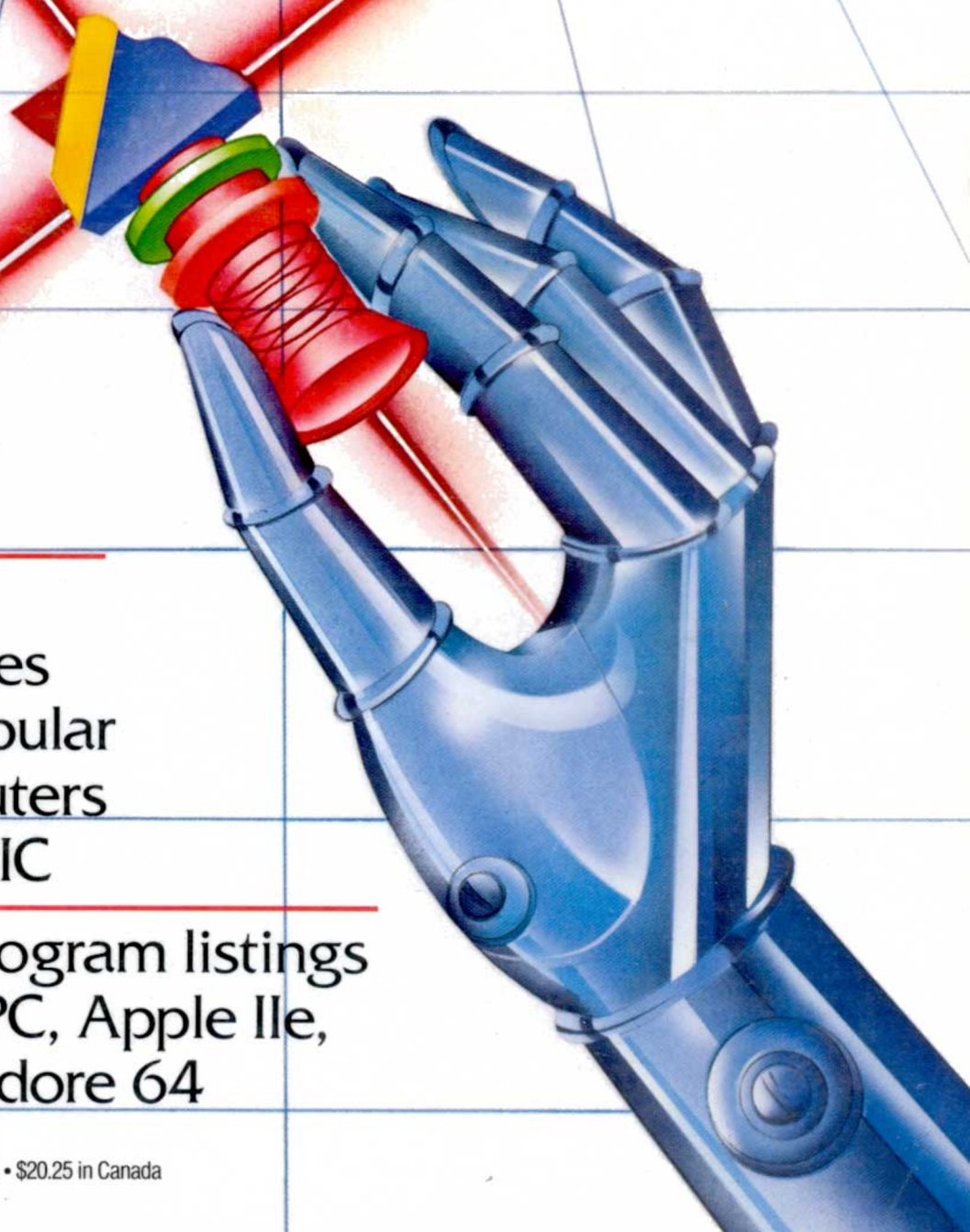


Tim Hartnell

Creating Simulation Games on Your Computer

One dozen
all-new games
for most popular
microcomputers
that use BASIC

Complete program listings
for the IBM PC, Apple IIe,
and Commodore 64



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Tim Hartnell

Ballantine Books • New York

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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 $A = \text{RND}(1)$. If I need random integers in the range between 1 and 10, I use $A = \text{INT}(\text{RND}(1) * 10) + 1$. 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 indispensable 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.

```
+-----> FUEL = FUEL - THRUST
: IF FUEL = 0 ----->----->----->-----+
:           VARIABLE FLAG (VF) = THRUST - 2      :
:           HEIGHT = HEIGHT + VELOCITY + VF/4    :
:           VELOCITY = VELOCITY + VF              :
:                                                     V
: IF HEIGHT < 10 ----->----->-----+      :
-----<-----<--GOTO NEW THRUST INPUT      :      :
                                           V      V
IF VELOCITY > -9 AND VELOCITY < 5 THEN LAND SUCCESSFULLY :
      ELSE -----+                               :
      :                                               :
      : CRASH -----<-----+
      :
```

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

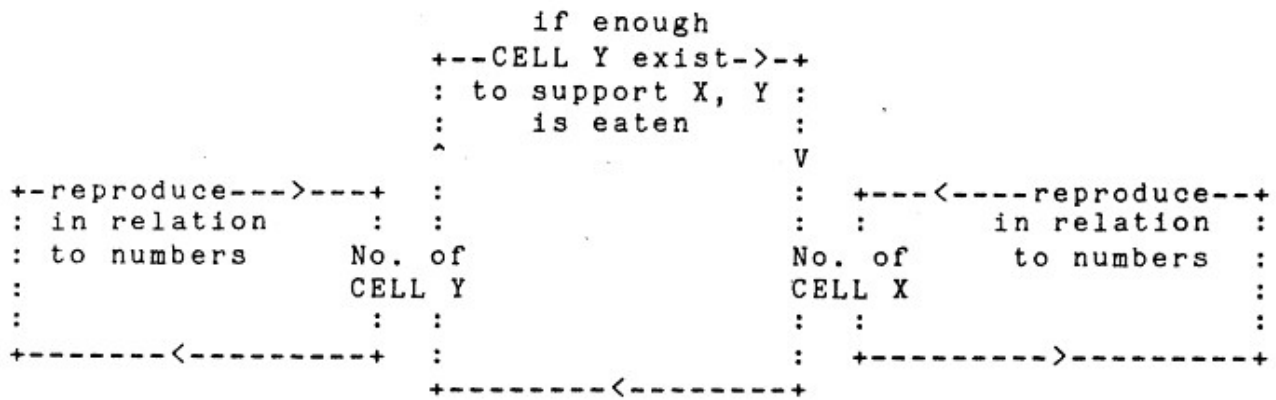
A *negative* feedback loop tends to push the system toward an equilibrium point. (As the room gets hotter, the thermostat turns the heater down.) A *positive* feedback loop tends to lead to dramatically accelerating or decelerating rates, pushing the system away from an equilibrium point. (As the room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

