ = "":XZ = 0:XZ =  PEEK ( - 16384)
- 128: IF XZ > 0 THEN X$ =  CHR$
     (XZ)
 150  IF X$ = "R" THEN RPT = 1: GOTO 70
 160  IF RPT = 1 AND E$(CLOCK + 1) = "" TH
EN RPT = 0: GOTO 140
 170  IF RPT = 1 THEN X$ = E$(CLOCK + 1)
 180  IF X$ = "" THEN 140
 185  POKE  - 16368,0
 190  IF CLOCK < 999 THEN E$(CLOCK + 1) =
X$
 200  IF TAKEOV = 1 THEN EL =  INT (EL +
RND (1) * 2 -  RND (1) * 3)
 210  IF AI < 3 THEN 290
 220  IF X$ = "Q" THEN EL = EL + 5:EFLAG =
 5: IF EL > 60 THEN STALL = 1
 230  IF X$ = "A" THEN EL = EL - 5:EFLAG =
  - 5: IF EL <  - 70 THEN STALL
       =  - 1
 240  IF STALL <  > 0 THEN  GOSUB 1640
```

```
 250  IF ALTIMETER < 1 THEN 290: REM  PREV
ENTS DRAMATIC TURNS ON THE GROU
     ND
 260  IF X$ = "Z" THEN WA = WA - .5:ANG =
ANG - 6: IF WA <  - 3 THEN WA =
     - 3
 270  IF X$ = "M" THEN WA = WA + .5:ANG =
ANG + 6: IF WA > 3 THEN WA = 3
 280 ANG =  INT (ANG +  RND (1) * 2 -  RND
 (1) * 2)
 290  IF X$ = " " THEN AI = AI + 8.5
 300  IF X$ = "." THEN AI = AI - 7
 310 AI = AI - EL / 5
 320  IF UFLAG = 1 THEN AI = AI - 1.5:FUEL
 = FUEL - .5
 330  IF AI < 0 THEN AI = 0
 340  IF AI > 400 THEN AI = 400
 350  IF X$ = "1" AND UFLAG = 0 THEN UFLAG
 = 1: GOTO 370
 360  IF X$ = "1" AND UFLAG = 1 THEN UFLAG
 = 0
 370 FUEL = FUEL - ( ABS (T - AI) / 10) -
3.75
 380  IF FUEL < 1 THEN  GOSUB 1780
 390  IF TAKEOV = 1 THEN 420
 400  IF EL > 10 AND AI > 45 AND AI < 60 A
ND UFLAG = 1 THEN TAKEOV = 1
 410  IF TAKEOV = 0 THEN ALTIMETER = 0: GO
TO 450
 420  IF LA = 0 AND AI < 30 THEN EL = EL -
 5:ALTIMETER = 9 * ALTIMETER /
     10
 430 ALTIMETER = ALTIMETER +  INT (((EL +
.1) * AI) + EFLAG * AI / 1000) /
     80
 440  IF ALTIMETER < 300 AND TAKEOV = 1 TH
EN ALTIMETER = ALTIMETER + AI /
     30 + EL
 450  IF ALTIMETER < 0 THEN  GOSUB 1780: R
EM  CRASH
 460  REM  CHANGE NEXT TWO LINES TO MAKE I
T EASIER (OR EVEN HARDER) TO LA
     ND
```

```
 470  IF ALTIMETER > 15 AND AI > 20 OR TAK
EOV = 0 THEN 80
 480  IF  ABS (ANG - LD) < 13 OR  ABS (ANG
 + 360 - LD) < 13 THEN LA = 1: GOTO
     80
 490  REM  ******************
 500  REM  PRINTOUT
 510  HOME
 520  PRINT "   HORIZON"; TAB( 20)"HEADING
"
 530 EV =  INT (EL / 10)
 540  IF EV > 2 THEN EV = 2
 550  IF EV <  - 2 THEN EV =  - 2
 560  IF EV <  > 0 AND TAKEOV = 1 AND CRAS
H = 0 THEN  GOSUB 1920
 570  PRINT ":----------------:---------:"
 580  FOR J = 1 TO 7
 590  PRINT ": ";A$(J);" :";C$(J);" :"
 600 A$(J) = ""
 610  NEXT J
 620  PRINT ":-------------------------:"
 630 DIST = DIST +  ABS (( COS (EL)) * AI)
 / 360
 640 CLOCK = CLOCK + 1
 650  PRINT ":RANGE "; INT (DIST * 10) / 1
0;": TIME "; INT (CLOCK) / 10;"
     : ";LD
 660  PRINT ":-------------------------:"
 670  PRINT ":AIRSPEED : "; INT (AI)
 675  IF AI < 20 THEN  PRINT ">": GOTO 690
 680  PRINT ": "; LEFT$ (Q$, INT (AI / 20)
);">"
 690  PRINT ":ALTIMETER: "; INT (ALTIMETER
);
 700  IF ANG < 0 THEN  PRINT  TAB( 19)360
+ ANG;" DEG."
 710  IF ANG >  = 0 THEN  PRINT  TAB( 19)A
NG;" DEG."
 720 MR =  INT (ALTIMETER / 30): IF MR > 2
0 THEN MR = 20
 725  IF MR = 0 THEN  PRINT ">": GOTO 740
 730  PRINT ": "; LEFT$ (Q$,MR);">"
 740  PRINT ":FUEL     : "; INT (FUEL)
```

```
 750  PRINT ": "; LEFT$ (Q$,20 -  INT (FUE
L / 750));">"
 760  PRINT ":-------------------------:"
 770  PRINT ":ELEVATION: ";EL;": ";: GOSUB
 2210: PRINT U$
 780  IF UFLAG = 1 THEN  PRINT ":"; TAB( 5
)"> UNDERCARRIAGE DOWN < :"
 790  IF UFLAG = 0 THEN  PRINT ":"; TAB( 6
)"> UNDERCARRIAGE UP <   :"
 795  IF CRASH = 1 THEN  END
 800  RETURN
 810  REM  ************************
 820  REM  ASSIGN HORIZON/COMPASS
 830  IF  ABS ( INT (WA + .5)) = 3 THEN  G
OSUB 980
 840  IF  ABS ( INT (WA + .5)) = 2 THEN  G
OSUB 1070
 850  IF  ABS ( INT (WA + .5)) = 1 THEN  G
OSUB 1160
 860  IF  INT (WA + .5) = 0 THEN  GOSUB 12
50
 870  REM  NEXT TWO LINES USED TO GRADUALL
Y STRAIGHTEN UP WINGS
 880  IF WA > 0 THEN WA = WA - .2
 890  IF WA < 0 THEN WA = WA + .2
 900  IF WA > .2 THEN 1350
 910  FOR Z = 1 TO 7
 920 M$(8 - Z) = A$(Z)
 930  NEXT Z
 940  FOR Z = 1 TO 7
 950 A$(Z) = M$(Z)
 960  NEXT Z
 970  GOTO 1350
 980  REM  WA=3 OR -3
 990 A$(1) = "              = "
1000 A$(2) = "            ==  "
1010 A$(3) = "          ==    "
1020 A$(4) = "        ==      "
1030 A$(5) = "      ==        "
1040 A$(6) = "   ==           "
1050 A$(7) = "==              "
1060  RETURN
1070  REM  WA=2 OR WA=-2
```

```
 1080 A$(1) = "                  "
 1090 A$(2) = "              == "
 1100 A$(3) = "          ===    "
 1110 A$(4) = "      ===        "
 1120 A$(5) = "  ===            "
 1130 A$(6) = "===              "
 1140 A$(7) = "                 "
 1150  RETURN
 1160  REM  WA=1 OR WA=-1
 1170 A$(1) = "                 "
 1180 A$(2) = "                 "
 1190 A$(3) = "           =====" 
 1200 A$(4) = "   ======        "
 1210 A$(5) = "====             "
 1220 A$(6) = "                 "
 1230 A$(7) = "                 "
 1240  RETURN
 1250  REM  WA=0
 1260 A$(1) = "                 "
 1270 A$(2) = "                 "
 1280 A$(3) = "                 "
 1290 A$(4) = "==============="
 1300 A$(5) = "                 "
 1310 A$(6) = "                 "
 1320 A$(7) = "                 "
 1330  RETURN
 1340  REM  ********************
 1350  REM  ASSIGN COMPASS STRINGS
 1360 F2 = ANG - F1
 1370  IF F2 < 0 THEN FA =  INT ((F2 + 375
) / 30)
 1380  IF F2 >  = 0 THEN FA =  INT ((F2 +
15) / 30)
 1390  IF FA = 12 THEN FA = 0
 1400 C$(1) = "    .N.  "
 1410  IF FA = 11 THEN C$(2) = "  .@:.. ":
 GOTO 1450
 1420  IF FA = 0 THEN C$(2) = "  ..@.. ":
GOTO 1450
 1430  IF FA = 1 THEN C$(2) = "  ..:@. ":
GOTO 1450
 1440 C$(2) = "  ..:.. "
```

```
 1450  IF FA = 10 THEN C$(3) = " .@ : ..":
 GOTO 1480
 1460  IF FA = 2 THEN C$(3) = " .. : @.":
GOTO 1480
 1470 C$(3) = " .. : .."
 1480  IF FA = 9 THEN C$(4) = " W@-X--E":
GOTO 1510
 1490  IF FA = 3 THEN C$(4) = " W--X-@E":
GOTO 1510
 1500 C$(4) = " W--X--E"
 1510  IF FA = 8 THEN C$(5) = " .@ : ..":
GOTO 1540
 1520  IF FA = 4 THEN C$(5) = " .. : @.":
GOTO 1540
 1530 C$(5) = " .. : .."
 1540  IF FA = 7 THEN C$(6) = "  .@:.. ":
GOTO 1580
 1550  IF FA = 8 THEN C$(6) = "  ..@.. ":
GOTO 1580
 1560  IF FA = 5 THEN C$(6) = "  ..:@. ":
GOTO 1580
 1570 C$(6) = "  ..:.. "
 1580 C$(7) = "   .S.  "
 1590  IF ANG > 360 THEN ANG = ANG - 360
 1600 F2 = ANG
 1610  IF W > 0 THEN W = W - .4
 1620  IF W < 0 THEN W = W + .4
 1630  RETURN
 1640  REM  STALL/FALL
 1650  IF STALL =  - 1 THEN 1710
 1660  FOR J = 1 TO 10
 1670  PRINT  TAB( J)"YOU HAVE STALLED!"
 1680  NEXT J
 1690 AI = AI / 4
 1700  RETURN
 1710  FOR J = 1 TO 10
 1720  PRINT  TAB( J)"UNCONTROLLED DIVE!!"
 1730  PRINT  TAB( 21 - J)"PULL UP!!"
 1740  NEXT J
 1750 ALTIMETER = 4 * ALTIMETER / 5
 1760  RETURN
 1770  REM  ********************
```

```
 1780  REM  CRASH
 1790 CRASH = 1
 1800 ALTIMETER = 0
 1810 M$ = "** *C R**  A ** S* H* !!*": RE
M  25 CHARACTERS LONG
 1820  FOR J = 1 TO 20
 1830  PRINT  TAB( J)"CRASH!"
 1840  PRINT  TAB( 21 - J)"CRASH!"
 1850  NEXT J
 1860  FOR J = 1 TO 7
 1870 G =  INT ( RND (1) * 11) + 1
 1880 A$(J) =  MID$ (M$,G,14)
 1890  NEXT J
 1900  RETURN
 1910  REM  ********************
 1920  REM  ADJUST HORIZON
 1930 G$ = "              ": REM  14 SPACE
S
 1940  ON EV + 3 GOSUB 1960,2020,2070,2080
,2140
 1950  RETURN
 1960  REM  EV=-2
 1970  FOR J = 1 TO 4
 1980 A$(J) = A$(J + 3)
 1990  NEXT J
 2000 A$(5) = G$:A$(6) = G$:A$(J) = G$
 2010  RETURN
 2020  REM  EV=-1
 2030  FOR J = 1 TO 6
 2040 A$(J) = A$(J + 1)
 2050  NEXT J
 2060 A$(7) = G$
 2070  RETURN : REM  EV=0
 2080  REM  EV=1
 2090  FOR J = 6 TO 1 STEP  - 1
 2100 A$(J + 1) = A$(J)
 2110  NEXT J
 2120 A$(1) = G$
 2130  RETURN
 2140  REM  EV=2
 2150  FOR J = 4 TO 1 STEP  - 1
 2160 A$(J + 3) = A$(J)
 2170  NEXT J
```

```
 2180 A$(1) = G$:A$(2) = G$:A$(3) = G$
 2190  RETURN
 2200  REM  **********************
 2210  REM  INPUT INTO COMMAND NAME
 2220 U$ = "--------"
 2230  IF X$ = " " THEN U$ = "THROTTLE ON"
 2240  IF X$ = "." THEN U$ = "THROTTLE OFF
"
 2250  IF X$ = "Q" AND ALTIMETER > 0 THEN
U$ = "CLIMB"
 2260  IF X$ = "Q" AND ALTIMETER = 0 THEN
U$ = "NOSE UP"
 2270  IF X$ = "A" THEN U$ = "NOSE DOWN"
 2280  IF X$ = "Z" THEN U$ = "BANK LEFT"
 2290  IF X$ = "M" THEN U$ = "BANK RIGHT"
 2300  RETURN
 2310  REM  ********************
 2320  REM  INITIALIZATION
 2330  HOME
 2350 Q$ = "----------------------": REM  2
1 CHARACTERS IN STRING
 2360 UFLAG = 1: REM  UNDERCARRIAGE - 1 -
DOWN, 0 - UP
 2370 EFLAG = 0: REM  CLIMB RATE
 2380 ANG = 0:TAKEOV = 0:LA = 0
 2390 AI = 0: REM  AIRSPEED
 2400 DIST = 0: REM  DISTANCE COVERED 'RAN
GE'
 2410 ALTIMETER = 0
 2420 EL = 0: REM  ANGLE OF ELEVATION
 2430 WA = 0: REM  'WING ANGLE; USED IN HO
RIZON PRINTOUT
 2440 FUEL = 750:CRASH = 0:F2 = 0:F1 = 0:
REM  FOR DIRECTION CHANGE/COMPA
     SS ROUTINE
 2450 CLOCK = 0: REM  TIME
 2460 X$ = ""
 2470  RETURN
```

COMMODORE 64

SPACE LANDING SIMULATION / Commodore 64 version

```
10 REM SPACE LANDING SIMULATION
20 FLAG=INT(RND(VAL(RIGHT$(TI$,2)))):REM
RANDOMIZE
30 REM ******************************
40 REM SET STARTING VALUES
45 POKE 53280,0:POKE 53281,0
50 FUEL=200+RND(1)*40
60 VELOCITY=RND(1)*20-6
70 HEIGHT=500-RND(1)*10
80 PRINT"
{CLR}{WHT}"
90 PRINT" FUEL";TAB(12);" VELOCITY";TAB(
24);" HEIGHT"
100 REM ******************************
110 REM MAJOR CYCLE
120 GOSUB 430
130 IF FUEL<=0 THEN FUEL=0:THRUST=0:GOTO
 170
140 GET A$
150 IF A$<"0" OR A$>"9" THEN 140
160 THRUST=VAL(A$)+.1
170 FUEL=FUEL-THRUST
180 FLAG=THRUST-2
190 THRUST=0
200 HEIGHT=HEIGHT+VELOCITY+FLAG/4
210 VELOCITY=VELOCITY+FLAG
220 IF HEIGHT<=10 THEN 240
230 IF HEIGHT>10 THEN 120
240 IF VELOCITY>-9 AND VELOCITY<5 THEN 2
90
250 GOSUB 410
```

```
260 PRINT"YOU HAVE CRASHED INTO THE SURF
ACE..."
270 IF HEIGHT>0 THEN HEIGHT=-HEIGHT
280 GOTO 320
290 GOSUB 4000:PRINT"YOU HAVE LANDED SAF
ELY!"
300 PRINT"YOUR SKILL RATING IS"INT(-1000
*FUEL/(VELOCITY-HEIGHT))
310 HEIGHT=0
320 GOSUB 410
330 PRINT"FINAL INSTRUMENT READINGS WERE
:"
340 PRINT" FUEL";TAB(12);" VELOCITY";TAB
(24);" HEIGHT"
350 GOSUB 430
360 GOSUB 410
370 IF HEIGHT>=0 THEN END
380 PRINT"NEW CRATER ON MOON"INT(ABS(100
*(HEIGHT+.2)/3))/100"METERS DEEP!"
390 PRINT"YOUR SKILL RATING IS "INT(100*
FUEL/(VELOCITY-HEIGHT))
400 END
410 PRINT"------------------------------
--------"
420 RETURN
430 PRINT INT(100*FUEL)/100;
440 PRINT TAB(12);-INT(100*VELOCITY)/100
;
450 IF HEIGHT>=0 THEN PRINT TAB(24);INT(
100*HEIGHT)/100
460 IF HEIGHT<0 THEN PRINT
470 RETURN
4000 SID=54272
4010 FOR L1=0 TO 23
4020 POKE SID+L1,0
4030 NEXT L1
4040 POKE SID+24,15
4050 POKE SID+5,15
4060 POKE SID+6,255
4070 POKE SID+4,17
4080 FOR L1=48 TO 220 STEP .7
4090 POKE SID+1,L1
4100 NEXT L1
```

```
4110 FOR L1=28 TO 200
4120 POKE SID+1,L1
4130 NEXT L1
4140 FOR L1=200 TO 28 STEP -1
4150 POKE SID+1,L1
4160 NEXT L1
4170 POKE SID+1,0
4180 RETURN
```

MONTE CARLO DEMONSTRATION / Commodore 64 version

```
10 REM MONTE CARLO DEMONSTRATION
20 GOSUB 370:REM INITIALISE
30 REM ****************************
40 REM MAJOR CYCLE
45 PRINT"
{CLR}"
50 GOSUB 100:REM PRINT
60 IF P=EP AND Q=EQ THEN PRINT:PRINT"DEM
ONSTRATION OVER":END
70 GOSUB 230:REM GENERATE MOVE
80 GOTO 50
90 REM ****************************
100 REM PRINTOUT
110 A$(P,Q)="O"
120 M=M+1
130 PRINT"
{HOME}":PRINT:PRINT
140 PRINT"MOVE"M
150 FOR X=1 TO 10
160 FOR Y=1 TO 10
170 PRINTA$(X,Y);" ";
180 NEXT Y
190 PRINT
200 NEXT X
210 RETURN
220 REM ****************************
230 REM GENERATE MOVE
240 A$(P,Q)="."
250 G=0
260 T=INT(RND(1)*4)+1
270 ON T GOSUB 310,320,330,340
280 IF G=0 THEN 260
290 IF G=1 AND RND(1)>.5 THEN 260
300 RETURN
310 IF P>1 THEN P=P-1:G=G+1:RETURN
320 IF P<10 THEN P=P+1:G=G+1:RETURN
330 IF Q>1 THEN Q=Q-1:G=G+1:RETURN
340 IF Q<10 THEN Q=Q+1:G=G+1:RETURN
350 RETURN
360 REM ****************************
```

```
370 REM INITIALISE
380 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}"
390 X=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
400 DIM A$(10,10)
410 FOR X=1 TO 10
420 FOR Y=1 TO 10
430 A$(X,Y)="."
440 NEXT Y
450 NEXT X
460 PRINT:PRINT
470 PRINT"ENTER FIRST START CO-ORDINATE
(LESS      THAN 10)"
480 INPUT P
490 IF P<1 OR P>10 THEN 480
500 PRINT"ENTER SECOND START CO-ORDINATE
 (LESS     THAN 10)"
510 INPUT Q
520 IF Q<1 OR Q>10 THEN 510
530 PRINT:PRINT
540 PRINT"ENTER FIRST END CO-ORDINATE (L
ESS        THAN 10)"
550 INPUT EP
560 IF EP<1 OR EP>10 THEN 550
570 PRINT"ENTER SECOND END CO-ORDINATE (
LESS       THAN 10)"
580 INPUT EQ
590 IF EQ<1 OR EQ>10 THEN 580
600 A$(P,Q)="O"
610 A$(EP,EQ)="X"
620 RETURN
```

CELL CLASH SIMULATION / Commodore 64 version

```
10 REM SIMULTANEOUS EQUATIONS
20 POKE 53280,0:POKE 53280,0:PRINT"
{CLR}"
30 T=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
40 HS=0
50 FD=RND(0)
60 PRINT:PRINT"DECAY FACTOR IS"FD
70 GOSUB 550
80 PRINT"
{CLR}"
90 PRINT:PRINT
100 PRINT"ENTER NUMBER OF CELL X TO
          START (LESS THAN 40)"
110 INPUT CP:IF CP<1 OR CP>39 THEN 110
120 PRINT:PRINT
130 PRINT"WE HAVE"CP" X CELLS"
140 PRINT:PRINT
150 PRINT"ENTER NUMBER OF CELL Y TO
          START (LESS THAN 40)"
160 INPUT EP:IF EP<1 OR EP>39 THEN 160
170 PRINT "
{CLR}":PRINT:PRINT"PLEASE STAND BY..."
180 GOSUB 550:PRINT"
{CLR}"
190 DA=1
200 IF CP>EP/FD THEN CP=EP/FD
210 PRINT"--------------"
215 IF INT(CP)<0 THEN CP=0
216 IF INT(EP)<0 THEN EP=0
220 PRINT "TIME ELAPSED:"DA
230 PRINT INT(CP)"CELL X"
240 PRINT INT(EP)"CELL Y"
250 REM ****************************
260 REM MAJOR CYCLE
270 GOSUB 550
280 DA=DA+1
290 PRINT"--------------"
300 PRINT "TIME ELAPSED:"DA
310 IF CP>EP/FD THEN CP=EP/FD
```

```
320 REM EQUATIONS FOLLOW; MODIFY PARTS
      OF THEM TO SEE WHAT HAPPENS
330 CP=CP+((8*CP-CP*EP/3)*FD)
340 EP=EP+((8*EP-EP*CP/3)*.01)
350 PRINT INT(CP)"CELL X"
360 PRINT INT(EP)"CELL Y"
370 IF EP<2 OR CP<2 THEN 410
380 GOSUB 550
390 GOTO 280
400 REM ****************************
410 IF DA>HS THEN HS=DA
420 PRINT:PRINT
430 PRINT"YOUR CELL CLASH SIMULATION SUR
VIVED"
440 PRINT"FOR"DA"TIME PERIODS."
450 PRINT"------------------------------
----"
460 PRINT"THE BEST SURVIVAL TIME SO FAR
IS"HS
470 GOSUB 550
480 PRINT"------------------------------
----"
490 PRINT"DO YOU WANT A NEW RUN (Y OR N)
?"
500 GET A$
510 IF A$<>"Y" AND A$<>"N" THEN 500
520 IF A$="Y" THEN PRINT "
(CLR)":GOTO 60
530 PRINT"OK":PRINT:PRINT:END
540 REM ****************************
550 FOR J=1 TO 2000:NEXT
560 RETURN
```

LIFE / Commodore 64 version

```
10 REM CONWAY'S LIFE SIMULATION
20 REM DEFINED INITIAL COLONY
30 GOSUB 460:REM INITIALISE
40 REM ************************
50 REM MAJOR CYCLE
60 GENERATIN=GENERATIN+1
70 GOSUB 290:REM PRINTOUT
80 GOSUB110:REM EVOLVE
90 GOTO 60
100 REM ************************
110 REM EVOLVE
120 FOR X=2 TO 12
130 FOR Y=2 TO 12
140 C=0
150 IF A$(X-1,Y-1)="X" THEN C=C+1
160 IF A$(X-1,Y)="X" THEN C=C+1
170 IF A$(X-1,Y+1)="X" THEN C=C+1
180 IF A$(X,Y-1)="X" THEN C=C+1
190 IF A$(X,Y+1)="X" THEN C=C+1
200 IF A$(X+1,Y-1)="X" THEN C=C+1
210 IF A$(X+1,Y)="X" THEN C=C+1
220 IF A$(X+1,Y+1)="X" THEN C=C+1
230 IF A$(X,Y)="X" AND C<>2 AND C<>3 THE
N B$(X,Y)=CHR$(32)
240 IF A$(X,Y)=" " AND C=3 THEN B$(X,Y)=
"X"
250 NEXT Y
260 NEXT X
270 RETURN
280 REM ************************
290 REM PRINTOUT
300 PRINT"
{CLR}"
310 PRINT
320 PRINTTAB(4);"GENERATION"GENERATIN
330 PRINT
340 FOR X=2 TO 12
350 FOR Y=2 TO 12
360 A$(X,Y)=B$(X,Y)
370 PRINT A$(X,Y);
380 NEXT Y
```

```
390 FOR Y=12 TO 2 STEP -1
400 PRINT A$(X,Y);
410 NEXT Y
420 PRINT
430 NEXT X
440 RETURN
450 REM ************************
460 REM INITIALISE
470 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}{PUR}"
480 D=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
500 DIM A$(13,13),B$(13,13)
510 PRINT:PRINT"  PLEASE STAND BY..."
520 FOR X=1 TO 13
530 PRINT 14-X;
540 FOR Y=1 TO 13
550 REM FILL ARRAY WITH BLANKS
560 A$(X,Y)=CHR$(32)
570 B$(X,Y)=A$(X,Y)
580 NEXT Y
590 NEXT X
600 READ D:IF D=99 THEN 630
610 READ E:A$(D,E)="X":B$(D,E)="X"
620 GOTO 600
630 GENERATIN=0
640 RETURN
650 DATA 5,5,5,9,6,6,6,8
660 DATA 7,7
670 DATA 8,6,8,8,9,5,9,9
700 DATA 99
```

ROBOT LOGO / Commodore 64 version

```
100 REM ROBOT LOGO
110 GOSUB 1730:REM INITIALISE
120 GOTO 490
130 REM ******************************
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 DATA "*"
330 REM ******************************
340 REM INT UX,AX
350 UX=INT(UX+.5):AX=INT(AX+.5)
360 RETURN
370 REM ******************************
380 REM          PRINT OUT
390 PRINT "
{CLR}"
400 PRINT"STEP"PSN" > ";A$(PSN):PRINT
410 FOR J=1 TO DEPTH
420 FOR K=1 TO BREATH
430 PRINT Z$(J,K);
440 NEXT K
450 PRINT
460 NEXT J
470 RETURN
480 REM ******************************
490 REM READ PROGRAM
```

```
500 COUNT=COUNT+1
510 READ A$(COUNT)
520 IF A$(COUNT)="*" THEN 550
530 IF COUNT<20 THEN 500
540 REM ****************************
550 REM EXECUTE PROGRAM
560 PSN=0:REM PROGRAM STEP NUMBER
570 PSN=PSN+1
580 IF PSN=21 THEN 580:REM END
590 FLAG=0
600 M$=A$(PSN)
610 IF M$="*" THEN 610:REM END
620 N$=LEFT$(M$,2)
630 IF N$="ST" THEN 560:REM START AGAIN
640 IF N$="PR" THEN GOSUB 380:REM PRINTO
UT
650 IF N$="FO" THEN FLAG=1
660 IF N$="BA" THEN FLAG=2
670 IF N$="TU" THEN FLAG=3
680 IF N$="HO" THEN FLAG=4
690 IF N$="CL" THEN FLAG=5
700 IF N$="GO" THEN FLAG=6
710 IF N$="RA" THEN FLAG=7
720 IF N$="RE" THEN FLAG=8
730 IF N$="EN" THEN FLAG=9
740 IF N$="FA" THEN FLAG=10
750 ON FLAG GOSUB 780,940,1000,1160,1220
,1260,1400,1460,1530,1580
760 GOTO 570
770 REM ****************************
780 REM       FORWARD
790 M$=MID$(M$,4)
800 IF ASC(M$)=87 THEN M$=MID$(M$,6)
810 F$="F"
820 NUM=VAL(M$)
830 FOR E=1 TO NUM
840 IF UX<1 OR UX>DEPTH THEN 880
850 IF AX<1 OR AX>BREATH THEN 880
860 Z$(UX,AX)=T$
880 IF F$="F" THEN UX=UX+UP:AX=AX+AC
890 IF F$="B" THEN UX=UX-UP:AX=AX-AC
900 GOSUB 340
910 NEXT E
```

```
920 RETURN
930 REM ******************************
940 REM          BACK
950 M$=MID$(M$,4)
960 IF ASC(M$)=78 THEN M$=MID$(M$,3)
970 F$="B"
980 GOTO 820
990 REM ******************************
1000 REM         TURN
1010 M$=MID$(M$,4)
1020 IF ASC(M$)=78 THEN M$=MID$(M$,3)
1030 NUM=VAL(M$)
1040 Y=INT((NUM+17.5)/45)
1050 IF Y=0 OR Y=8 THEN RETURN
1060 FOR J=1 TO Y
1070 IF UP=-1 AND AC=0 THEN AC=1:GOTO 11
30
1080 IF UP=0 AND AC=1 THEN UP=1:GOTO 113
0
1090 IF UP=1 AND AC=0 THEN AC=-1:GOTO 11
30
1100 IF UP=0 AND AC=-1 THEN UP=-1:GOTO 1
130
1110 IF UP=-1 AND AC=-1 OR UP=1 AND AC=1
 THEN AC=0:GOTO 1130
1120 IF UP=-1 AND AC=1 OR UP=1 AND AC=-1
 THEN UP=0
1130 NEXT J
1140 RETURN
1150 REM ******************************
1160 REM HOME
1170 AX=INT((BREATH+.5)/2)
1180 UX=INT((DEPTH+.5)/2)
1190 UP=-1:AC=0:REM FACES UP
1200 RETURN
1210 REM ******************************
1220 REM         CLEAN
1230 GOSUB 1870
1240 RETURN
1250 REM ******************************
1260 REM        GO X,Y
1270 P=0
1280 P=P+1
```

```
1290 IF MID$(M$,P,1)="," THEN 1320
1300 IF P<LEN(M$) THEN 1280
1310 RETURN:REM ERROR
1320 UX=VAL(MID$(M$,4,P-1))
1330 AX=VAL(RIGHT$(M$,LEN(M$)-P))
1340 GOSUB 340
1350 IF UX<1 OR UX>DEPTH THEN 1380
1360 IF AC<1 OR AC>BREATH THEN 1380
1370 Z$(UX,AX)=R$
1380 RETURN
1390 REM ****************************
1400 REM       RANDOM
1410 AX=INT(RND(1)*BREATH)
1420 UX=INT(RND(1)*DEPTH)
1430 Z$(UX,AX)=R$
1440 RETURN
1450 REM ****************************
1460 REM        REPEAT
1470 M$=MID$(M$,4)
1480 IF ASC(M$)=69 THEN M$=MID$(M$,5)
1490 RECOUNT=VAL(M$)
1500 MARKER=PSN
1510 RETURN
1520 REM ****************************
1530 REM     END REPEAT
1540 RECOUNT=RECOUNT-1
1550 IF RECOUNT>0 THEN PSN=MARKER
1560 RETURN
1570 REM ****************************
1580 REM        FACE
1590 M$=MID$(M$,4)
1600 IF ASC(M$)=69 THEN M$=MID$(M$,3)
1610 NUM=VAL(M$)
1620 Y=INT((NUM+17.5)/45)*45
1630 IF Y=0 OR Y=360 THEN UP=-1:AC=0
1640 IF Y=45 THEN UP=-1:AC=1
1650 IF Y=90 THEN UP=0:AC=1
1660 IF Y=135 THEN UP=1:AC=1
1670 IF Y=180 THEN UP=1:AC=0
1680 IF Y=225 THEN UP=1:AC=-1
1690 IF Y=270 THEN UP=0:AC=-1
1700 IF Y=315 THEN UP=-1:AC=-1
1710 RETURN
```