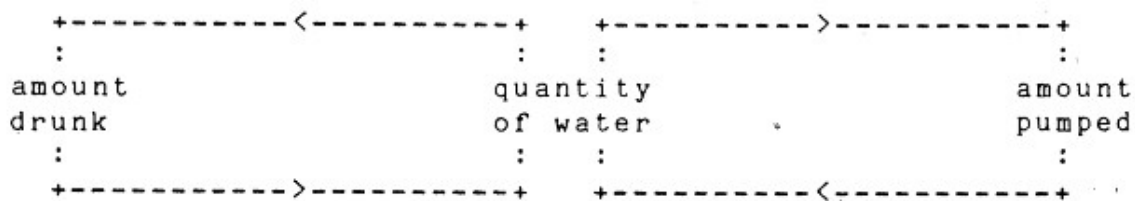


A situation like this can either stabilize, or can move so that either X or Y becomes dominant, with the other type of cell reduced to an ineffectual level.

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.

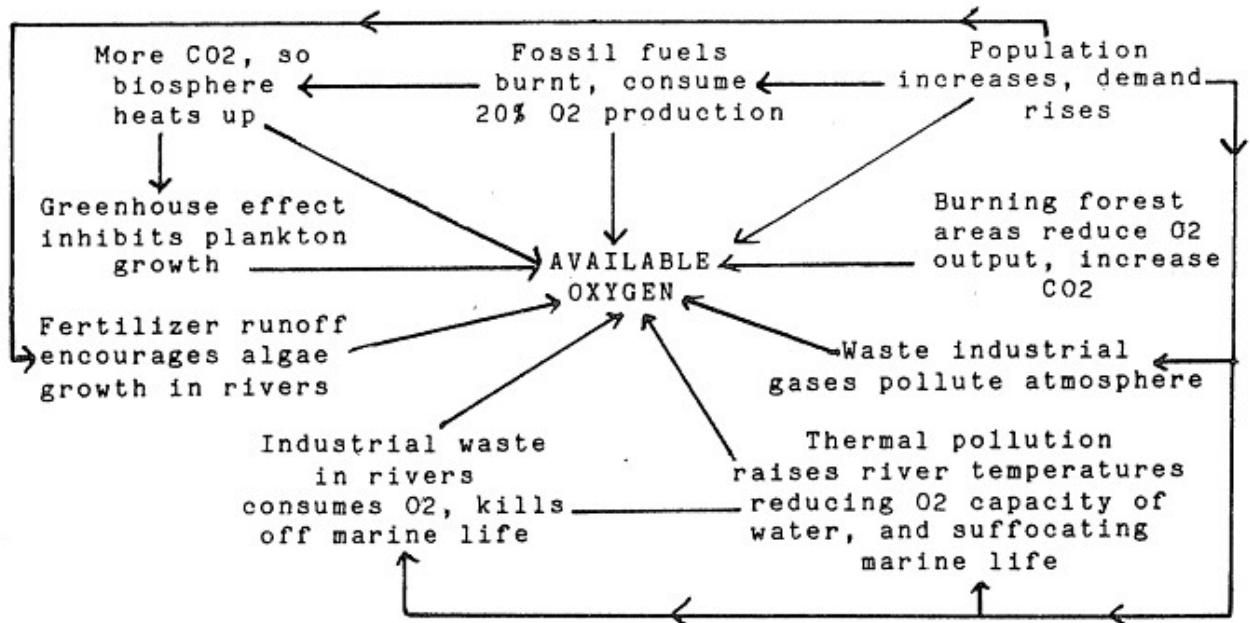
Your own simulation programs will be easier to write if you consider the behavior of the system you want to model in terms of positive or negative feedback loops.

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.

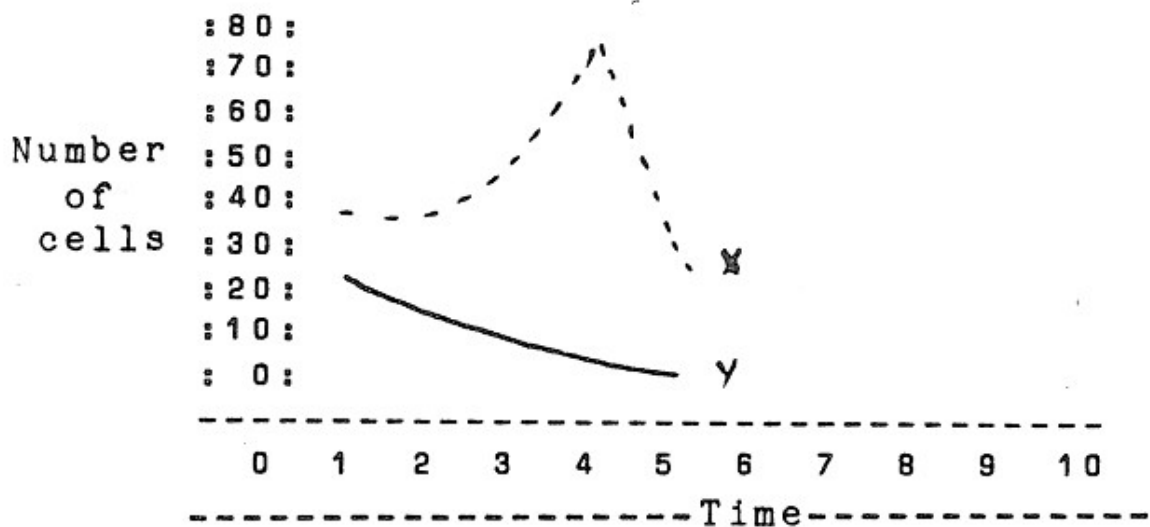
For example, the ecological system of oxygen use and replenishment on Earth can be shown with the following diagram:

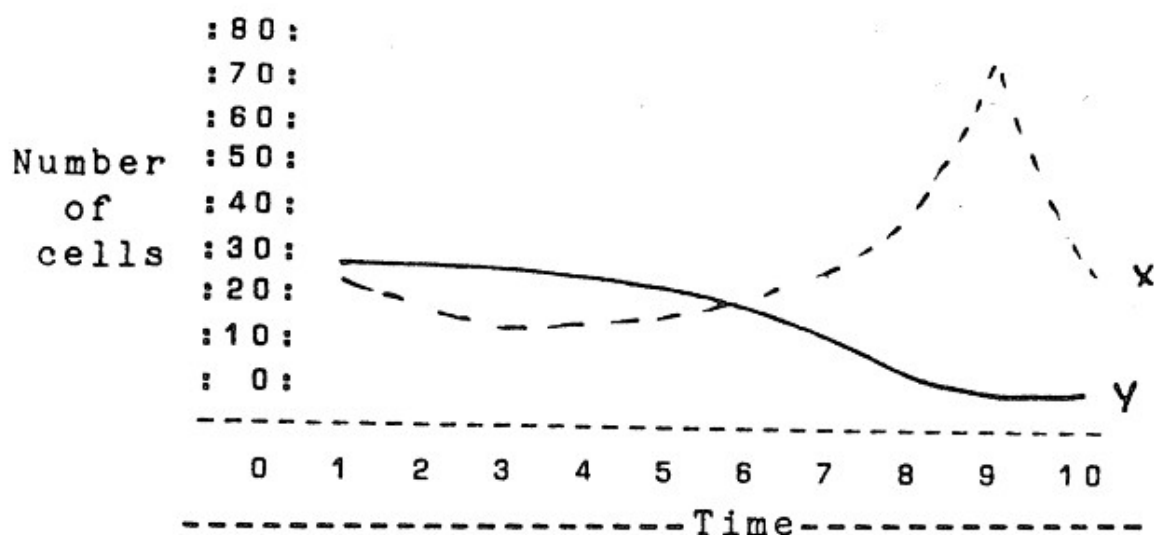


Time Against Action

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

```
. . . . .  
. . . . .  
. . . 0 . . . . .  
. . . . .  
. . . . .  
. . . . . X . . . . .  
. . . . .  
. . . . .  
. . . . .  
. . . . .
```

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

MOVE 5

```
. . . . .  
. . . . .  
. . . . .  
. . . . .  
. . . . .  
. . . 0 . . X . . . .  
. . . . .  
. . . . .  
. . . . .  
. . . . .
```


MOVE 9

.
.
.
.
.	.	.	.	0	.	X	.	.	.
.
.
.
.

MOVE 11

.
.
.
.
.	.	.	.	.	.	0	.	.	.
.	.	.	.	.	.	X	.	.	.
.
.
.
.

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

MOVE 14

.
.
.
.
.
.	.	.	.	.	.	0	.	.	.
.
.
.
.

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$(P,Q)="0"
120 M=M+1
130 CLS:PRINT:PRINT
140 PRINT "MOVE" M
150 FOR X=1 TO 10
160 FOR Y=1 TO 10
170 PRINT A$(X,Y); " ";
180 NEXT Y
190 PRINT
200 NEXT X
210 RETURN
220 REM *****
230 REM GENERATE MOVE
240 A$(P,Q)="."
250 G=0
260 T=INT(RND(1)*4)+1
270 ON T GOSUB 310,320,330,340
280 IF G=0 THEN 260
290 IF G=1 AND RND(1)>.5 THEN 260
300 RETURN
310 IF P>1 THEN P=P-1:G=G+1:RETURN
320 IF P<10 THEN P=P+1:G=G+1:RETURN
330 IF Q>1 THEN Q=Q-1:G=G+1:RETURN
340 IF Q<10 THEN Q=Q+1:G=G+1:RETURN
350 RETURN
360 REM *****
370 REM INITIALIZE
380 CLS
390 RANDOMIZE VAL(RIGHT$(TIMES$,2))
400 DIM A$(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

XXXXXX	XXXXXX
X X	X X
X X	X X
X X	X X
XXXXXX	XXXXXX

GENERATION 2

```

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

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

```

GENERATION 3

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

GENERATION 2

XXX
X X
XXX

XXX
X X
XXX

GENERATION 3

 X
 X X
X X
 X X
 X

 X
 X X
X X
 X X
 X

GENERATION 4

 X
 XXX
XX XX
 XXX
 X

 X
 XXX
XX XX
 XXX
 X

GENERATION 5

 XXX
X X
X X
X X
 XXX

 XXX
X X
X X
X X
 XXX

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$(X,Y)="X" AND C<>2 AND C<>3 THEN
  N B$(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  XXXXXXXXXXXX  X  X
X      XX  XX  XX      X
X  X  X      XX      X  X  X
X      XXXXXXX      X
      X      XX      X
      X  X      X  X
X  XX      XXXXXXX      XX  X
X      XXX  X  X  XXX      X
X      XXXXXXX      X
XXX      XXX      XXX
XXXXXXX      XX      XXXXXXX
```

GENERATION 2

```

      XX  XXXXXXX  XX
XX  X      XX      X  XX
XX      XXX  XX  XXX      XX
      X      XX      X
      XX
      XXX      XX      XXX
XXXXXX  XXXXXXX  XXXXX
XX      XX      XX      XX
      XXXXXXXXXXXX
X      XX      XX      XX  X
X  XXX      XXX  X
```

GENERATION 3

```

      X   XXXX   X
XX      XX      XX
XX   X X   XX   X X   XX
      X   XX   X
      X   XXXX   X
X   X   XX   X   X
X   XXXXXXXXXXXXX   X
XX XX                      XX XX
XX      XXXXXX      XX
      X   XX XX XX   X
X X                      X X

```

GENERATION 9

```

XX                      XX
XX   X                      X   XX
      X                      X
      X   XXXX   X
      X   XX   X
      X   XX   X
XX   X                      XX
X   XX      XX      X
XX                      XX

```

GENERATION 12

```

XX                      XX
XX                      XX
      XXX   XXX
      XXXXXXXXXXXXX
      XX   XX   XX
      XXXXXX
      X   X   X   X
      XXX      XXX
      X        X

```


GENERATION 24

```

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

GENERATION 39

```

  XX              XX
X      X  XX  XX  X  X
      XXX      XXX
XX  XXX  X  X  XXX  XX
  X      XXX  XXX  X
  XXX  X  X  X  X  XXX
    XX  XXXXXXXXX  XX
  X  X  XX  XX  XX  X  X
  X  XX      XX      XX  X
  X  X              X  X
    XX      XX
  
```

GENERATION 51

```

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

GENERATION 62

```

  X              X
X  X              X  X
X  X      XX      XX  X  X
  X      XX      XX      X
  
```

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 simpler 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
```

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 program 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).