```
1720 REM ****************************
1730 REM INITIALISE
1740 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}"
1750 J=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
1770 BREATH=40:REM CHARACTERS ACROSS
1780 DEPTH=24:REM CHARACTERS DOWN
1790 BREATH=BREATH-1
1800 DEPTH=DEPTH-3
1810 UP=-1:AC=0:REM STARTS FACING UP
1820 DIM A$(20):REM FOR ROBOT PROGRAM
1830 DIM Z$(DEPTH,BREATH):REM DISPLAY
1840 T$="X":REM PUT SYMBOL HERE YOU
    WANT TO USE FOR ROBOT'S TRAIL
1850 AX=0:UX=0
1860 REM FILL ARRAY WITH SPACES
1870 FOR J=1 TO DEPTH
1880 FOR K=1 TO BREATH
1890 Z$(J,K)=" "
1900 NEXT K
1910 NEXT J
1920 RETURN
```

POINT-DUTY ROBOT / Commodore 64 version

```
100 REM POINT-DUTY ROBOT
110 GOSUB 1730:REM INITIALISE
120 GOTO 490
130 REM ******************************
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
280 REM
290 REM
300 REM
310 REM
320 DATA "*"
330 REM ******************************
340 REM INT UX,AX
350 UX=INT(UX+.5):AX=INT(AX+.5)
360 RETURN
480 REM ******************************
490 REM READ PROGRAM
500 COUNT=COUNT+1
510 READ A$(COUNT)
520 IF A$(COUNT)="*" THEN 550
530 IF COUNT<20 THEN 500
540 REM ******************************
550 REM EXECUTE PROGRAM
560 PSN=0:REM PROGRAM STEP NUMBER
570 PSN=PSN+1
580 IF PSN=21 THEN 580:REM END
590 FLAG=0
600 M$=A$(PSN)
610 IF M$="*" THEN 610:REM END
```

```
620 N$=LEFT$(M$,2)
630 IF N$="ST" THEN 560:REM START AGAIN
650 IF N$="FO" THEN FLAG=1
660 IF N$="BA" THEN FLAG=2
670 IF N$="TU" THEN FLAG=3
680 IF N$="HO" THEN FLAG=4
700 IF N$="GO" THEN FLAG=5
710 IF N$="RA" THEN FLAG=6
720 IF N$="RE" THEN FLAG=7
730 IF N$="EN" THEN FLAG=8
740 IF N$="FA" THEN FLAG=9
750 ON FLAG GOSUB 780,940,1000,1160,1260
,1400,1460,1530,1580
760 GOTO 570
770 REM ******************************
780 REM       FORWARD
790 M$=MID$(M$,4)
800 IF ASC(M$)=87 THEN M$=MID$(M$,6)
810 F$="F"
820 NUM=VAL(M$)
830 FOR E=1 TO NUM
840 IF UX<1 OR UX>DEPTH THEN 880
850 IF AX<1 OR AX>BREATH THEN 880
860 GOSUB 2000
880 IF F$="F" THEN UX=UX+UP:AX=AX+AC
890 IF F$="B" THEN UX=UX-UP:AX=AX-AC
900 GOSUB 340
910 NEXT E
920 RETURN
930 REM ******************************
940 REM          BACK
950 M$=MID$(M$,4)
960 IF ASC(M$)=75 THEN M$=MID$(M$,3)
970 F$="B"
980 GOTO 820
990 REM ******************************
1000 REM        TURN
1010 M$=MID$(M$,4)
1020 IF ASC(M$)=78 THEN M$=MID$(M$,3)
1030 NUM=VAL(M$)
1040 Y=INT((NUM+11.25)/22.5)
1050 IF Y=0 OR Y=16 THEN RETURN
1060 FOR J=1 TO Y
```

```
1065 IF UP=-2 AND AC=0 OR UP=2 AND AC=2
THEN AC=1:GOTO 1130
1070 IF UP=-2 AND AC=1 THEN AC=2:GOTO 11
30
1075 IF UP=-2 AND AC=2 OR UP=0 AND AC=-2
 THEN UP=-1:GOTO 1130
1080 IF UP=-1 AND AC=2 OR UP=1 AND AC=-2
 THEN UP=0:GOTO 1130
1085 IF UP=0 AND AC=2 OR UP=2 AND AC=-2
THEN UP=1:GOTO 1130
1090 IF UP=1 AND AC=2 THEN UP=2:GOTO 113
0
1095 IF UP=2 AND AC=1 THEN AC=0:GOTO 113
0
1100 IF UP=2 AND AC=0 THEN AC=-1:GOTO 11
30
1105 IF UP=2 AND AC=-1 THEN AC=-2:GOTO 1
130
1110 IF UP=-1 AND AC=-2 THEN UP=-2:GOTO
1130
1115 IF UP=-2 AND AC=-2 THEN AC=-1:GOTO
1130
1120 IF UP=-2 AND AC=-1 THEN AC=0
1130 NEXT J
1140 RETURN
1150 REM ****************************
1160 REM          HOME
1170 AX=INT((BREATH+.5)/2)
1180 UX=INT((DEPTH+.5)/2)
1190 UP=-2:AC=0:REM FACES UP
1200 RETURN
1210 REM ****************************
1220 REM         CLEAN
1230 GOSUB 1870
1240 RETURN
1250 REM ****************************
1260 REM        GO X,Y
1270 P=0
1280 P=P+1
1290 IF MID$(M$,P,1)="," THEN 1320
1300 IF P<LEN(M$) THEN 1280
1310 RETURN:REM ERROR
1320 UX=VAL(MID$(M$,4,P-1))
```

```
1330 AX=VAL(RIGHT$(M$,LEN(M$)-P))
1340 GOSUB 340
1350 IF UX<1 OR UX>DEPTH THEN 1380
1360 IF AC<1 OR AC>BREATH THEN 1380
1370 GOSUB 2000
1380 RETURN
1390 REM ******************************
1400 REM       RANDOM
1410 AX=INT(RND(1)*BREATH)
1420 UX=INT(RND(1)*DEPTH)
1430 GOSUB 2000
1440 RETURN
1450 REM ******************************
1460 REM        REPEAT
1470 M$=MID$(M$,4)
1480 IF ASC(M$)=69 THEN M$=MID$(M$,5)
1490 RECOUNT=VAL(M$)
1500 MARKER=PSN
1510 RETURN
1520 REM ******************************
1530 REM      END REPEAT
1540 RECOUNT=RECOUNT-1
1550 IF RECOUNT>0 THEN PSN=MARKER
1560 RETURN
1570 REM ******************************
1580 REM        FACE
1590 M$=MID$(M$,4)
1600 IF ASC(M$)=69 THEN M$=MID$(M$,3)
1610 NUM=VAL(M$)
1620 Y=INT((NUM+17.5)/45)*45
1630 IF Y=0 OR Y=360 THEN UP=-2:AC=0
1635 IF Y=22.5 THEN UP=-2:AC=1
1640 IF Y=45 THEN UP=-2:AC=2
1645 IF Y=67.5 THEN UP=-1:AC=2
1650 IF Y=90 THEN UP=0:AC=2
1655 IF Y=112.5 THEN UP=1:AC=2
1660 IF Y=135 THEN UP=2:AC=2
1665 IF Y=157.5 THEN UP=2:AC=1
1670 IF Y=180 THEN UP=2:AC=0
1675 IF Y=202.5 THEN UP=2:AC=-1
1680 IF Y=225 THEN UP=2:AC=-2
1685 IF Y=247.5 THEN UP=1:AC=-2
1690 IF Y=270 THEN UP=0:AC=-2
```

```
1695 IF Y=292.5 THEN UP=-1:AC=-2
1700 IF Y=315 THEN UP=-2:AC=-2
1705 IF Y=337.5 THEN UP=-2:AC=-1
1710 RETURN
1720 REM ****************************
1730 REM INITIALISE
1740 PRINT "
{CLR}"
1750 J=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
1770 BREATH=320:REM CHARACTERS ACROSS
1780 DEPTH=200:REM CHARACTERS DOWN
1790 BREATH=BREATH-1
1800 DEPTH=DEPTH-3
1810 UP=-2:AC=0:REM STARTS FACING UP
1820 DIM A$(20):REM FOR ROBOT PROGRAM
1830 REM TURN ON HIRES SCREEN
1840 BASE=2*4096:POKE 53272,PEEK(53272)O
R8
1850 POKE 53265,PEEK(53265)OR32
1860 REM SET SCREEN TO CYAN AND BLACK
1870 FOR I=BASE TO BASE+7999:POKE I,0:NE
XT I
1880 FOR I=1024 TO 2023:POKE I,3:NEXT I
1920 RETURN
2000 REM ****** SET A POINT *********
2010 ROW=INT(UX/8)
2020 CHAR=INT(AX/8)
2030 LINE=UXAND7
2040 BIT=7-(AXAND7)
2050 BYTE=BASE+ROW*320+CHAR*8+LINE
2060 POKE BYTE,PEEK(BYTE)OR2^BIT
2070 RETURN
```

CONNECT FOUR / Commodore 64 version

```
10 REM CONNECT FOUR
20 REM A. W. PEARSON
30 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}{WHT}"
40 PRINT
50 PRINT
60 PRINT"CONNECT FOUR"
70 PRINT
80 PRINT "ENTER YOUR MOVE AS A NUMBER BE
TWEEN"
90 PRINT "1 AND 8, ENTER 0 FOR A NEW GAM
E"
100 FOR F=1 TO 1000:NEXT F
110 DIM A$(10,10),B(10,2)
120 FLAG=0
130 REM CHANGE NEXT LINE FOR YOUR OWN
      CHOICE OF SYMBOLS (C$-COMPUTER)
140 C$="M":H$="O":REM M FOR MACHINE!
150 FOR F=1 TO 8
160 B(F,1)=6
170 NEXT F
180 FOR F=1 TO 6
190 FOR G=1 TO 8
200 A$(F,G)="."
210 NEXT G
220 NEXT F
230 REM ***************************
240 REM ACCEPT HUMAN MOVE
250 GOSUB 430
260 PRINT:PRINT"
{PUR}YOUR MOVE..."
270 INPUT A:PRINT"
{WHT}";
280 IF A=0 THEN RUN
290 IF A<1 OR A>9 THEN 270
300 L=0
310 IF A$(L+1,A)<>"." OR L=6 THEN 340
320 L=L+1
330 GOTO 310
340 IF L=0 THEN 270
350 A$(L,A)=H$
```

```
360 B(A,1)=B(A,1)-1
370 GOSUB 430
380 GOSUB 560
390 GOSUB 430
400 GOTO 260
410 REM ***************************
420 REM PRINT BOARD
430 PRINT"
{CLR}"
440 FOR F=1 TO 6
450 FOR G=1 TO 8
460 PRINT A$(F,G);
470 NEXT G
480 PRINT
490 NEXT F
500 PRINT"12345678"
510 PRINT
520 IF FLAG=1 THEN PRINT"I HAVE WON":END
530 RETURN
540 REM ***************************
550 REM COMPUTER MOVES
560 PRINT"MY MOVE..."
570 MV=0
580 FOR F=1 TO 8
590 B(F,2)=0
600 NEXT F
610 FOR F=1 TO 8
620 FOR X=-1 TO 1
630 FOR Y=-1 TO 1
640 IF B(F,1)=0 THEN 680
650 IF A$(B(F,1)+X,F+Y)="" OR A$(B(F,1)+
X,F+Y)="." THEN 680
660 IF A$(B(F,1)+X,F+Y)=H$ THEN GOSUB 81
0
670 IF A$(B(F,1)+X,F+Y)=C$ THEN GOSUB 91
0
680 NEXT Y
690 NEXT X
700 NEXT F
710 P=0
720 FOR F=1 TO 8
730 IF B(F,2)>P THEN P=B(F,2):N=F
740 NEXT F
```

```
750 A$(B(N,1),N)=C$
760 B(N,1)=B(N,1)-1
770 P=0
780 N=0
790 RETURN
800 REM ****************************
810 MV=2
820 M1=MV
830 IF A$(B(F,1)+(X*2),F+(Y*2))=H$ THEN
MV=MV+10
840 IF A$(B(F,1)-X,F-Y)=H$ THEN MV=MV+20
850 IF MV<>M1+10 THEN 870
860 IF A$(B(F,1)+(X*3),F+(Y*3))=H$ THEN
MV=MV+1000
870 B(F,2)=B(F,2)+MV
880 M1=0
890 RETURN
900 REM ****************************
910 MV=2
920 M1=MV
930 IF A$(B(F,1)+(X*2),F+(Y*2))=C$ THEN
MV=MV+9
940 IF A$(B(F,1)-X,F-Y)=C$ THEN MV=MV+20
950 IF MV<>M1+9 THEN 970
960 IF A$(B(F,1)+(X*3),F+(Y*3))=C$ THEN
MV=MV+2000:FLAG=1
970 B(F,2)=B(F,2)+MV
980 RETURN
```

QUEVEDO CHESS MACHINE / Commodore 64 version

```
10 REM QUEVEDO CHESS MACHINE
20 GOSUB 1510:REM INITIALISE
30 GOTO 60
40 GOSUB 1320:REM PRINT BOARD
50 GOSUB 110:REM COMPUTER MOVES
60 GOSUB 1320
70 GOSUB 1120:REM ACCEPT HUMAN MOVE
80 GOTO 40
90 END
100 REM ************
110 REM COMPUTER MOVES
120 IF QUIT=1 THEN 1080
130 W1=WK
140 REM ************
150 REM MOVE ONE
160 MOVE=1
170 KM=INT(BK/10)
180 RM=INT(R/10)
190 IF ABS(KM-RM)>3 THEN 330
200 A(R)=46
210 X=INT(BK/10):Y=INT(R/10)
220 IF X>Y THEN 270
230 IF A(R-10)<>46 THEN 270
240 IF A(R-19)=BK OR A(R-21)=BK OR A(R-2
0)=BK THEN 270
250 IF A(R-11)=BK OR A(R-9)=BK THEN 270
260 R=R-10:GOTO 300
270 IF A(R+10)<>46 THEN A(R)=R:GOTO 330
280 IF A(R+19)=BK OR A(R+21)=BK OR A(R+2
0)=BK THEN A(R)=R:GOTO 330
290 R=R+10
300 A(R)=ASC("R")
310 RETURN
320 REM ************
330 REM MOVE TWO
340 MOVE=2
350 KM=BK-10*KM
360 RM=R-10*RM
370 IF ABS(KM-RM)<2 THEN 480
380 A(R)=46
390 IF R>11 THEN IF (A(R-12)=BK OR A(R-2
```

```
)=BK OR A(R+8)=BK) THEN A(R)=R:GOTO 480
400 IF R>11 THEN IF (A(R-1)=BK OR A(R-11
)=BK OR A(R+9)=BK) THEN A(R)=R:GOTO 480
410 Y=BK-10*INT(BK/10)
420 Z=R-10*INT(R/10)
430 IF (Z=1 OR Y>Z) AND A(R+1)=46 THEN R
=R+1:GOTO 450
440 R=R-1
450 A(R)=ASC("R")
460 RETURN
470 REM ************
480 REM MOVE THREE
490 MOVE=3
500 WM=WK-10*INT(WK/10)
510 BM=BK-10*INT(BK/10)
520 IF ABS(WM-BM)<3 THEN 600
530 IF A(WK-1)<>46 OR A(WK-18)=BK OR A(W
K-2)=BK OR A(WK+8)=BK THEN 610
540 IF A(WK-11)=BK OR A(WK+9)=BK OR A(WK
-22)=BK THEN 610
550 A(WK)=46
560 WK=WK-1
570 A(WK)=ASC("K")
590 REM ************
600 REM MOVES FOUR, FIVE AND SIX
610 Z=ABS(INT(BK/10)-INT(WK/10))
620 IF Z=0 THEN 950
630 IF 2*INT(Z/2)=Z THEN 790
640 REM ************
650 REM MOVE FOUR
660 MOVE=4
670 A(R)=46
680 IF A(R-10)<>46 THEN 720
690 IF A(R-9)=BK OR A(R-11)=BK THEN 720
700 IF A(R-19)=BK OR A(R-21)=BK OR A(R-2
0)=BK THEN 720
710 R=R-10:GOTO 760
720 IF A(R+10)<>46 THEN A(R)=R:GOTO 790
730 IF A(R+19)=BK OR A(R+21)=BK OR A(R+2
0)=BK THEN A(R)=ASC("R"):GOTO 790
740 IF A(R+11)=BK OR A(R+9)=BK THEN A(R)
=ASC("R"):GOTO 790
750 R=R+10
```