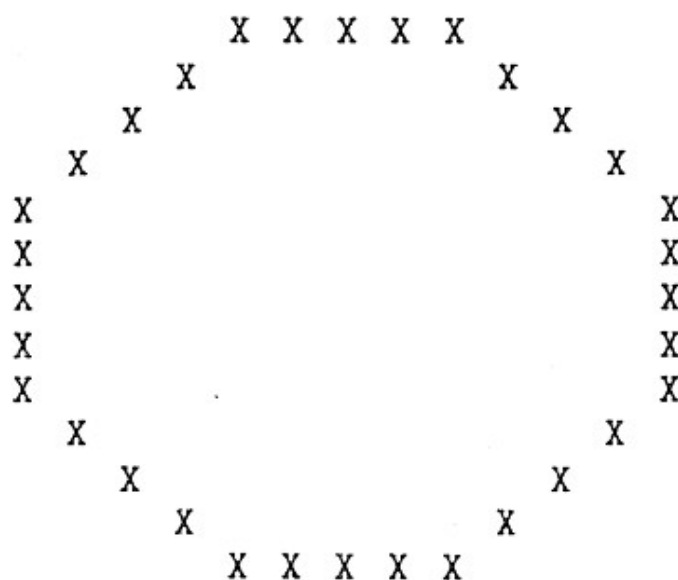
This short set of commands can be combined to produce many startling results. If you are at all familiar with the Logo programming language, you will recognize that several of the RCL commands are very similar to the turtle graphic commands in Logo. Logo was developed under Seymour Papert, with Marvin 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

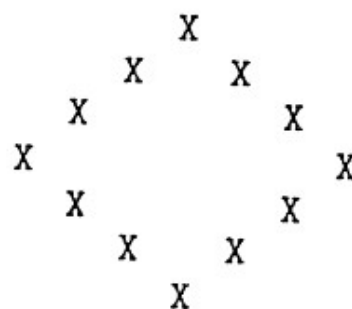
```
GO 11,35
REPEAT 8
FORWARD 4
TURN 45
END REPEAT
PRINTOUT
*
```



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

```

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

```

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
#

[illegible]

STAIRS

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

✱

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
```

得

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 figure consists of two 10x10 grids. The left grid shows the following 'X' marks (row, column): (1,1), (1,9), (2,3), (2,8), (3,4), (3,5), (3,6), (4,2), (4,3), (4,4), (5,1), (5,6), (6,7), (6,8), (6,9), (7,2), (7,3), (7,4), (7,5), (7,6), (7,7), (7,8), (7,9), (7,10), (8,1), (8,2), (8,3), (8,4), (8,5), (8,6), (8,7), (8,8), (8,9), (8,10), (9,1), (9,2), (9,3), (9,4), (9,5), (9,6), (9,7), (9,8), (9,9), (9,10), (10,1), (10,2), (10,3), (10,4), (10,5), (10,6), (10,7), (10,8), (10,9), (10,10). The right grid shows the following 'X' marks (row, column): (1,4), (1,5), (1,6), (2,3), (2,7), (3,1), (3,2), (3,3), (3,4), (3,5), (3,6), (3,7), (3,8), (3,9), (3,10), (4,1), (4,2), (4,3), (4,4), (4,5), (4,6), (4,7), (4,8), (4,9), (4,10), (5,1), (5,2), (5,3), (5,4), (5,5), (5,6), (5,7), (5,8), (5,9), (5,10), (6,1), (6,2), (6,3), (6,4), (6,5), (6,6), (6,7), (6,8), (6,9), (6,10), (7,1), (7,2), (7,3), (7,4), (7,5), (7,6), (7,7), (7,8), (7,9), (7,10), (8,1), (8,2), (8,3), (8,4), (8,5), (8,6), (8,7), (8,8), (8,9), (8,10), (9,1), (9,2), (9,3), (9,4), (9,5), (9,6), (9,7), (9,8), (9,9), (9,10), (10,1), (10,2), (10,3), (10,4), (10,5), (10,6), (10,7), (10,8), (10,9), (10,10).

```

      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

```

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 through 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 1130
1080 IF UP=0 AND AC=1 THEN UP=1:GOTO 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
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$(TIMES$,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 re-numbered, so you should find it easy to modify the first listing into the second one. The RCL commands are the same, except that PRINT-OUT 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 .
1 2 3 4 5 6 7 8

```

YOUR MOVE...

? 7

```

. . . . .
. . . . .
. . . . .
. . . MM .
. . . Moo .
. . MoMoo .
1 2 3 4 5 6 7 8

```

YOUR MOVE...

? 7

```

. . . . .
. . . . .
. . . . M .
. . . MM .
. . . MoOo .
. . MoMoo .
1 2 3 4 5 6 7 8

```

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

	A	B	C	D	E	F	G	H
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

	A	B	C	D	E	F	G	H
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"MOVE
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/W0}/100]*100
600 IV={CN*67}/{IP*IP}
610 W0=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 $"W0" 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 ECONOMIC"
930 PRINT "PERFORMANCE HAS LED TO AN UNACCEPTABLE"
940 IF FLAG=1 THEN PRINT "BUDGET DEFICIT"
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 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 $"INT[10*BD]/10
1140 END
1150 REM *****
1160 REM INITIALIZATION
1170 CLS
1180 RANDOMIZE VAL[RIGHT$(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
  HI!":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 GOOD"
1300 DATA "GREAT","EXCELLENT","SUPERLATIVE"
```

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 $"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 $"INT[(AS-AC)*Y[3]/(100*1
000)]/10"PER MONTH"
790 PRINT "-----
---"
800 PRINT "PROFIT FOR THE MONTH IS $"MP
/10
810 PRINT "& TOTAL PROFIT TO DATE IS $"
INT[TP*10]/10
820 PRINT "-----
---"
830 RETURN
840 REM *****
850 REM MONTH REPORT
860 CLS
870 IF MT>0 THEN PRINT "YOUR MONTHLY SAL
ES ARE"INT[Y[3]]
880 PRINT "-----
---"
890 PRINT "MAXIMUM MONTHLY OUTPUT:"
900 PRINT TAB[3];"FACTORY 1:"INT[M[1]]
910 PRINT TAB[3];"FACTORY 2:"INT[M[2]]
920 PRINT TAB[3];"FACTORY 3:"INT[M[3]]
930 IF SF=1 THEN 960
940 PRINT TAB[3];"FACTORY 4:"INT[M[4]]
950 PRINT "-----
---"
960 PRINT "TOTAL OUTPUT IS"INT[M[5]]
970 PRINT "-----
---"
980 PRINT "EFFICIENCY LEVEL IS"INT[EF]"%
"
990 RETURN
1000 REM *****
1010 REM GET REPLIES
1020 A$=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 I
1"
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

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

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 60"
670 GOSUB 70
680 PRINT "-----
    ----"
690 PRINT Z$" IN POSSESSION"
700 PRINT TAB(4);D"DOWN"
710 PRINT TAB(4);TG"YARDS TO 60"
720 PRINT "-----
    ----"
730 PRINT "START AT"SL"YARD LINE"
740 PRINT "NOW ON"NU"YARD LINE"
750 PRINT 100-NU"YARDS TO TOUCHDOWN"
760 PRINT "-----
    ----"
770 PRINT "ON THIS PLAY ";
780 IF Z$=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 "FUMBLER...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$="BJORNX":VC=1
110 IF VC=1 THEN 160
120 PRINT "PLEASE ENTER A SIX-LETTER NAME"
130 INPUT "NAME OF FIRST PLAYER";A$
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$="0":D$="0":G
OTO 1560
1480 IF S=2 THEN YA=YA+1:C$="0":D$="0":G
OTO 1580
1490 IF S=3 THEN ZA=ZA+1:C$="0":D$="0":G
OTO 1600
1500 CLS
1510 PRINT "GAME TO ";B$
1520 GOSUB 1720
1530 IF S=1 THEN XB=XB+1:C$="0":D$="0":G
OTO 1560
1540 IF S=2 THEN YB=YB+1:C$="0":D$="0":G
OTO 1580
1550 IF S=3 THEN ZB=ZB+1:C$="0":D$="0":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.
```