```
760 A(R)=ASC("R")
770 RETURN
780 REM ************
790 REM MOVE FIVE
800 MOVE=5
810 J=INT(BK/10)
820 K=BK-10*J
830 L=INT(WK/10)
840 M=WK-10*L
850 Z=10:IF J<L THEN Z=-10
860 X=1:IF K<M THEN X=-1
870 A(WK)=46
880 W1=WK
890 WK=WK+Z+X
900 G=ABS(WK-BK)
910 IF G=1 OR G=9 OR G=10 OR G=11 THEN W
K=W1:A(WK)=75:GOTO 950
920 A(WK)=ASC("K")
930 RETURN
940 REM ************
950 REM MOVE SIX
960 MOVE=6
970 A(R)=46
980 IF R>11 THEN IF A(R-12)=BK OR A(R-2)
=BK OR A(R+8)=BK OR A(R-1)<>R THEN 1070
990 IF R>11 THEN IF (A(R-1)=BK OR A(R-11
)=BK OR A(R+9)=BK THEN 1070
1000 Y=BK-10*INT(BK/10)
1010 Z=R-10*INT(R/10)
1020 IF (Z=1 OR Y>Z) AND A(R+1)=46 R=R+1
:GOTO 1040
1030 R=R-1
1040 A(R)=ASC("R")
1050 RETURN
1060 REM ************
1070 GOSUB 1320
1080 PRINT:PRINT
1090 PRINT"I CONCEDE TO THE MASTER"
1100 END
1110 REM ************
1120 REM ACCEPT HUMAN MOVE
1130 REM ENTER 'Q' TO QUIT
1140 MOVE=0
```

```
1150 PRINT">> MOVE TO (LETTER, NO.)";
1160 INPUT G$
1170 IF G$="Q" THEN 1280
1180 IF LEN(G$)<>2 THEN 1160
1190 Z=ASC(G$)
1200 IF Z<65 AND Z>72 THEN 1160
1210 X=VAL(RIGHT$(G$,1))
1220 IF X<1 OR X>8 THEN 1160
1230 A(BK)=46
1240 BK=10*(Z-64)+X
1250 IF A(BK)=ASC("R") THEN QUIT=1
1260 A(BK)=ASC("$")
1270 RETURN
1280 PRINT:PRINT
1290 PRINT"THANKS FOR THE GAME"
1300 END
1310 REM ************
1320 REM PRINT BOARD
1330 PRINT"
(CLR)"
1340 PRINT:PRINT
1350 IF MOVE>0 THEN PRINT"I USED MOVE"MO
VE
1360 IF MOVE=0 THEN PRINT
1370 PRINT:PRINT
1380 PRINT TAB(11);"ABCDEFGH"
1390 FOR J=8 TO 1 STEP -1
1400 PRINT TAB(8);J;
1410 FOR K=10 TO 80 STEP 10
1420 PRINT CHR$(A(J+K));
1430 NEXT K
1440 PRINT J
1450 NEXT J
1460 PRINT
1470 PRINT TAB(11);"ABCDEFGH"
1480 PRINT:PRINT
1490 RETURN
1500 REM ************
1510 REM INITIALISATION
1520 POKE 53280,0:POKE 53281,0:PRINT"
(CLR)"
1530 J=RND(VAL(RIGHT$(TI$,2))):REM
 RANDOMIZE
```

```
1540 MOVE=0
1550 QUIT=0
1560 DIM A(130)
1570 FOR J=10 TO 80 STEP 10
1580 FOR K=1 TO 8
1590 A(J+K)=46:REM ASCII OF "."
1600 NEXT K
1610 NEXT J
1620 REM ** PLACE PIECES **
1630 REM BLACK KING - HUMAN
1640 BK=INT(RND(1)*3)+1
1650 BK=10*BK+BK+INT(RND(1)*5)
1660 A(BK)=ASC("$")
1670 REM WHITE KING - COMPUTER
1680 WK=INT(RND(1)*4)+4
1690 WK=10*WK+WK+INT(RND(1)*2)
1700 IF WK=BK THEN 1680
1710 A(WK)=ASC("K")
1720 REM WHITE ROOK - COMPUTER
1730 R=INT(RND(1)*4)+4
1740 R=10*R+R+INT(RND(1)*2)
1750 IF R=BK OR R=WK THEN 1730
1760 IF ABS(R-BK)<12 THEN 1730
1770 A(R)=ASC("R")
1780 RETURN
```

WASHINGTON D.C. / Commodore 64 version

```
10 REM WASHINGTON D.C.
20 GOSUB 1160:REM INITIALISE
30 REM ****************************
40 REM MAJOR CYCLE
50 P=INT(P+(P*273/ML))
60 GOSUB 160:REM PRINTOUT
70 GOSUB 510:REM CALCULATE
80 REM NOW CHECK END GAME
90 GOSUB 710:REM STANDARD OF LIVING
100 GOSUB 780:REM INFLATION RATE
110 GOSUB 840:REM UNEMPLOYMENT
120 IF GAME=1 THEN PRINT"
{CLR}":GOTO 890
130 GOTO 50
140 REM ****************************
150 REM PRINTOUT
160 PRINT"
{CLR}{WHT}"
170 PRINT "PRESIDENT ";A$;":"
180 PRINT"YOUR ADMINISTRATION HAS BEEN I
N                  POWER FOR"Y+Z/4"YEARS"
190 PRINT"--------------------------------
----"
200 PRINT"-----STATE OF THE NATION------
----"
210 PRINT"--------------------------------
----"
220 PRINT"POPULATION"P
230 PRINT"NO. UNEMPLOYED"INT(U)"  "INT(1
00*U/P)"%"
240 PRINT"CURRENT WAGES $"WO" INFLATION"
INT(IP)"%"
250 PRINT"GOVT. EXPENDITURE LAST QTR. $M
"GE
260 PRINT "UNEMPLOYMENT COST $M"INT(10*G
U)/10
270 PRINT "INCOME FROM TAXES $M"INT(10*G
I)/10
280 PRINT"BUDGET SURPLUS(+)/DEFICIT(-) $
M"INT(BD*10)/10
```

```
290 PRINT"GROSS DOMESTIC PRODUCT $M"INT(
GDP*10)/10
300 IF Y+Z/4>.5 THEN PRINT"CHANGE IN LIV
ING STANDARD ";
305 IF Y+Z/4>.5 THEN PRINTINT((2*((RGDP/
AGDP)*100)-100)/3)"%"
310 PRINT"------------------------------
----"
320 PRINT"PUBLIC INVESTMENT"Y"@"Z"$M"INT
(IV*10)/10
330 PRINT"------------------------------
----"
340 PRINT"OK, PRESIDENT ";A$;"..."
350 INPUT "ENTER GOVERNMENT SPENDING $M"
;GE
360 INPUT "
{PUR}ENTER COST OF WAGES $M";WN
370 PRINT"IS YOUR ADMINISTRATION IN FAVO
R OF"
380 PRINT"IMMIGRATION THIS QUARTER (Y/N)
?
{WHT}"
390 GET X$
400 IF X$<>"Y" AND X$<>"N" THEN 390
410 PRINT TAB(20);"OK...";X$
420 FOR H=1 TO 1000:NEXT H
430 IF X$<>"Y" THEN RETURN
440 PRINT "
{PUR}HOW MANY IMMIGRANTS WILL YOU ALLOW
                INTO THE US"
450 INPUT M:PRINT"
{PUR}";
460 IF M<0 THEN 450
470 P=P+M
480 RETURN
490 REM ****************************
500 REM CALCULATIONS
510 CN=CN+(CN*IP/100)
520 U=P*(GE+IV)/(CN*10)+P*(IP/1000)
530 GU=U*WN/ML:REM UNEMPLOYMENT COST
540 GI=(((P-U)*WN*.4)/ML):REM INCOME
                              FROM TAXES
550 BD=BD+GI-GU-GE:REM BUDGET DEFICIT
```

```
560 AGDP=AGDP*(1+(IP/1000))
570 GDP=GE+IV+((P-U)*WN/ML)
580 RGDP=GDP*440/AGDP
590 IP=((GE+IV)/CN*.1+(WN/WO)/100)*100
600 IV=(CN*67)/(IP*IP)
610 WO=WN
620 Z=Z+1:IF Z>4 THEN Z=1:Y=Y+1
630 RETURN
640 REM ****************************
650 REM CHECK BUDGET DEFICIT
660 IF BD>-1000 THEN RETURN
670 GAME=1
680 FLAG=1
690 RETURN
700 REM ****************************
710 REM CHECK STANDARD OF LIVING
720 IF Y<.75 THEN RETURN
730 IF INT((2*((RGDP/AGDP)*100)-100)/3)>
-15 THEN RETURN
740 GAME=1
750 FLAG=2
760 RETURN
770 REM ****************************
780 REM CHECK INFLATION RATE
790 IF IP<15 THEN RETURN
800 GAME=1
810 FLAG=3
820 RETURN
830 REM ****************************
840 REM CHECK UNEMPLOYMENT
850 IF INT(U*100/P)<15 THEN RETURN
860 GAME=1
870 FLAG=4
880 RETURN
890 REM ****************************
900 REM END OF THE GAME
910 PRINT"PRESIDENT ";A$;", YOUR"
920 PRINT"ADMINISTRATION'S POOR ECONOMIC"
930 PRINT"PERFORMANCE HAS LED TO AN UNAC
CEPTABLE"
940 IF FLAG=1 THEN PRINT"BUDGET DEFICET"
950 IF FLAG=2 THEN PRINT"DROP IN THE STA
NDARD OF LIVING"
```

```
960 IF FLAG=3 THEN PRINT"RISE IN THE INF
LATION RATE"
970 IF FLAG=4 THEN PRINT"RISE IN UNEMPLO
YMENT"
980 PRINT"     AMONG OTHER THINGS..."
990 PRINT"-------------------------------
----"
1000 PRINT"THE LACK OF CONFIDENCE IN YOU
R"
1010 PRINT"ADMINISTRATION IS SO BAD THER
E ARE"
1020 PRINT"CALLS FOR YOU TO RESIGN...YOU
 STEP"
1030 PRINT"ASIDE TO ALLOW THE VICE-PRESI
DENT TO"
1040 PRINT"        OCCUPY THE OVAL OFFICE
"
1050 FOR H=1 TO 1000:NEXT H
1060 PRINT"-------------------------------
----"
1070 PRINT"YOU WERE PRESIDENT FOR"Y+(Z*.
25)"YEARS"
1080 PRINT"DURING YOUR TERM OF OFFICE, T
HE"
1090 PRINT"POPULATION ROSE BY"P-3*ML
1100 PRINT"THE UNEMPLOYED RATE BECAME"IN
T(U*1000/P)/10"%"
1110 PRINT"AND THE INFLATION RATE BECAME
"INT(IP*10)/10"%"
1120 PRINT"STANDARD OF LIVING CHANGED BY
"INT((2*((RGDP/AGDP)*100)-100)/3)"%"
1130 PRINT"AND THE BUDGET SURPLUS/DEFICI
T          WAS $M"INT(BD*10)/10
1140 END
1150 REM ************************
1160 REM INITIALISE
1170 POKE 53280,0:POKE 53281,0:PRINT"
(CLR)"
1180 H=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
1190 ML=1000*1000
1200 P=3*ML:REM POPULATION
1210 U=P/10:REM UNEMPLOYMENT
```

```
1220 IV=236:REM INVESTMENT
1230 GE=118:REM GOVERNMENT EXPENDITURE
1240 GU=0:REM COST OF UNEMPLOYMENT
1250 GI=0:REM INCOME FROM TAXES
1260 WN=100:REM NEW WAGES
1270 WO=100:REM OLD WAGES
1280 IP=5:REM INFLATION PERCENT
1290 GDP=440:REM GROSS DOMESTIC PRODUCT
1300 AGDP=440:REM BASE YEAR GDP
1310 RGDP=440:REM REAL GDP
1320 CN=354:REM ECONOMIC CONSTANT
     (USED THROUGHOUT SIMULATION)
1330 Z=1:GAME=0:FLAG=0
1340 Y=0:REM YEAR
1350 PRINT "ENTER YOUR LAST NAME"
1360 INPUT A$
1370 RETURN
```

STOCK MARKET / Commodore 64 version

```
10 REM STOCK MARKET
20 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}"
30 C=INT(RND(VAL(RIGHT$(TI$,2)))):REM
RANDOMIZE
40 DIM S(5),N(5),P(5),D(5)
50 S(1)=1.49:S(2)=1.99:S(3)=2.49:S(4)=2.
99:S(5)=3.49
60 N(1)=2000:N(2)=1500:N(3)=1200:N(4)=10
00:N(5)=800
70 BB=265:TV=15000:QQ=15000:DAY=1
80 PRINT:PRINT"
{PUR}ENTER YOUR GOAL FOR THIS SIMULATION
,"
90 PRINTTAB(8);"$16,000 TO $100,000"
100 INPUT GAL:REM INPUT GOAL
110 IF GAL<16000 THEN PRINT "
{WHT}TOO LOW!":GOTO 80
120 IF GAL>100*1000 THEN PRINT "
{WHT}TOO HIGH!":GOTO 80
130 REM **********************
140 REM MAJOR LOOP
150 FOR C=1 TO 5
160 REM ADJUST THE 55 IN NEXT LINE TO
MODIFY GAME; 80 VERY HARD, 30 VERY EASY
170 D(C)=INT(RND(1)*55)+1
180 P(C)=INT(RND(1)*(100-D(C)))+1
190 NEXT C
200 GOSUB 230
210 GOTO 460
220 REM **********************
230 REM PRINTOUT
240 PRINT"
{CLR}{WHT}"
250 PRINT"-------------------------------
---------"
260 PRINT "DAY"DAY"        YOUR GOAL IS $
"GAL
270 PRINT"-------------------------------
---------"
```

```
280 PRINT"COMPANY NUMBER:"
290 PRINT TAB(2);1;TAB(9);2;TAB(16);3;TA
B(25);4;TAB(35);5
300 PRINT "CHANCE OF INCREASE (%):"
310 PRINT TAB(2);P(1);TAB(9);P(2);TAB(16
);P(3);TAB(25);P(4);TAB(35);P(5)
320 PRINT "CHANCE OF DECREASE (%):"
330 PRINT TAB(2);D(1);TAB(9);D(2);TAB(16
);D(3);TAB(25);D(4);TAB(35);D(5)
340 PRINT"CURRENT VALUE PER SHARE:"
350 PRINT "$";INT(S(1)*100)/100;TAB(8);"
$";INT(S(2)*100)/100;
360 PRINT TAB(15);"$";INT(S(3)*100)/100;
TAB(23);"$";INT(S(4)*100)/100;
370 PRINT TAB(30);"$";INT(S(4)*100)/100
380 PRINT"NO. OF SHARES HELD:"
390 PRINT TAB(2);N(1);TAB(9);N(2);TAB(16
);N(3);TAB(25);N(4);TAB(35);N(5)
400 PRINT"BANK $"INT(BB)" TOTAL WORTH $"
INT(100*TV)/100
410 PRINT"----------------------------
---------"
420 IF TV>GAL THEN PRINT"YOU'VE HIT YOUR
 FINANCIAL GOAL!":END
430 RETURN
440 REM **********************
450 REM        ** SELL **
460 PRINT"
{PUR}DO YOU WANT TO SELL ANY SHARES (Y/N
)?"
470 GET A$
480 IF A$<>"Y" AND A$<>"N" THEN 470
490 IF A$="N" THEN 690
500 GOSUB 230
510 PRINT"
{WHT}WHICH ONES TO SELL?";
520 GET A$
530 IF A$<"1" OR A$>"5" THEN 520
540 C=VAL(A$)
550 PRINT"
{WHT}     OK"C
560 PRINT"
```