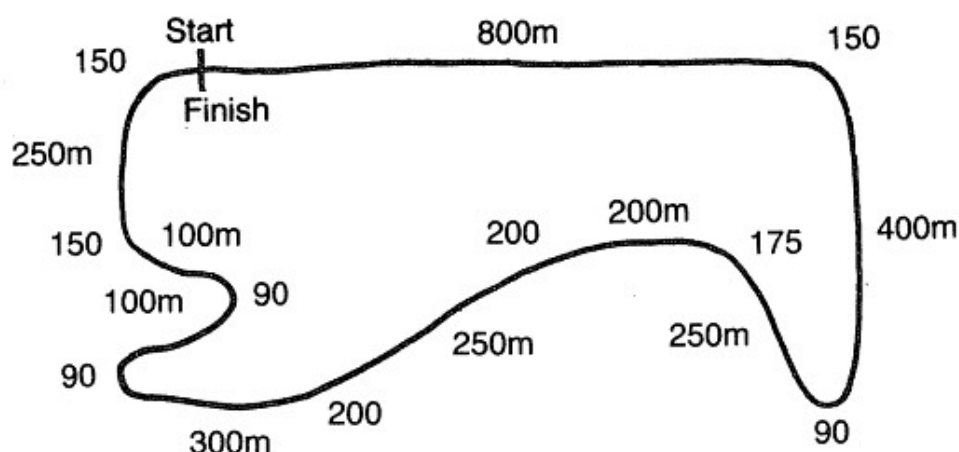
```
PRESS 'S' FOR SAME RACE, 'N' FOR NEW
RACE, 'E' TO END
```

The Tracks

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

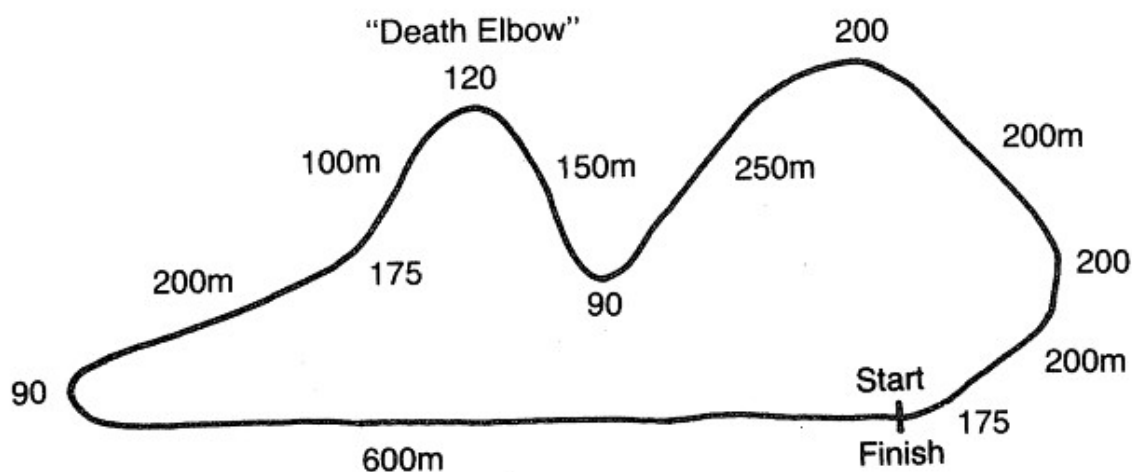
British Grand Prix

"The Whale," 2650 meters:



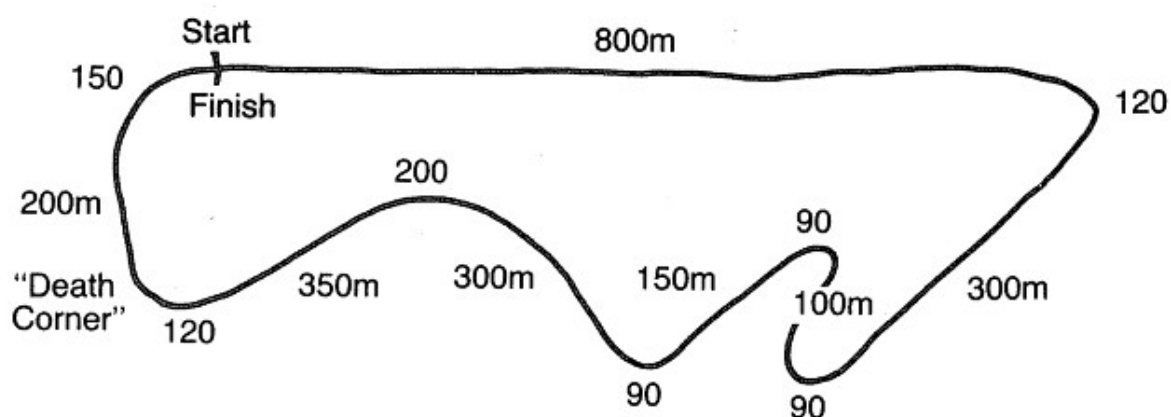
German Grand Prix

"The Key," 1700 meters:



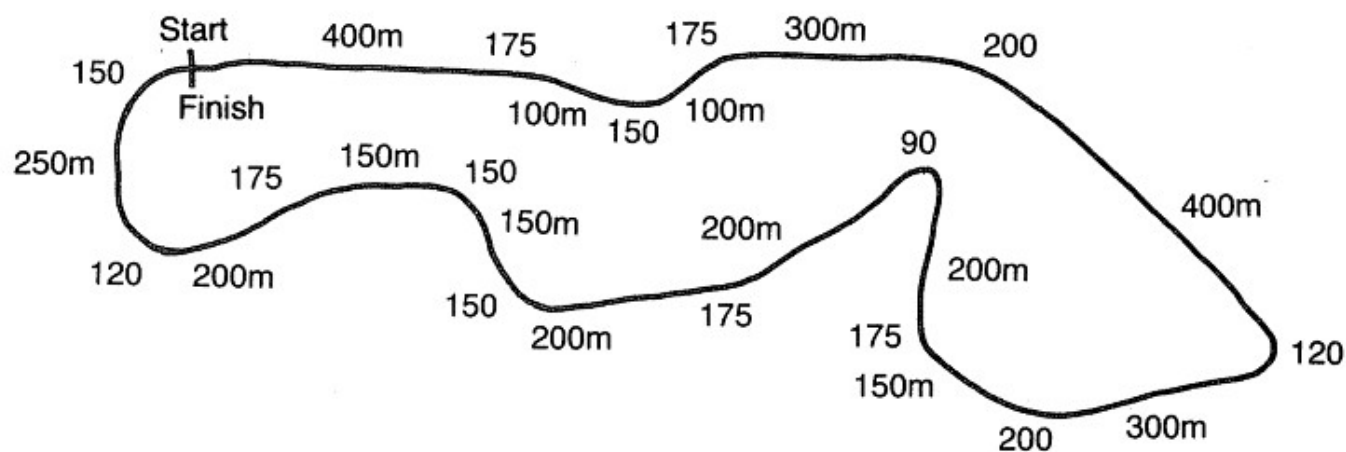
Italian Grand Prix

"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 <

```

Figure 1. The effect of the concentration of the Ca^{2+} solution on the Ca^{2+} concentration in the Ca^{2+} solution. The concentration of the Ca^{2+} solution was 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 6.0, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 7.0, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.0, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 10.0, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, 11.0, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 12.0, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 13.0, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 14.0, 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 15.0, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.8, 15.9, 16.0, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 17.0, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 18.0, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 19.0, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, 19.9, 20.0, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 21.0, 21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 21.7, 21.8, 21.9, 22.0, 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9, 23.0, 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7, 23.8, 23.9, 24.0, 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, 24.9, 25.0, 25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7, 25.8, 25.9, 26.0, 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 27.0, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.0, 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 29.0, 29.1, 29.2, 29.3, 29.4, 29.5, 29.6, 29.7, 29.8, 29.9, 30.0, 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, 30.9, 31.0, 31.1, 31.2, 31.3, 31.4, 31.5, 31.6, 31.7, 31.8, 31.9, 32.0, 32.1, 32.2, 32.3, 32.4, 32.5, 32.6, 32.7, 32.8, 32.9, 33.0, 33.1, 33.2, 33.3, 33.4, 33.5, 33.6, 33.7, 33.8, 33.9, 34.0, 34.1, 34.2, 34.3, 34.4, 34.5, 34.6, 34.7, 34.8, 34.9, 35.0, 35.1, 35.2, 35.3, 35.4, 35.5, 35.6, 35.7, 35.8, 35.9, 36.0, 36.1, 36.2, 36.3, 36.4, 36.5, 36.6, 36.7, 36.8, 36.9, 37.0, 37.1, 37.2, 37.3, 37.4, 37.5, 37.6, 37.7, 37.8, 37.9, 38.0, 38.1, 38.2, 38.3, 38.4, 38.5, 38.6, 38.7, 38.8, 38.9, 39.0, 39.1, 39.2, 39.3, 39.4, 39.5, 39.6, 39.7, 39.8, 39.9, 40.0, 40.1, 40.2, 40.3, 40.4, 40.5, 40.6, 40.7, 40.8, 40.9, 41.0, 41.1, 41.2, 41.3, 41.4, 41.5, 41.6, 41.7, 41.8, 41.9, 42.0, 42.1, 42.2, 42.3, 42.4, 42.5, 42.6, 42.7, 42.8, 42.9, 43.0, 43.1, 43.2, 43.3, 43.4, 43.5, 43.6, 43.7, 43.8, 43.9, 44.0, 44.1, 44.2, 44.3, 44.4, 44.5, 44.6, 44.7, 44.8, 44.9, 45.0, 45.1, 45.2, 45.3, 45.4, 45.5, 45.6, 45.7, 45.8, 45.9, 46.0, 46.1, 46.2, 46.3, 46.4, 46.5, 46.6, 46.7, 46.8, 46.9, 47.0, 47.1, 47.2, 47.3, 47.4, 47.5, 47.6, 47.7, 47.8, 47.9, 48.0, 48.1, 48.2, 48.3, 48.4, 48.5, 48.6, 48.7, 48.8, 48.9, 49.0, 49.1, 49.2, 49.3, 49.4, 49.5, 49.6, 49.7, 49.8, 49.9, 50.0, 50.1, 50.2, 50.3, 50.4, 50.5, 50.6, 50.7, 50.8, 50.9, 51.0, 51.1, 51.2, 51.3, 51.4, 51.5, 51.6, 51.7, 51.8, 51.9, 52.0, 52.1, 52.2, 52.3, 52.4, 52.5, 52.6, 52.7, 52.8, 52.9, 53.0, 53.1, 53.2, 53.3, 53.4, 53.5, 53.6, 53.7, 53.8, 53.9, 54.0, 54.1, 54.2, 54.3, 54.4, 54.5, 54.6, 54.7, 54.8, 54.9, 55.0, 55.1, 55.2, 55.3, 55.4, 55.5, 55.6, 55.7, 55.8, 55.9, 56.0, 56.1, 56.2, 56.3, 56.4, 56.5, 56.6, 56.7, 56.8, 56.9, 57.0, 57.1, 57.2, 57.3, 57.4, 57.5, 57.6, 57.7, 57.8, 57.9, 58.0, 58.1, 58.2, 58.3, 58.4, 58.5, 58.6, 58.7, 58.8, 58.9, 59.0, 59.1, 59.2, 59.3, 59.4, 59.5, 59.6, 59.7, 59.8, 59.9, 60.0, 60.1, 60.2, 60.3, 60.4, 60.5, 60.6, 60.7, 60.8, 60.9, 61.0, 61.1, 61.2, 61.3, 61.4, 61.5, 61.6, 61.7, 61.8, 61.9, 62.0, 62.1, 62.2, 62.3, 62.4, 62.5, 62.6, 62.7, 62.8, 62.9, 63.0, 63.1, 63.2, 63.3, 63.4, 63.5, 63.6, 63.7, 63.8, 63.9, 64.0, 64.1, 64.2, 64.3, 64.4, 64.5, 64.6, 64.7, 64.8, 64.9, 65.0, 65.1, 65.2, 65.3, 65.4, 65.5, 65.6, 65.7, 65.8, 65.9, 66.0, 66.1, 66.2, 66.3, 66.4, 66.5, 66.6, 66.7, 66.8, 66.9, 67.0, 67.1, 67.2, 67.3, 67.4, 67.5, 67.6, 67.7, 67.8, 67.9, 68.0, 68.1, 68.2, 68.3, 68.4, 68.5, 68.6,

CRASH!

CRASH I

CRASH I

CRASH!

CRASH!

CRASH I

CRASH I

CRASH I

CRASH I

CRASH I

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.

I 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
0 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* I!":REM
    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 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 = - HEIGHT
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 * VELOCIT
Y) / 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

```

Apple IIe

```
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
```

Apple IIe

```
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
```

Apple IIe

```

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:

```

Apple IIe

```
      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
```

Apple IIe

```

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

```

Apple IIe

```

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)

```

Apple IIe

```

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

```

Apple IIe

```

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
```


Apple IIe

```

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

```

Apple IIe

```
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
```

Apple IIe

```

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
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

```

Apple IIe

```

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 ("S")
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 ("K")
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

```

Apple IIe

```
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
```

Apple IIe

```

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"

```

Apple IIe

```

920 PRINT "ADMINISTRATION'S POOR ECONOMIC"
930 PRINT "PERFORMANCE HAS LED TO AN UNACCEPTABLE"
940 IF FLAG = 1 THEN PRINT "BUDGET DEFICIT"
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 UNEMPLOYMENT"
980 PRINT "                                AMONG OTHER THINGS..."
990 PRINT "-----"
1000 PRINT "THE LACK OF CONFIDENCE IN YOUR"
1010 PRINT "ADMINISTRATION IS SO BAD THERE ARE"
1020 PRINT "CALLS FOR YOU TO RESIGN...YOU STEP"
1030 PRINT "ASIDE TO ALLOW THE VICE-PRESIDENT 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 BECAME "; INT (10 * IP) / 10;"%"
1120 PRINT "STANDARD OF LIVING CHANGED BY "; 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

```

Apple IIe

```

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>"

```

Apple IIe

```
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
```

Apple IIe

```

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 "-----"
-----"

```

Apple IIe

```

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"

```


Apple IIe

```

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;" YARD 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

```

Apple IIe

```

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$;"CAN": GOT
0 800
790 PRINT B$;"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

```

Apple IIe

```

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 "FUMBLLED...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

```


Apple IIe

```

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"

```

Apple IIe

```

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

```

Apple IIe

```

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$ = "0":
D$ = "0": GOTO 1560
1480 IF S = 2 THEN YA = YA + 1:C$ = "0":
D$ = "0": GOTO 1580
1490 IF S = 3 THEN ZA = ZA + 1:C$ = "0":
D$ = "0": GOTO 1600
1500 HOME
1505 GOSUB 5500
1510 PRINT "GAME TO ";B$
1520 GOSUB 1720
1530 IF S = 1 THEN XB = XB + 1:C$ = "0":
D$ = "0": GOTO 1560
1540 IF S = 2 THEN YB = YB + 1:C$ = "0":
D$ = "0": GOTO 1580
1550 IF S = 3 THEN ZB = ZB + 1:C$ = "0":
D$ = "0": 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

```

Apple IIe

```

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."

```

Apple IIe

```

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
RNNERS
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

```

Apple IIe

```

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$(7): REM THESE ARRAYS HO
LD HORIZON AND COMPASS OUTPUT
60 REM *****
70 GOSUB 2320: REM INITIALIZE
80 IF CRASH = 0 THEN GOSUB 820: REM H
ORIZON/COMPASS
90 GOSUB 500: REM PRINTOUT
100 IF CRASH = 1 THEN END
110 IF LA = 1 AND UFLAG = 1 THEN PRINT
"WELL DONE. A PERFECT LANDING!!
": END
120 IF LA = 1 AND UFLAG = 0 THEN PRINT
"YOUR WHEELS ARE UP": GOSUB 178
O: GOTO 90
130 T = AI:STALL = 0
140 X$ = "":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

```

Apple IIe

```

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

```

Apple IIe

```

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 *****

```

Apple IIe

```

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

```

Commodore 64

```
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$(P,Q)="Q"
120 M=M+1
130 PRINT"
{HOME}":PRINT:PRINT
140 PRINT"MOVE" M
150 FOR X=1 TO 10
160 FOR Y=1 TO 10
170 PRINTA$(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 *****
```

Commodore 64

```
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
```

Commodore 64

```
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 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$(X,Y)="X" AND C<>2 AND C<>3 THEN
N B$(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
```

Commodore 64

```
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
```

Commodore 64

```

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 1130
1080 IF UP=0 AND AC=1 THEN UP=1:GOTO 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
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

```

Commodore 64

```

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

```


Commodore 64

```

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

```

Commodore 64

```

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)OR
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:NEXT 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$(L,A)=H$
```

Commodore 64

```
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-20)=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+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 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

```


Commodore 64

```

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("$")
1270 RETURN
1280 PRINT:PRINT
1290 PRINT"THANKS FOR THE GAME"
1300 END
1310 REM *****
1320 REM PRINT BOARD
1330 PRINT"
(CLR)"
1340 PRINT:PRINT
1350 IF MOVE>0 THEN PRINT"I USED MOVE"MOVE
VE
1360 IF MOVE=0 THEN PRINT
1370 PRINT:PRINT
1380 PRINT TAB(11);"ABCDEFGH"
1390 FOR J=8 TO 1 STEP -1
1400 PRINT TAB(8);J;
1410 FOR K=10 TO 80 STEP 10
1420 PRINT CHR$(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