```
{PUR}HOW MANY OF"C"TO SELL";
570 INPUT N
580 IF N>N(C) THEN PRINT"
{WHT}YOU DON'T HAVE THAT MANY!":GOTO 570
590 REM **********************
600 REM ADJUST FIGURES AFTER SALE
610 BB=BB+S(C)*N:REM ADD VALUE TO BANK
620 N(C)=N(C)-N:REM SUBTRACT NO. SOLD
630 TV=0:REM SET TOTAL WORTH TO ZERO
640 REM NOW DETERMINE CURRENT WORTH
650 FOR C=1 TO 5
660 TV=TV+N(C)*S(C)
670 NEXT C
680 TV=TV+BB:REM ADD IN BANK BALANCE
690 GOSUB 230
700 REM **********************
710 REM        ** BUY **
720 PRINT "
{PUR}DO YOU WANT TO BUY ANY SHARES (Y/N)
?"
730 GET A$
740 IF A$<>"Y" AND A$<>"N" THEN 730
750 IF A$="N" THEN 890
760 GOSUB 230
770 PRINT"
{PUR}WHICH COMPANY TO BUY?";
780 GET A$
790 IF A$<"1" OR A$>"5" THEN 780
800 C=VAL(A$)
810 PRINT"
{WHT}     OK"C
820 PRINT"
{PUR}HOW MANY OF"C"TO BUY";
830 INPUT N
840 IF N*S(C)>BB THEN PRINT"
{WHT}YOU DON'T HAVE ENOUGH MONEY!":GOTO
830
850 REM **********************
860 REM ADJUST FIGURES AFTER BUY
870 BB=BB-S(C)*N
880 N(C)=N(C)+N
890 TV=0
```

```
900 FOR C=1 TO 5
910 TV=TV+N(C)*S(C)
920 NEXT C
930 TV=TV+BB
940 GOSUB 230
950 REM **********************
960 REM MODIFY ALL INDICATORS
970 TV=0
980 FOR C=1 TO 5
990 K=INT(RND(1)*100)+1
1000 IF K<P(C) THEN S(C)=S(C)*(1+(P(C)/1
000))
1010 K=INT(RND(1)*100)+1
1020 IF K<D(C) THEN S(C)=S(C)/(1+(P(C)/1
000))
1030 TV=TV+(S(C)*N(C))
1040 NEXT C
1050 TV=TV+BB
1060 QQ=QQ+1
1070 W=(TV*100/QQ)-100
1080 IF W=0 THEN W=.1
1090 W=W+6
1100 IF W<1 THEN W=1
1110 IF W>15 THEN W=15
1120 RESTORE
1130 FOR T=1 TO W
1140 READ A$
1150 NEXT T
1160 PRINT
1170 REM **********************
1180 REM GIVE RATING, START NEW ROUND
1190 PRINT"
{WHT}YOUR RATING AFTER THAT ROUND OF"
1200 PRINT"TRADING IS '";A$;"'"
1210 PRINT:PRINT "
{PUR}   <PRESS SPACEBAR TO CONTINUE  >"
1220 GET ZZ$:IF ZZ$<>" " THEN 1220
1230 DAY=DAY+1
1240 GOTO 150
1250 DATA "HOPELESS","VERY, VERY POOR"
1260 DATA "TERRIBLE","AWFUL","BAD"
1270 DATA "VERY ORDINARY","AVERAGE"
```

```
1280 DATA "REASONABLE","A LITTLE ABOVE A
VERAGE"
1290 DATA "FAIRLY GOOD","GOOD","VERY GOO
D"
1300 DATA "GREAT","EXCELLENT","SUPERLATI
VE"
```

DETROIT CITY / Commodore 64 version

```
10 REM DETROIT CITY
20 GOSUB 1640:REM INITIALISE
30 GOTO 110
40 MT=MT+1
50 GOSUB 650
60 IF TP>200 THEN 1560
70 PRINT"
{CYN}DO YOU WANT TO RESIGN (Y/N)?{WHT}"
80 GOSUB 1010
90 IF A$="Y" THEN PRINT"OK, CHIEF":END
100 GOSUB 1380
110 GOSUB 650
120 FOR T=1 TO 1000:NEXT T
130 GOSUB 850
140 PRINT"DO YOU WANT TO EXPAND OUTPUT (
Y/N)?"
150 GOSUB 1010
160 IF A$="Y" THEN 1080
170 IF SF=1 THEN 210
180 PRINT"DO YOU WANT TO SELL FACTORY 4
(Y/N)?"
190 GOSUB 1010
200 IF A$="Y" THEN 1250
210 GOSUB 650
220 INPUT "HOW MANY EMPLOYEES TO HIRE";H
E
230 NE=NE+HE:IF HE>0 THEN 260
240 INPUT "HOW MANY EMPLOYEES TO FIRE";H
E
250 NE=NE-HE
260 GOSUB 650
270 P1=AS:REM SET P1 EQUAL TO OLD PRICE
280 INPUT "WHAT IS YOUR SELLING PRICE";A
S
290 REM  NEXT LINE REJECTS TOO BIG A
          CHANGE IN SELLING PRICE
300 IF ABS(P1-AS)>2500 THEN PRINT"TOO BI
G A CHANGE FOR THE MARKET":GOTO 280
310 PRINT"
{CLR}"
320 PRINT:PRINT:PRINT
```

```
330 MI=INT(RND(1)*4000)+48*1000:REM THIS
      MONTH'S SALES BY INDUSTRY
340 C=C+1:REM COUNTS NUMBER OF MONTHS
350 IF C<3 THEN 470
360 M=INT(RND(1)*10+1)/4:REM INFLATION
370 PRINT"
(CLR)"
380 PRINT"INFLATION RATE THIS QUARTER IS
"M"%"
390 PRINT"AVERAGE WAGES BILL WILL NOW RI
SE TO"
400 AW=(AW*M/100)+AW
410 PRINTTAB(8);"$"INT(AW)"  PER EMPLOYE
E"
420 GET ZZ$:IF ZZ$<>"" THEN 420
430 PRINT:PRINTTAB(12);"ANY KEY TO CONTI
NUE"
440 GET ZZ$:IF ZZ$="" THEN 440
450 FA=(FA*M/100)+FA
460 C=0
470 Y(1)=NE*15/12:REM SALES BASED ON
                NUMBER OF EMPLOYEES
480 Y(2)=(100-AS/FA)*MI/100:REM SALES
 BASED ON MONTHLY INDUSTRY SALES
490 REM NEXT LINE SETS LOWEST FIGURE
    FROM Y(1), Y(2), M(5) EQUAL TO Y(3)
500 IF Y(1)<Y(2) AND Y(1)<M(5) THEN Y(3)
=Y(1):GOTO 540
510 IF Y(2)<Y(1) AND Y(2)<M(5) THEN Y(3)
=Y(2):GOTO 540
520 Y(3)=M(5)
530 REM NEXT LINES DETERMINE
          MONTHLY SALES
540 IF ABS(P1-AS)<501 THEN Y(3)=3.6*Y(3)
/3
550 IF Y(3)>M(5) THEN Y(3)=Y(3)-1975:GOT
O 550
560 MC=(MC*M/100)+MC
570 EF=Y(3)/M(5)*100:REM EFFECIENCY %
 AS SALES DIVIDED BY TOTAL OUTPUT
580 AC=(MC*(ABS(85-EF)/3)/100)+MC:REM
        AVERAGE COST PER VEHICLE
```

```
590 MP=((Y(3)*(AS-AC))-(NE*AW/12)):REM
      MONTHLY PROFIT
600 MP=INT(MP/(100*1000))
610 TP=TP+MP/10:REM TOTAL PROFIT
                    IN MILLIONS
620 M=0
630 GOTO 40
640 REM ****************************
650 REM REPORT PRINTOUT
660 PRINT"
(CLR)"
670 PRINT"INDUSTRY SALES"MI"IN MONTH"MT
680 IF MT>0 THEN PRINT"YOUR SALES:"INT(Y
(3))" ("INT(Y(3)*1000/MI)/10"% OF TOTAL
)"
690 PRINT"------------------------------
---"
700 PRINT"YOU HAVE"NE"EMPLOYEES"
710 PRINT"AVERAGE WAGES ARE $"AW
720 PRINT " OR $M"INT(AW*NE/(100*1000)/1
2)/10"PER MONTH"
730 PRINT"------------------------------
---"
740 IF MT=0 THEN RETURN
750 PRINT"AVERAGE COST PER VEHICLE IS $"
INT(AC)
760 PRINT"AND AVERAGE SELLING PRICE IS $
"INT(AS)
770 PRINT"SO THE AVERAGE PROFIT IS $"INT
(AS-AC)
780 PRINT"OR $M"INT((AS-AC)*Y(3)/(100*10
00))/10"PER MONTH"
790 PRINT"------------------------------
---"
800 PRINT"PROFIT FOR THE MONTH IS $M"MP/
10
810 PRINT"& TOTAL PROFIT TO DATE IS $M"I
NT(TP*10)/10
820 PRINT"------------------------------
---"
830 RETURN
840 REM ****************************
```

```
850 REM MONTH REPORT
860 PRINT"
(CLR)"
870 IF MT>0 THEN PRINT"YOUR MONTHLY SALE
S ARE"INT(Y(3))
880 PRINT"------------------------------
---"
890 PRINT"MAXIMUM MONTHLY OUTPUT:"
900 PRINT TAB(3);"FACTORY 1:"INT(M(1))
910 PRINT TAB(3);"FACTORY 2:"INT(M(2))
920 PRINT TAB(3);"FACTORY 3:"INT(M(3))
930 IF SF=1 THEN 960
940 PRINT TAB(3);"FACTORY 4:"INT(M(4))
950 PRINT"------------------------------
---"
960 PRINT "TOTAL OUTPUT IS"INT(M(5))
970 PRINT"------------------------------
---"
980 PRINT "EFFICIENCY LEVEL IS"INT(EF)"%
"
990 RETURN
1000 REM ****************************
1010 REM GET REPLIES
1020 GET A$
1030 IF A$<>"Y" AND A$<>"N" THEN 1020
1040 PRINT TAB(22);A$
1050 FOR J=1 TO 500:NEXT J
1060 RETURN
1070 REM ****************************
1080 REM INCREASE OUTPUT?
1090 IF M(4)=0 THEN X=15:GOTO 1110
1100 X=18
1110 PRINT"IT WILL COST $M"X" TO EXPAND"
1120 PRINTTAB(8);"OUTPUT BY 1%"
1130 PRINT"------------------------------
----"
1140 PRINT"HOW MANY % DO YOU WISH TO RAI
SE OUTPUT"
1150 INPUT EP:IF EP<0 OREP>100 THEN 1150
1160 M(5)=0
1170 FOR T=1 TO 4
1180 M(T)=M(T)+M(T)*EP/100
1190 M(5)=M(5)+M(T)
```

```
1200 NEXT T
1210 TP=TP-EP*X
1220 FOR T=1 TO 500:NEXT T
1230 GOTO 170
1240 REM ******************************
1250 REM SALE OF FACTORY FOUR
1260 PRINT "FACTORY FOUR IS VALUED FOR S
ALE AT $M104"
1270 PRINT"YOU CAN'T REBUY IT LATER IF
          YOU SELL IT..."
1280 PRINT"DO YOU WANT TO SELL (Y/N)?"
1290 GOSUB 1010
1300 IF A$="N" THEN 210
1310 TP=TP+104
1320 SF=1
1330 M(5)=M(1)+M(2)+M(3)
1340 M(4)=0
1350 GOTO 170
1360 REM ******************************
1370 REM CHECK ON LOSSES
1380 IF MP>0 THEN SA=0:GOTO 1480
1390 SA=SA+1
1400 IF SA>11 THEN 1420
1410 GOTO 1480
1420 PRINT"
{CLR}":PRINT
1430 PRINT"YOU JUST MADE YOUR TWELTH MON
THLY"
1440 PRINT"LOSS IN A ROW.............
..."
1450 PRINTTAB(6);"YOUR EMPLOYMENT"
1460 PRINTTAB(6);"IS HEREBY TERMINATED!!
"
1470 END
1480 IF TP>=-250 THEN 1350
1490 PRINT"
{CLR}":PRINT
1500 PRINT"UNDER YOUR MANAGEMENT, THE CO
MPANY HAS"
1510 PRINT"LOST MORE THAN $M250!"
1520 GOTO 1450
1530 IF TP>200 THEN 1570
1540 RETURN
```

```
1550 REM ****************************
1560 REM SWEET SWEET SUCCESS!!!
1570 PRINT"
(CLR)":PRINT
1580 PRINT"WELL DONE! THE COMPANY HAS MA
DE MORE"
1590 PRINT"    THAN $M200.    YOU'VE BEEN
MADE"
1600 PRINT"          A MEMBER OF THE BOARD
"
1610 FOR T=1 TO 2000:NEXT T
1620 END
1630 REM ****************************
1640 REM INITIALISE
1660 T=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
1670 DIM M(5),Y(5)
1680 NE=12000:REM STARTING NO EMPLOYEES
1690 AW=22995:REM STARTING AVERAGE WAGE
1700 AC=11100:REM COST PRICE/VEHICLE
1710 AS=12000:REM SELLING PRICE
1720 MI=50*1000:MC=10100
1730 Y(3)=12500
1740 MS=25:EF=77:FA=160:SF=0:MT=0
1750 FOR J=1 TO 5
1760 READ M(J)
1770 NEXT J
1780 POKE 53280,0:POKE 53281,0:RETURN
1790 DATA 8900,3250,2500,1625,16275
```

GRIDIRON / Commodore 64 version

```
5 POKE 53280,0:POKE 53281,0
10 REM GRIDIRON
20 PRINT"
{CLR}"
30 X=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
40 GOSUB 70
50 GOTO 220
60 REM ************************
70 FOR X=1 TO 1500:NEXT X
80 RETURN
90 REM ************************
100 PRINT A$;SA
110 PRINT B$;SB
120 RETURN
130 REM ************************
140 IF Z$=A$ THEN Z$=B$:RETURN
150 Z$=A$:RETURN
160 REM ************************
170 GET ZZ$:IF ZZ$<>"" THEN 170
180 PRINT"      > PRESS ANY KEY <"
190 GET ZZ$:IF ZZ$="" THEN 190
200 PRINT TAB(20);"OK":RETURN
210 REM ************************
220 REM INITIALISE
230 DEF FNA(X)=INT(RND(1)*X)+1
240 PRINT"
{WHT}ONE PLAYER OR TWO"
250 INPUT X
260 IF X<1 OR X>2 THEN 250
270 IF X=1 THEN VC=1:A$="SILICON COWBOYS
":GOTO 300
280 PRINT"WHAT IS THE NAME OF THE HOME T
EAM"
290 INPUT A$:IF A$="" THEN 290
300 PRINT"AND WHAT IS THE NAME OF THE VI
SITING     TEAM"
310 INPUT B$:IF B$="" THEN 310
315 A$="
{WHT}"+A$:B$="{PUR}"+B$
320 Z$=A$:NU=35
```

```
330 PRINT"
{CLR}"
340 PRINT"THERE ARE"INT(10*(60-(W/4)))/1
0"MINUTES TO GO"
350 PRINT TAB(8);Z$" TO KICK OFF"
360 PRINT"
{WHT}YOU ARE ON YOUR OWN"NU"YARD LINE"
370 IF VC=1 AND Z$=A$ THEN GOSUB 70:GOTO
 400
380 PRINT"TO KICK OFF..."
390 GOSUB 170
400 A=FNA(20)+40
410 PRINT Z$;" HAVE..."
420 FOR X=1 TO A
430 PRINT TAB(X/3);"KICKED"X"YARDS"
440 NEXT X
450 NU=NU+X
460 GOSUB 70
470 PRINT "
{PUR}THE BALL IS CAUGHT!"
480 GOSUB 70
490 A=FNA(30)+10
500 FOR X=1 TO A
510 PRINT TAB(X/5);"AND RETURNED"X"YARDS
"
520 NEXT X
530 NU=ABS(100-NU+X)
540 GOSUB 140
550 PRINT"------------------------------
----"
560 PRINT"THE BALL IS DOWN ON"
570 PRINT Z$;"'S"NU"YARD LINE"
580 IF Z$=A$ AND VC=1 THEN GOSUB 70:GOTO
600
590 GOSUB 170
600 TG=10:D=0:SL=NU
610 IF W=60 OR W=180 THEN 2010
620 IF W=120 THEN 2070
630 IF W=240 THEN 2140
640 PRINT"
{CLR}"
650 PRINTLEFT$(A$,6);SA;LEFT$(B$,6);SB
```

```
660 PRINT INT(10*(60-(W/4)))/10"MINUTES
TO GO"
670 GOSUB 70
680 PRINT"------------------------------
----"
690 PRINT Z$" IN POSSESSION"
700 PRINT TAB(4);D"DOWN"
710 PRINT TAB(4);TG"YARDS TO GO"
720 PRINT"------------------------------
----"
730 PRINT"START AT"SL"YARD LINE"
740 PRINT"NOW ON"NU"YARD LINE"
750 PRINT 100-NU"YARDS TO TOUCHDOWN"
760 PRINT"------------------------------
----"
770 PRINT "ON THIS PLAY ";
780 IF Z$=A$ THEN PRINT A$;" CAN":GOTO 8
00
790 PRINT B$;" CAN"
800 PRINT"EITHER 1 - THROW"
810 PRINT"        2 - CARRY"
820 PRINT"    OR 3 - PUNT"
830 P=0
840 IF A$=Z$ AND VC=1 AND D<3 THEN P=2:G
OTO 900
850 IF A$=Z$ AND VC=1 AND TG<7 THEN P=2:
GOTO 900
860 IF A$=Z$ AND VC=1 AND (100-NU)<31 TH
EN P=3:GOTO 900
870 IF A$=Z$ AND VC=1 THEN P=1:GOTO 900
880 GET K$:IF K$<"1" OR K$>"3" THEN 880
890 P=VAL(K$):PRINT TAB(10);"OK"P
900 GOSUB 70
910 W=W+1
920 PRINT"
{CLR}"
930 PRINT Z$;", YOUR QUARTERBACK HAS"
940 PRINTTAB(8);"GOT THE BALL"
950 PRINT"------------------------------
----"
960 PRINT"WAIT FOR THE COUNT, ";Z$;","
970 PRINT TAB(8);"THEN HIT ANY KEY..."
```

```
980 GET ZZ$:IF ZZ$<>"" THEN 980
990 GOSUB 70
1000 GOSUB 2200
1010 IF E=11 THEN 2340
1020 PRINT"------------------------------
-----"
1030 ON P GOTO 1050,1310,1590
1040 REM **********************
1050 PRINT"YOU'VE THROWN"E*5"YARDS"
1060 PRINT"AND THE PLAY IS..."
1070 A=FNA(8)
1080 IF A=1 THEN 1520
1090 A=FNA(E+1)
1100 IF A=1 THEN PRINTTAB(20);"...COMPLE
TE":GOTO 1220
1110 PRINT TAB(20);"...INCOMPLETE":D=D+1
1120 GOSUB 170
1130 PRINT"------------------------------
-----"
1140 IF D>3 THEN 1160
1150 GOTO 610
1160 PRINT"THAT WAS YOUR 4TH DOWN"
1170 PRINT"AND YOU'VE LOST POSSESSION!!"
1180 D=0:TG=10:NU=ABS(100-NU):SL=NU
1190 GOSUB 70
1200 GOSUB 140
1210 GOTO 610
1220 GOSUB 170
1230 NU=NU+(E*5):TG=TG-(E*5)
1240 IF NU>100 THEN 1800
1250 IF TG<1 THEN 1280
1260 D=D+1:IF D>3 THEN 1160
1270 GOTO 610
1280 D=0:TG=10:SL=NU
1290 GOTO 610
1300 REM **********************
1310 A=FNA(15)
1320 IF A=1 THEN 1510
1330 E=A-5
1340 IF E<0 THEN 1440
1350 IF E=0 THEN E=1:GOTO 1370
1360 PRINT"GOOD SNAP, PASS AND RUN"
1370 PRINT"YOU'VE GAINED"E"YARDS"
```

```
138Ø GOSUB 17Ø
139Ø TG=TG-E:NU=ABS(NU+E):D=D+1
14ØØ IF NU>1ØØ THEN 18ØØ
141Ø IF TG<1 THEN 128Ø
142Ø IF D>3 THEN 116Ø
143Ø GOTO 61Ø
144Ø PRINT"GREAT RUNNING BY THE OPPOSITI
ON HAS"
145Ø PRINT"CAUSED YOU TO LOSE"ABS(E)"YAR
DS"
146Ø TG=TG-E:NU=NU+E:D=D+1
147Ø GOSUB 17Ø
148Ø IF D>3 THEN 116Ø
149Ø GOTO 61Ø
15ØØ REM ************************
151Ø PRINT"BAD SNAP...YOU'VE"
152Ø PRINT"FUMBLED...AND"
153Ø PRINT"YOU'VE LOST POSSESSION..."
154Ø NU=1ØØ-NU:D=Ø:TG=1Ø:SL=NU
155Ø REM **********************
156Ø GOSUB 17Ø
157Ø GOTO 46Ø
158Ø REM ************************
159Ø PRINT"NICE PUNT..."
16ØØ PRINT"YOU'VE KICKED"E*4"YARDS"
161Ø NU=NU+E*4
162Ø IF NU>1ØØ THEN 165Ø
163Ø PRINT"-----------------------------
-----"
164Ø GOTO 46Ø
165Ø A=FNA(3)
166Ø IF A>1 THEN 174Ø
167Ø PRINT"BUT YOU'VE MISSED THE GOAL!!"
168Ø IF NU-E*4<8Ø THEN NU=ABS(1ØØ-(NU-E*
4)):GOTO 17ØØ
169Ø NU=2Ø
17ØØ D=Ø:TG=1Ø:SL=NU
171Ø GOSUB 14Ø
172Ø GOSUB 17Ø
173Ø GOTO 61Ø
174Ø PRINT".........AND SCORED!"
175Ø IF Z$=B$ THEN SB=SB+3:GOTO 177Ø
176Ø SA=SA+3
```

```
1770 GOSUB 100
1780 GOSUB 170
1790 NU=35:GOTO 330
1800 PRINT"
{CLR}":GOSUB 4000
1810 FOR X=1 TO 5
1820 PRINTTAB(X*2);"TOUCHDOWN!!!"
1830 NEXT X
1840 IF Z$=A$ THEN SA=SA+6:GOTO 1860
1850 SB=SB+6
1860 GOSUB 100
1870 PRINT"TO PLAY FOR EXTRA POINT"
1880 GOSUB 170
1890 PRINT"-----------------------------
-----"
1900 PRINT "THE BALL IS SNAPPED...PREPAR
E TO KICK!"
1910 GOSUB 70
1920 GOSUB 2200
1930 IF E>9 THEN PRINT"YOU MISSED":NU=20
:GOTO 1970
1940 PRINT"YOU SCORED...":NU=35
1950 IF Z$=A$ THEN SA=SA+1:GOTO 1980
1960 SB=SB+1:GOTO 1980
1970 GOSUB 140
1980 GOSUB 100
1990 GOSUB 170
2000 GOTO 330
2010 FOR X=1 TO 10
2020 PRINT TAB(2*X);"PERIOD OVER"
2030 NEXT X
2040 GOSUB 100
2050 GOSUB 170
2060 GOTO660
2070 FOR X=1 TO 10
2080 PRINT TAB(2*X);"HALF TIME"
2090 NEXT X
2100 GOSUB 100
2110 Z$=B$
2120 GOSUB 170
2130 NU=35:W=W+2:GOTO 330
2140 FOR X=1 TO 10
2150 PRINT TAB(2*X);"GAME OVER"
```

```
2160 NEXT X
2170 GOSUB 100
2180 END
2190 REM **********************
2200 E=0:X=10
2210 IF Z$=A$ AND VC=1 THEN PRINT"THIS O
NE FOR ";A$:GOTO2290
2220 E=E+1:X=X-1
2230 PRINT TAB(E);E
2240 FOR Y=1 TO X*1.5
2250 GET ZZ$:IF ZZ$<>"" THEN Y=X*1.5+1:R
ETURN
2260 NEXT Y
2270 IF E=11 THEN RETURN
2280 GOTO 2220
2290 FOR E=1 TO FNA(7)+2
2300 FOR J=1 TO 60:NEXT J
2310 PRINT TAB(E);E
2320 NEXT E
2330 RETURN
2340 PRINT"TOO LATE!"
2350 PRINT"YOU'VE BEEN SACKED!"
2360 E=FNA(4)
2370 IF E=3 THEN 2430
2380 PRINT"AND LOST FIVE YARDS!"
2390 TG=TG+5:D=D+1:NU=NU-5
2400 GOSUB 170
2410 IF D>3 THEN 1160
2420 GOTO 610
2430 PRINT"AND LOST POSSESSION!"
2440 D=0:NU=ABS(100-NU+5):SL=NU:TG=10
2450 GOSUB 170
2460 GOSUB 140
2470 GOTO 610
4000 SID=54272
4010 FOR L1=0 TO 23
4020 POKE SID+L1,0
4030 NEXT L1
4040 POKE SID+24,15
4050 POKE SID+5,15
4060 POKE SID+6,255
4070 POKE SID+4,17
4080 FOR L1=48 TO 220 STEP .7
```

```
4090 POKE SID+1,L1
4100 NEXT L1
4110 FOR L1=28 TO 200
4120 POKE SID+1,L1
4130 NEXT L1
4140 FOR L1=200 TO 28 STEP -1
4150 POKE SID+1,L1
4160 NEXT L1
4170 POKE SID+1,0
4180 RETURN
```

TENNIS / Commodore 64 version

```
10 REM TENNIS
20 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}"
30 D=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
40 AA=0:BB=0:T=0:KA=0
50 XA=0:YA=0:ZA=0
60 XB=0:YB=0:ZB=0
70 DEF FNA(X)=INT(RND(1)*X)+1
80 INPUT "ONE HUMAN PLAYER OR TWO";A
90 IF A<1 OR A>2 THEN 80
100 IF A=1 THEN A$="BJORNX":VC=1
110 IF VC=1 THEN 160
120 PRINT"PLEASE ENTER SIX-LETTER NAME"
130 INPUT "NAME OF FIRST PLAYER";A$
140 IF LEN(A$)<6 THEN A$=A$+CHR$(32):GOT
O 140
150 A$=LEFT$(A$,6)
160 INPUT "NAME OF SECOND PLAYER";B$
170 IF LEN(B$)<6 THEN B$=B$+CHR$(32):GOT
O 170
180 B$=LEFT$(B$,6)
190 S=1:AA=1:BB=1
200 PRINT"
{CLR}"
205 A$="
{PUR}"+A$:B$="{WHT}"+B$
210 P$=A$:R$=B$
220 REM ********************************
230 IF P$=A$ THEN R$=B$
240 IF P$=B$ THEN R$=A$
250 PRINTP$;" SERVING"
260 PRINT"DO YOU WANT TO SERVE 1 - FAST"
270 PRINT"                      OR 2 - SLOW"
280 IF P$=A$ AND VC=1 AND SC=0 THEN KB=1
:GOSUB 1720:GOTO 330
290 IF P$=A$ AND VC=1 AND SC=1 THEN KB=2
:GOSUB 1720:GOTO 330
300 GET K$
310 IF K$<"1" OR K$>"2" THEN 300
320 KB=VAL(K$)
```

```
330 PRINT:PRINTTAB(6);KB;TAB(10);"> IT'S
 A ";
340 IF KB=1 THEN PRINT"FAST";
350 IF KB=2 THEN PRINT"SLOW";
360 PRINT" SERVE..."
370 GOSUB 1720
380 IF KB=1 THEN EB=FNA(3):GOTO 400
390 EB=FNA(8)
400 IF EB=1 THEN 450
410 IF EB=3 AND SC=0 THEN 520
420 IF EB=3 AND SC=1 THEN 590
430 GOTO 670
440 REM ********************************
450 PRINT"
{CLR}":PRINT:GOSUB 4000
460 PRINT TAB(8);"....ACE...."
470 GOSUB 1720
480 SC=0
490 IF P$=A$ THEN 1140
500 GOTO 1150
510 REM ********************************
520 PRINT"
{CLR}":PRINT
530 PRINT TAB(12);"....OUT...."
540 PRINT TAB(8);"...SECOND SERVE..."
550 GOSUB 1720
560 SC=1
570 GOTO 230
580 REM ********************************
590 PRINT"
{CLR}":PRINT
600 PRINT TAB(12);"....OUT...."
610 PRINT TAB(8);"...DOUBLE FAULT..."
620 GOSUB 1720
630 SC=0
640 IF P$=A$ THEN 1150
650 GOTO 1140
660 REM ********************************
670 SC=0
680 PRINT"
{CLR}":PRINT
690 GET ZZ$:IF ZZ$<>"" THEN 690
```

```
700 PRINTR$;", THE BALL IS":PRINT"IN YOU
R COURT"
710 PRINT"------------------------"
720 IF R$=A$ AND VC=1 THEN 750
730 PRINT"HIT ANY KEY, WHEN YOU SEE THE
ZERO,           TO RETURN THE BALL..."
740 GET ZZ$:IF ZZ$<>"" THEN 740
750 X=4*FNA(3):Y=X
760 GOSUB 1720
770 E=5
780 PRINTTAB(2*(11-E));E
790 Y=Y-1
800 GET S$
810 IF S$<>"" AND E=0 THEN 890
820 IF S$<>"" THEN 990
830 IF Y>0 THEN 790
840 E=E-1:Y=X
850 IF E<-1 THEN 990
860 IF E=-1 AND R$=A$ AND VC=1 THEN 890
870 GOTO 780
880 IF KB=1 THEN EA=FNA(2):GOTO 1000
890 EA=FNA(4)
900 IF E=0 AND R$=A$ AND VC=1 THEN EA=FN
A(8)
910 IF EA=1 THEN 940
920 IF R$=A$ THEN R$=B$:GOTO 670
930 R$=A$:GOTO 670
940 PRINTR$;", YOU'VE HIT THE BALL"
950 PRINT TAB(8);"OUT OF PLAY..."
960 GOSUB 1720
970 IF R$=A$ THEN R$=B$:GOTO 1150
980 GOTO 1140
990 EA=FNA(4)
1000 IF EA=1 THEN 1070
1010 PRINT"YOU MISSED THE BALL, AND..."
1020 GOSUB 1720
1030 PRINT"   IT WAS IN...BAD MISTAKE"
1040 GOSUB 1720
1050 IF R$=A$ THEN R$=B$:GOTO 1140
1060 GOTO 1140
1070 PRINT"YOU MISSED THE BALL AND..."
1080 GOSUB 1720
```