```

Commodore 64

```
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
```

Commodore 64

```

290 PRINT"GROSS DOMESTIC PRODUCT $M"INT(
GDP*10)/10
300 IF Y+Z/4>.5 THEN PRINT"CHANGE IN LIV
ING STANDARD ";
305 IF Y+Z/4>.5 THEN PRINTINT((2*((RGDP/
AGDP)*100)-100)/3)%"
310 PRINT"-----
----"
320 PRINT"PUBLIC INVESTMENT"Y"Q"Z"$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/WD)/100)*100
600 IV=(CN*67)/(IP*IP)
610 WD=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 DEFICIT"
950 IF FLAG=2 THEN PRINT"DROP IN THE STA
NDARD OF LIVING"

```

Commodore 64

```

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$(TIME,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 "

```

Commodore 64

```

(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)/100))
1010 K=INT(RND(1)*100)+1
1020 IF K<D(C) THEN S(C)=S(C)/(1+(P(C)/100))
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"

```

Commodore 64

1280 DATA "REASONABLE", "A LITTLE ABOVE A
VERAGE"

1290 DATA "FAIRLY GOOD", "GOOD", "VERY GOOD"

1300 DATA "GREAT", "EXCELLENT", "SUPERLATIVE"

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
```

Commodore 64

```
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 $"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 $"INT((AS-AC)*Y(3)/(100*10
00))/10"PER MONTH"
790 PRINT"-----
----"
800 PRINT"PROFIT FOR THE MONTH IS $"MP/
10
810 PRINT"& TOTAL PROFIT TO DATE IS $"I
NT(TP*10)/10
820 PRINT"-----
----"
830 RETURN
840 REM *****

```

Commodore 64

```

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

```

Commodore 64

```
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
```

Commodore 64

```

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..."

```

Commodore 64

```

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"

```

```

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 OPPOSITI
ON HAS"
1450 PRINT"CAUSED YOU TO LOSE"ABS(E)"YAR
DS"
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"FUMBLLED...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

```


Commodore 64

```

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

```

Commodore 64

```
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$="0":D$="0":G
OTO 1560
1480 IF S=2 THEN YA=YA+1:C$="0":D$="0":G
OTO 1580
1490 IF S=3 THEN ZA=ZA+1:C$="0":D$="0":G
OTO 1600
1500 PRINT"
(CLR)"
1510 PRINT"GAME TO ";B$
1520 GOSUB 1720
1530 IF S=1 THEN XB=XB+1:C$="0":D$="0":G
OTO 1560
1540 IF S=2 THEN YB=YB+1:C$="0":D$="0":G
OTO 1580
1550 IF S=3 THEN ZB=ZB+1:C$="0":D$="0":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

```

Commodore 64

```
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
```

Commodore 64

```

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"

```

Commodore 64

```

(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

```

```

1220 FOR X=1 TO 3
1230 PRINT TAB(X*4);"OK, GOOD LUCK, ";A$
1240 GOSUB 2330:NEXT X
1250 PRINT"*****
*****"
1260 PRINT"WHICH RACE DO YOU WANT TO TAK
E PART IN:"
1270 PRINT
1280 PRINT TAB(7);"BRITISH GRAND PRIX 26
50MT :1"
1290 PRINT TAB(7);"GERMAN GRAND PRIX 17
00MT :2"
1300 PRINT TAB(7);"ITALIAN GRAND PRIX 22
00MT :3"
1310 PRINT TAB(7);"MONACO GRAND PRIX 31
00MT :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 SPEED=140
1510 FOR X=1 TO 9
1520 READ D(X):REM DISTANCE BETWEEN
CORNERS
1530 NEXT X

```

Commodore 64

```

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:BRK=10:TRAV=0:DIST=0
2280 EFLAG=0
2290 X=0

```

Commodore 64

```
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$(7):REM THESE ARRAYS
  HOLD HORIZON AND COMPASS OUTPUT
60 REM *****
70 GOSUB 2320:REM INITIALISE
80 IF CRASH=0 THEN GOSUB 820:REM HORIZON
                        /COMPASS
90 GOSUB 500:REM PRINTOUT
100 IF CRASH=1 THEN END
110 IF LND=1 AND UFLAG=1 THEN GOSUB 4000:P
RINT"WELL DONE. A PERFECT LANDING!":END
120 IF LND=1 AND UFLAG=0 THEN PRINT"YOUR
  WHEELS ARE UP":GOSUB 1780:GOTO 90
130 T=AIRSPEED:SALL=0
140 GET X$
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)
```

Commodore 64

```

290 IF X$=CHR$(32) 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:GOTO 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 AIRSPEED<60 AND UFLAG=1 THEN TAKEOV=1
410 IF TAKEOV=0 THEN ALTIMETER=0:GOTO 450
420 IF LND=0 AND AIRSPEED<30 THEN ELEVATE=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 ALTIMETER=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 TAKEOV=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 THEN GOSUB 1920

```

```

570 PRINT " :-----:-----: "
580 FOR J=1 TO 7
590 PRINT " :";A$(J);" :";C$(J);" : "
600 A$(J)=" "
610 NEXT J
620 PRINT " :-----:-----: "
630 DIST=DIST+ABS((COS(ELEVATE))*AIRSPEED)/360
640 CLOCK=CLOCK+1
650 PRINT " :RANGE"INT(DIST*10)/10" : TIME"
INT(CLOCK)/10;" : "LD
660 PRINT " :-----:-----: "
670 PRINT " :AIRSPEED : "INT(AIRSPEED)
680 PRINT " :";LEFT$(Q$,INT(AIRSPEED/20));
">"
690 PRINT " :ALTIMETER: "INT(ALTIMETER);
700 IF ANG<0 THEN PRINTTAB(19);360+ANG"DEG."
710 IF ANG>=0 THEN PRINTTAB(19);ANG"DEG."
720 MR=INT(ALTIMETER/30):IF MR>20 THEN MR=20
730 PRINT " :";LEFT$(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

```

Commodore 64

```

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

```

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```

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

```

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```
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

Books

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Acknowledgments

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SPACE LANDING—Tim Hartnell; MONTE CARLO—Tim Hartnell; SIMULTANEOUS EQUATIONS—Tim Hartnell; LIFE—Tim Hartnell; ROBOT LOGO and POINT DUTY ROBOT—Tim Hartnell; CONNECT FOUR—Anthony W. Pearson; QUEVEDO CHESS MACHINE—Tim Hartnell; WASHINGTON D.C.—Philip J. Coates; STOCK MARKET—Philip J. Coates; DETROIT CITY—Philip J. Coates; GRIDIRON—Philip J. Coates; TENNIS—Philip J. Coates; GRAND PRIX—Philip J. Coates; FLIGHT SIMULATION—Tim Hartnell

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

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