```
1090 PRINT"IT WAS OUT...WELL LEFT"
1100 GOSUB 1720
1110 IF R$=A$ THEN R$=B$:GOTO 1140
1120 GOTO 1150
1130 REM ********************************
1140 AA=AA+1:GOTO 1160
1150 BB=BB+1
1160 IF AA<5 AND BB<5 THEN 1230
1170 IF (BB>4 AND AA<4) OR (BB>4 AND BB-
AA>1) THEN AA=1:BB=1:GOTO 1500
1180 IF (AA>4 AND BB<4) OR (AA>4 AND AA-
BB>1) THEN AA=1:BB=1:GOTO 1440
1190 IF AA>4 AND AA>BB THEN C$="ADV":D$=
"---":GOTO 1320
1200 IF BB>4 AND BB>AA THEN D$="ADV":C$=
"---":GOTO 1320
1210 C$="(DEUCE":D$="(DEUCE":GOTO 1320
1220 REM ********************************
1230 RESTORE
1240 FOR D=1 TO AA
1250 READ C$
1260 NEXT D
1270 RESTORE
1280 FOR D=1 TO BB
1290 READ D$
1300 NEXT D
1310 REM ********************************
1320 PRINT"
{CLR}"
1330 PRINT"--------------------"
1340 PRINT"          SET SET SET"
1350 PRINT"--------------------"
1360 PRINT"            1   2   3  GAME"
1370 PRINT A$;"   ";XA;" ";YA;" ";ZA;" "
;C$
1380 PRINT B$;"   ";XB;" ";YB;" ";ZB;" "
;D$
1390 PRINT"--------------------"
1400 GOSUB 1720
1410 IF T<>1 THEN 230
1420 END
1430 REM ********************************
```

```
1440 PRINT"
{CLR}"
1450 PRINT"GAME TO ";A$
1460 GOSUB 1720
1470 IF S=1 THEN XA=XA+1:C$="Ø":D$="Ø":G
OTO 1560
1480 IF S=2 THEN YA=YA+1:C$="Ø":D$="Ø":G
OTO 1580
1490 IF S=3 THEN ZA=ZA+1:C$="Ø":D$="Ø":G
OTO 1600
1500 PRINT"
{CLR}"
1510 PRINT"GAME TO ";B$
1520 GOSUB 1720
1530 IF S=1 THEN XB=XB+1:C$="Ø":D$="Ø":G
OTO 1560
1540 IF S=2 THEN YB=YB+1:C$="Ø":D$="Ø":G
OTO 1580
1550 IF S=3 THEN ZB=ZB+1:C$="Ø":D$="Ø":G
OTO 1600
1560 IF (XA>5 AND XB<5) OR (XA<5 AND XB>
5) THEN 1630
1570 IF (XA>5 AND XA-XB>1) OR (XA>5 AND
XB-XA>1) THEN 1630
1580 IF (YA>5 AND YB<5) OR (YA<5 AND YB>
5) THEN 1630
1590 IF (YA>5 AND YA-YB>1) OR (YA>5 AND
YB-YA>1) THEN 1630
1600 IF (ZA>5 AND ZB<5) OR (ZA<5 AND ZB>
5) THEN 1680
1610 IF (ZA>5 AND ZA-ZB>1) OR (ZA>5 AND
ZB-ZA>1) THEN 1680
1620 GOTO 1640
1630 S=S+1
1640 AA=1:BB=1
1650 IF P$=A$ THEN R$=A$:P$=B$:GOTO 1320
1660 P$=A$:R$=B$:GOTO 1320
1670 REM ******************************
1680 T=1
1690 GOTO 1320
1700 REM ******************************
1710 REM DELAY
```

```
1720 FOR M=1 TO 1000:NEXT M
1730 RETURN
1740 DATA "0","15","30","40"
4000 SID=54272
4010 FOR L1=0 TO 23
4020 POKE SID+L1,0
4030 NEXT L1
4040 POKE SID+24,15
4050 POKE SID+5,15
4060 POKE SID+6,255
4070 POKE SID+4,17
4080 FOR L1=48 TO 220 STEP .7
4090 POKE SID+1,L1
4100 NEXT L1
4110 FOR L1=28 TO 200
4120 POKE SID+1,L1
4130 NEXT L1
4140 FOR L1=200 TO 28 STEP -1
4150 POKE SID+1,L1
4160 NEXT L1
4170 POKE SID+1,0
4180 RETURN
```

GRAND PRIX / Commodore 64 version

```
10 REM GRAND PRIX
20 GOSUB 2200:REM INITIALISE
30 GOSUB 1190:REM CHOOSE TRACK
40 REM ************************
50 REM MAJOR LOOP
60 GOSUB 120:REM PRINTOUT
70 GOSUB 280:REM ACCELERATION/CHECK
80 GOSUB 450:REM ENGINE/BRAKES
90 GOSUB 500:REM CORNER/POSITION
100 GOTO 60
110 REM ************************
120 REM PRINTOUT
130 PRINT"
{CLR}{PUR}"
140 PRINT"ENGINE TEMPERATURE"INT(ENG*10)
/10"C. (MAX. 200)"
150 PRINT"BRAKE TEMPERATURE:"INT(BRAK*10
)/10"C. (MAX. 500)"
160 PRINT" DISTANCE COVERED:"INT(DIST*10
)/10"METERS"
170 PRINT"                    :"INT(DIST*10
0/RR)/100"LAPS"
180 PRINT"YOU'RE IN POSITION"INT(FP)
190 PRINT"------------------------------
------"
200 PRINT"    CURRENT SPEED:"INT(SPEED*1
0)/10"KPH"
210 PRINT"                    :"INT(SPEED*5
.555)/10"METERS PER MOVE"
220 PRINT"------------------------------
------"
230 PRINT"CORNER APPROACHING"INT(APP)"ME
TERS"
240 PRINT"RECOMMENDED SPEED:"C(C)"KPH"
250 PRINT"------------------------------
------"
260 RETURN
270 REM ************************
280 REM CHECK ACCELERATION AND FACTORS
290 GET X$:IF X$<>"Z" AND X$<>"M" AND X$
<>CHR$(32) THEN 290
```

```
300 PRINTTAB(12);"OK"
310 X=0
320 IF X$="M" THEN X=SPEED/15
330 IF X$="Z" THEN X=-SPEED/15
340 NUM=NUM+1:REM NUMBER OF MOVES
350 SPEED=SPEED+X
360 IF SPEED<0 THEN SPEED=0
370 TRAV=SPEED*.5555:REM DISTANCE
                          TRAVELLED
380 DIST=DIST+TRAV:REM TOTAL DISTANCE
                          TRAVELLED
390 ENG=ENG+(X/2)+.07:IF ENG<70 THEN ENG
=70+RND(1)*8:REM ENGINE TEMP
400 IF X>0 THEN BRAK=BRAK*.9:REM BRAKE
  TEMP FALLING; ACCELERATING
410 IF X<1 THEN BRAK=BRAK-(3*X)-RND(1)*3
:REM BRAKE TEMP INCREASING; BRAKING
420 IF BRAK<8 THEN BRAK=8+RND(1)*8
430 PRINT"
{WHT}";:RETURN
440 REM ************************
450 REM CHECK ENGINE/BRAKE TEMP
460 IF ENG>200 THEN PRINT"YOUR ENGINE HA
S OVER HEATED":GOTO 830
470 IF BRAK>500 THEN PRINT"YOUR BRAKES H
AVE OVERHEATED":GOTO 830
480 RETURN
490 REM ************************
500 REM CHECK CORNERING SPEED
            AND FIELD POSITION
510 APP=APP-TRAV
520 IF APP>0 THEN RETURN
530 CRASH=0
540 IF SPEED>(C(C)*1.125) THEN CRASH=1:G
OTO 690
550 IF SPEED>(C(C)*1.1) THEN GOTO 690
560 PNT=PNT+100-((C(C)*1.1)-SPEED):REM
CORNERING POINTS
570 NC=NC+1:REM NUMBER OF CORNERS
580 CP=96-(PNT/NC):REM CORNERING
                          POSITION
590 AM=AM+A(C):REM AVERAGE NUMBER
                  OF MOVES ALLOWED
```

```
600 RP=NUM-AM:REM RACING POSITION: YOUR
          MOVES MINUS AVERAGE MOVES
610 FP=(CP+RP)/2:REM FIELD POSITION IS
AVERAGE OF CORNER & RACE POSITIONS
620 IF FP<1 THEN FP=1
630 C=C+1
640 IF C=WW THEN C=1:REM LAP OVER
650 APP=APP+D(C)
660 IF LAP*QQ=AM THEN 910:REM RACE OVER
670 RETURN
680 REM ************************
690 REM CRASHED
700 PRINT"
(CLR)"
710 PRINT"YOU CORNERED AT"INT(10*SPEED)/
10"KPH"
720 PRINT"AND THE MAXIMUM SPEED WAS JUST
"C(C)
730 GOSUB 2330
740 PRINT"YOU SPIN OFF THE TRACK..."
750 GOSUB 2330
760 IF CRASH=1 THEN 830
770 PRINT"YOU'VE LOST 20 SECONDS, BUT YO
U'RE       ABLE TO REJOIN THE RACE"
780 NUM=NUM+10:SPEED=INT(2*C(C)/3)
790 PNT=PNT+50
800 GOSUB 2330
810 GOTO 570
820 REM ************************
830 PRINT".............AND CRASH!!!!!"
840 PRINT"-------------------------------
------"
850 PRINT"YOU ONLY COMPLETED"INT(DIST*10
)/10"METERS."
860 PRINT"OR"INT(DIST*100/RR)/100"LAPS A
ND AT THAT"
870 PRINT"STAGE YOU WERE IN POSITION"INT
(FP)
880 PRINT"-------------------------------
------"
890 GOTO 1050
910 REM RACE OVER
920 PRINT"
```

```
{CLR}"
930 EFLAG=1
940 FOR X=1 TO 20
950 PRINTTAB(X);"WELL DONE, ";A$;"!!"
960 PRINTTAB(21-X);"WELL DONE, ";A$;"!!"
970 NEXT X
980 PRINT"------------------------------
------"
990 PRINT"YOU MANAGED TO LAST OUT THE FU
LL                "LAP"LAP RACE..."
1000 PRINT"------------------------------
-------"
1010 GOSUB 2330
1020 PRINT"YOU FINISHED IN POSITION"INT(
FP)
1030 PRINT"AFTER STARTING IN 6TH POSITIO
N..."
1040 GOSUB 2330
1050 PRINT"YOUR AVERAGE SPEED WAS"INT(DI
ST*180/NUM)/100"KPH"
1060 GOSUB 2330
1070 IF RP<1 THEN RP=1
1080 IF CP<1 THEN CP=1
1090 PRINT"YOU WERE"INT(ABS(RP))"TH FAST
EST ON THE STRAIGHTS,"
1100 PRINT"AND"INT(ABS(CP))"TH FASTEST O
N THE CORNERS."
1110 PRINT:PRINT"PRESS 'S' FOR SAME RACE
, 'N' FOR NEW    RACE, 'E' TO END"
1120 GET I$:IF I$<>"S" AND I$<>"N" AND I
$<>"E" THEN 1120
1130 IF I$="E" THEN END
1140 GOSUB 2240
1150 RESTORE
1160 IF I$="S" THEN GOSUB 1490:LAP=L2AP:
GOTO 60
1170 IF I$="N" THEN PRINT"
{CLR}":GOSUB 1250:GOTO 60
1180 REM ************************
1190 REM NAME AND TRACK DATA
1200 INPUT "WHAT IS YOUR NAME, DRIVER";A
$
1210 PRINT
```

```
122Ø FOR X=1 TO 3
123Ø PRINT TAB(X*4);"OK, GOOD LUCK, ";A$
124Ø GOSUB 233Ø:NEXT X
125Ø PRINT"**********************************
**********"
126Ø PRINT"WHICH RACE DO YOU WANT TO TAK
E PART IN:"
127Ø PRINT
128Ø PRINT TAB(7);"BRITISH GRAND PRIX 26
5ØMT   :1"
129Ø PRINT TAB(7);"GERMAN  GRAND PRIX 17
ØØMT   :2"
13ØØ PRINT TAB(7);"ITALIAN GRAND PRIX 22
ØØMT   :3"
131Ø PRINT TAB(7);"MONACO  GRAND PRIX 31
ØØMT   :4"
132Ø PRINT
133Ø PRINT TAB(7);"ENTER A NUMBER (1 TO
4)"
134Ø GET K$
135Ø IF K$<"1" OR K$>"4" THEN 134Ø
136Ø GP=VAL(K$)
137Ø PRINT"**********************************
**********"
138Ø PRINT TAB(8);"OK, THE ";
139Ø IF GP=1 THEN PRINT"BRITISH";
14ØØ IF GP=2 THEN PRINT"GERMAN";
141Ø IF GP=3 THEN PRINT"ITALIAN";
142Ø IF GP=4 THEN PRINT"MONACO";
143Ø PRINT" RACE"
144Ø PRINT"**********************************
**********"

145Ø PRINT:PRINT"OVER HOW MANY LAPS?"
146Ø INPUT LAP:IF LAP<1 THEN 146Ø
147Ø LAP=INT(LAP+.5):L2AP=LAP
148Ø REM ************************
149Ø REM BRITISH DATA
15ØØ SPEED=14Ø
151Ø FOR X=1 TO 9
152Ø READ D(X):REM DISTANCE BETWEEN
                        CORNERS
153Ø NEXT X
```

```
1540 DATA 800,400,250,200,250,300,100,10
0,250
1550 FOR X=1 TO 9
1560 READ C(X)
1570 NEXT X
1580 DATA 150,90,175,200,200,90,90,150,1
50
1590 FOR X=1 TO 9
1600 READ A(X):REM AVERAGE NUMBER OF
       MOVES ALLOWED BETWEEN CORNERS
1610 NEXT X
1620 DATA 8,4,2,2,2,2,1,1,2
1630 APP=800:WW=10:QQ=24:RR=2650
1640 IF GP=1 THEN RETURN
1650 REM ************************
1660 REM GERMAN DATA
1670 SPEED=85
1680 FOR X=1 TO 7
1690 READ D(X)
1700 NEXT X
1710 DATA 600,200,100,150,250,200,200
1720 FOR X=1 TO 7
1730 READ C(X):REM RECOMMENDED
                MAXIMUM CORNERING SPEED
1740 NEXT X
1750 DATA 90,175,120,90,200,200,175
1760 FOR X=1 TO 7
1770 READ A(X)
1780 NEXT X
1790 DATA 6,2,1,2,2,2,2
1800 APP=600:WW=8:QQ=17:RR=1700
1810 IF GP=2 THEN RETURN
1820 REM ************************
1830 REM ITALIAN DATA
1840 SPEED=108
1850 FOR X=1 TO 7
1860 READ D(X)
1870 NEXT X
1880 DATA 800,300,100,150,300,350,200
1890 FOR X=1 TO 7
1900 READ C(X):REM RECOMMENDED
                MAXIMUM CORNERING SPEED
1910 NEXT X
```

```
1920 DATA 120,90,90,150,200,120,150
1930 FOR X=1 TO 7
1940 READ A(X)
1950 NEXT X
1960 DATA 8,3,3,1,3,3,2
1970 APP=800:WW=8:QQ=22:RR=2200
1980 IF GP=3 THEN RETURN
1990 REM ************************
2000 REM MONACO DATA
2010 SPEED=162.5
2020 FOR X=1 TO 14
2030 READ D(X)
2040 NEXT X
2050 DATA 400,100,100,300,400,300,150,20
0,200,200
2060 DATA 150,150,200,250
2070 FOR X=1 TO 14
2080 READ C(X):REM RECOMMENDED
                  MAXIMUM CORNERING SPEED
2090 NEXT X
2100 DATA 175,150,175,200,120,200,175,90
,175,150
2110 DATA 150,175,120,150
2120 FOR X=1 TO 14
2130 READ A(X)
2140 NEXT X
2150 DATA 4,1,1,3,4,3,1,2,2,2
2160 DATA 1,2,2,2
2170 APP=400:WW=15:QQ=30:RR=3100
2180 RETURN
2190 REM ************************
2200 REM INITIALISATION
2210 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}"
2220 X=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
2230 DIM A(14),C(14),D(14)
2240 C=1:FP=6:PNT=0:NC=0:CP=0
2250 AM=0:RP=0:APP=0
2260 NUM=0:REM NUMBER OF MOVES
2270 ENG=100:BRAK=10:TRAV=0:DIST=0
2280 EFLAG=0
2290 X=0
```

```
2300 RETURN
2310 REM ************************
2320 REM DELAY
2330 FOR O=1 TO 1000:NEXT O
2340 RETURN
4000 SID=54272
4010 FOR L1=0 TO 23
4020 POKE SID+L1,0
4030 NEXT L1
4040 POKE SID+24,15
4050 POKE SID+5,15
4060 POKE SID+6,255
4070 POKE SID+4,17
4080 FOR L1=48 TO 220 STEP .7
4090 POKE SID+1,L1
4100 NEXT L1
4110 FOR L1=28 TO 200
4120 POKE SID+1,L1
4130 NEXT L1
4140 FOR L1=200 TO 28 STEP -1
4150 POKE SID+1,L1
4160 NEXT L1
4170 POKE SID+1,0
4180 RETURN
```

FLIGHT SIMULATION / Commodore 64 version

```
10 REM FLIGHT SIMULATION
20 RPT=0
30 LD=INT(RND(1)*360)
40 DIM E$(1000):REM THIS HOLDS FLIGHT
                                  RECORD
50 DIM A$(7),C$(7):REM THESE ARRAYS
 HOLD HORIZON AND COMPASS OUTPUT
60 REM **************************
70 GOSUB 2320:REM INITALISE
80 IF CRASH=0 THEN GOSUB 820:REM HORIZON
                                    /COMPASS
90 GOSUB 500:REM PRINTOUT
100 IF CRASH=1 THEN END
110 IF LND=1 AND UFLAG=1 THENGOSUB4000:P
RINT"WELL DONE. A PERFECT LANDING!":END
120 IF LND=1 AND UFLAG=0 THEN PRINT"YOUR
 WHEELS ARE UP":GOSUB 1780:GOTO 90
130 T=AIRSPEED:SALL=0
140 GET X$
150 IF X$="R" THEN RPT=1:GOTO 70
160 IF RPT=1 AND E$(CLOCK+1)="" THEN RPT
=0:GOTO 140

170 IF RPT=1 THEN X$=E$(CLOCK+1)
180 IF X$="" THEN 140
190 IF CLOCK<999 THEN E$(CLOCK+1)=X$
200 IF TAKEOV=1 THEN ELEVATE=INT(ELEVATE
+RND(1)*2-RND(1)*3)
210 IF AIRSPEED<3 THEN 290
220 IF X$="Q" THEN ELEVATE=ELEVATE+5:EFL
AG=5:IF ELEVATE>60 THEN SALL=1
230 IF X$="A" THEN ELEVATE=ELEVATE-5:EFL
AG=-5:IF ELEVATE<-70 THEN SALL=-1
240 IF SALL<>0 THEN GOSUB 1640
250 IF ALTIMETER<1 THEN 290:REM PREVENTS
      DRAMATIC TURNS ON THE GROUND
260 IF X$="Z" THEN WA=WA-.5:ANG=ANG-6:IF
 WA<-3 THEN WA=-3
270 IF X$="M" THEN WA=WA+.5:ANG=ANG+6:IF
 WA>3 THEN WA=3
280 ANG=INT(ANG+RND(1)*2-RND(1)*2)
```

```
290 IF X$=CHR$(32) THEN AIRSPEED=AIRSPEE
D+8.5
300 IF X$="." THEN AIRSPEED=AIRSPEED-7
310 AIRSPEED=AIRSPEED-ELEVATE/5
320 IF UFLAG=1 THEN AIRSPEED=AIRSPEED-1.
5:FUEL=FUEL-.5
330 IF AIRSPEED<0 THEN AIRSPEED=0
340 IF AIRSPEED>400 THEN AIRSPEED=400
350 IF X$="1" AND UFLAG=0 THEN UFLAG=1:G
OTO 370
360 IF X$="1" AND UFLAG=1 THEN UFLAG=0
370 FUEL=FUEL-(ABS(T-AIRSPEED)/10)-3.75
380 IF FUEL<1 THEN GOSUB 1780
390 IF TAKEOV=1 THEN 420
400 IF ELEVATE>10 AND AIRSPEED>45 AND AI
RSPEED<60 AND UFLAG=1 THEN TAKEOV=1
410 IF TAKEOV=0 THEN ALTIMETER=0:GOTO 45
0
420 IF LND=0 AND AIRSPEED<30 THEN ELEVAT
E=ELEVATE-5:ALTIMETER=9*ALTIMETER/10
430 ALTIMETER=ALTIMETER+INT((ELEVATE+.1
)*AIRSPEED)+EFLAG*AIRSPEED/1000)/80
440 IF ALTIMETER<300 AND TAKEOV=1 THEN A
LTIMETER=ALTIMETER+AIRSPEED/30+ELEVATE
450 IF ALTIMETER<0 THEN GOSUB 1780:REM
      CRASH
460 REM CHANGE NEXT TWO LINES TO MAKE IT
      EASIER (OR EVEN HARDER) TO LAND
470 IF ALTIMETER>15 AND AIRSPEED>20 OR T
AKEOV=0 THEN 80
480 IF ABS(ANG-LD)<13 OR ABS(ANG+360-LD)
<13 THEN LND=1:GOTO 80
485 GOTO 80
490 REM **************************
500 REM PRINTOUT
510 PRINT"
{CLR}"
520 PRINT"   HORIZON";TAB(20);"HEADING"
530 EV=INT(ELEVATE/10)
540 IF EV>2 THEN EV=2
550 IF EV<-2 THEN EV=-2
560 IF EV<>0 AND TAKEOV=1 AND CRASH=0 TH
EN GOSUB 1920
```

```
570 PRINT ":----------------:---------:"
580 FOR J=1 TO 7
590 PRINT": ";A$(J);" :";C$(J);" :"
600 A$(J)=""
610 NEXT J
620 PRINT ":--------------------------:"
630 DIST=DIST+ABS((COS(ELEVATE))*AIRSPEE
D)/360
640 CLOCK=CLOCK+1
650 PRINT":RANGE"INT(DIST*10)/10": TIME"
INT(CLOCK)/10;":"LD
660 PRINT ":--------------------------:"
670 PRINT":AIRSPEED :"INT(AIRSPEED)
680 PRINT":";LEFT$(Q$,INT(AIRSPEED/20));
">"
690 PRINT":ALTIMETER:"INT(ALTIMETER);
700 IF ANG<0 THEN PRINTTAB(19);360+ANG"D
EG."
710 IF ANG>=0 THEN PRINTTAB(19);ANG"DEG.
"
720 MR=INT(ALTIMETER/30):IF MR>20 THEN M
R=20
730 PRINT":";LEFT$(Q$,MR);">"
740 PRINT":FUEL      :"INT(FUEL)
750 PRINT":";LEFT$(Q$,INT(FUEL/45));">"
760 PRINT ":--------------------------:"
770 PRINT":ELEVATION:"ELEVATE": ";:GOSUB
 2210:PRINTU$
780 IF UFLAG=1 THEN PRINT ":";TAB(5);">
UNDERCARRIAGE DOWN < :"
790 IF UFLAG=0 THEN PRINT ":";TAB(6);">
UNDERCARRIAGE UP   < :"
800 RETURN
810 REM ************************
820 REM ASSIGN HORIZON/COMPASS
830 IF ABS(INT(WA+.5))=3 THEN GOSUB 980
840 IF ABS(INT(WA+.5))=2 THEN GOSUB 1070
850 IF ABS(INT(WA+.5))=1 THEN GOSUB 1160
860 IF INT(WA+.5)=0 THEN GOSUB 1250
870 REM NEXT TWO LINES USED TO
   GRADUALLY STRAIGHTEN UP WINGS
880 IF WA>0 THEN WA=WA-.2
890 IF WA<0 THEN WA=WA+.2
```

```
900 IF WA>.2 THEN 1350
910 FOR Z=1 TO 7
920 M$(8-Z)=A$(Z)
930 NEXT Z
940 FOR Z=1 TO 7
950 M$(Z)=A$(Z)
960 NEXT Z
970 GOTO 1350
980 REM WA=3 OR -3
990 A$(1)="                 *  "
1000 A$(2)="               **   "
1010 A$(3)="             **     "
1020 A$(4)="           **       "
1030 A$(5)="         **         "
1040 A$(6)="       **           "
1050 A$(7)="**                  "
1060 RETURN
1070 REM WA=2 OR -2
1080 A$(1)="                    "
1090 A$(2)="                 **  "
1100 A$(3)="               ***    "
1110 A$(4)="           ***        "
1120 A$(5)="       ***            "
1130 A$(6)="***                   "
1140 A$(7)="                      "
1150 RETURN
1160 REM WA=1 OR -1
1170 A$(1)="                      "
1180 A$(2)="                      "
1190 A$(3)="               ******"
1200 A$(4)="        ******        "
1210 A$(5)="****                  "
1220 A$(6)="                      "
1230 A$(7)="                      "
1240 RETURN
1250 REM WA=0
1260 A$(1)="                      "
1270 A$(2)="                      "
1280 A$(3)="                      "
1290 A$(4)="**********************"
1300 A$(5)="                      "
1310 A$(6)="                      "
1320 A$(7)="                      "
```

```
1330 RETURN
1340 REM ************************
1350 REM ASSIGN COMPASS STRINGS
1360 F2=ANG-F1
1365 F2=ANG
1370 IF F2<0 THEN FA=INT((F2+375)/30)
1380 IF F2>=0 THEN FA=INT((F2+15)/30)
1390 IF FA=12 THEN FA=0
1400 C$(1)="    .N.   "
1410 IF FA=11 THEN C$(2)="  .@:..  ":GOTO
 1450
1420 IF FA=0 THEN C$(2)="   ..@..  ":GOTO
1450
1430 IF FA=1 THEN C$(2)="   ..:@.  ":GOTO
1450
1440 C$(2)="   ..:..  "
1450 IF FA=10 THEN C$(3)=" .@ : ..":GOTO
 1480
1460 IF FA=2 THEN C$(3)=" .. : @.":GOTO
1480
1470 C$(3)=" .. : .."
1480 IF FA=9 THEN C$(4)=" W@-X--E":GOTO
1510
1490 IF FA=3 THEN C$(4)=" W--X-@E":GOTO
1510
1500 C$(4)=" W--X--E"
1510 IF FA=8 THEN C$(5)=" .@ : ..":GOTO
1540
1520 IF FA=4 THEN C$(5)=" .. : @.":GOTO
1540
1530 C$(5)=" .. : .."
1540 IF FA=7 THEN C$(6)="   .@:..  ":GOTO
1580
1550 IF FA=6 THEN C$(6)="   ..@..  ":GOTO
1580
1560 IF FA=5 THEN C$(6)="   ..:@.  ":GOTO
1580
1570 C$(6)="   ..:..  "
1580 C$(7)="    .S.   "
1590 IF ANG>360 THEN ANG=ANG-360
1600 F2=ANG
1610 IF W>0 THEN W=W-.4
1620 IF W<0 THEN W=W+.4
```

```
1630 RETURN
1640 REM STALL/FALL
1650 IF SALL=-1 THEN 1710
1660 FOR J=1 TO 10
1670 PRINTTAB(J);"YOU HAVE STALLED!!"
1680 NEXT J
1690 AIRSPEED=AIRSPEED/4
1700 RETURN
1710 FOR J=1 TO 10
1720 PRINTTAB(J);"UNCONTROLLED DIVE!!"
1730 PRINTTAB(21-J);"PULL UP!!"
1740 NEXT J
1750 ALTIMETER=ALTIMETER/4
1760 RETURN
1770 REM ************************
1780 REM CRASH
1790 CRASH=1
1800 ALTIMETER=0
1810 M$="** *C R**  A ** S* H* !!*":REM
     25 CHARACTERS LONG
1820 FOR J=1 TO 20
1830 PRINTTAB(J);"CRASH!"
1840 PRINTTAB(21-J);"CRASH!"
1850 NEXT J
1860 FOR J=1 TO 7
1870 G=INT(RND(1)*11)+1
1880 A$(J)=MID$(M$,G,14)
1890 NEXT J
1900 RETURN
1910 REM ************************
1920 REM ADJUST HORIZON
1930 G$="                ":REM 14 SPACES
1940 ON EV+3 GOSUB 1960,2020,2070,2080,2
140
1950 RETURN
1960 REM EV=-2
1970 FOR J=1 TO 4
1980 A$(J)=A$(J+3)
1990 NEXT J
2000 A$(5)=G$:A$(6)=G$:A$(7)=G$
2010 RETURN
2020 REM EV=-1
2030 FOR J=1 TO 6
```

```
2040 A$(J)=A$(J+1)
2050 NEXT J
2060 A$(7)=G$
2070 RETURN:REM EV=0
2080 REM EV=1
2090 FOR J=6 TO 1 STEP -1
2100 A$(J+1)=A$(J)
2110 NEXT J
2120 A$(1)=G$
2130 RETURN
2140 REM EV=2
2150 FOR J=4 TO 1 STEP -1
2160 A$(J+3)=A$(J)
2170 NEXT J
2180 A$(1)=G$:A$(2)=G$:A$(3)=G$
2190 RETURN
2200 REM ************************
2210 REM INPUT INTO COMMAND NAME
2220 U$="-------"
2230 IF X$=CHR$(32) THEN U$="THROTTLE ON
"
2240 IF X$="." THEN U$="THROTTLE OFF"
2250 IF X$="Q" AND ALTIMETER>0 THEN U$="
CLIMB"
2260 IF X$="Q" AND ALTIMETER=0 THEN U$="
NOSE UP"
2270 IF X$="A" THEN U$="NOSE DOWN"
2280 IF X$="Z" THEN U$="BANK LEFT"
2290 IF X$="M" THEN U$="BANK RIGHT"
2300 RETURN
2310 REM ************************
2320 REM INITIALIZATION
2330 POKE 53280,0:POKE 53281,0:PRINT"
{CLR}{PUR}"
2340 J=RND(VAL(RIGHT$(TI$,2))):REM
RANDOMIZE
2350 Q$="--------------------":REM
   21 CHARACTERS IN STRING
2360 UFLAG=1:REM UNDERCARRIAGE -
                  1 - DOWN, 0 - UP
2370 EFLAG=1:REM CLIMB RATE
2380 ANG=0:TAKEOV=0:LND=0
2390 AIRSPEED=0
```

```
2400 DIST=0:REM DISTANCE COVERED 'RANGE'
2410 ALTIMETER=0
2420 ELEVATE=0:REM ANGLE OF ELEVATION
2430 WA=0:REM WING ANGLE; USED IN
                        HORIZON PRINTOUT
2440 FUEL=750:CRASH=0:F2=0:F1=0:REM
 FOR DIRECTION CHANGE/COMPASS ROUTINE
2450 CLOCK=0:REM TIME
2460 X$=""
2470 RETURN
4000 SID=54272
4010 FOR L1=0 TO 23
4020 POKE SID+L1,0
4030 NEXT L1
4040 POKE SID+24,15
4050 POKE SID+5,15
4060 POKE SID+6,255
4070 POKE SID+4,17
4080 FOR L1=48 TO 220 STEP .7
4090 POKE SID+1,L1
4100 NEXT L1
4110 FOR L1=28 TO 200
4120 POKE SID+1,L1
4130 NEXT L1
4140 FOR L1=200 TO 28 STEP -1
4150 POKE SID+1,L1
4160 NEXT L1
4170 POKE SID+1,0
4180 RETURN
```

Further Reading

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Acknowledgments

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Apple program conversions by Robert Young; Commodore 64 program conversions by Ross Symons.

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