SIMULATIONS

Ten unique programs in BASIC for the computer hobbyist

art auction
monster chase
lost treasure
gone fishing
space flight
forest fire
nautical navigation
business management
rare birds
diamond thief

by Dr. C. William Engel

STIMULATING SIMULATIONS

Ten unique programs in BASIC
for the computer hobbyist

by

C. William Engel

Dr. Engel is a professor of Mathematics
Education at the University of South Florida
Tampa, Florida

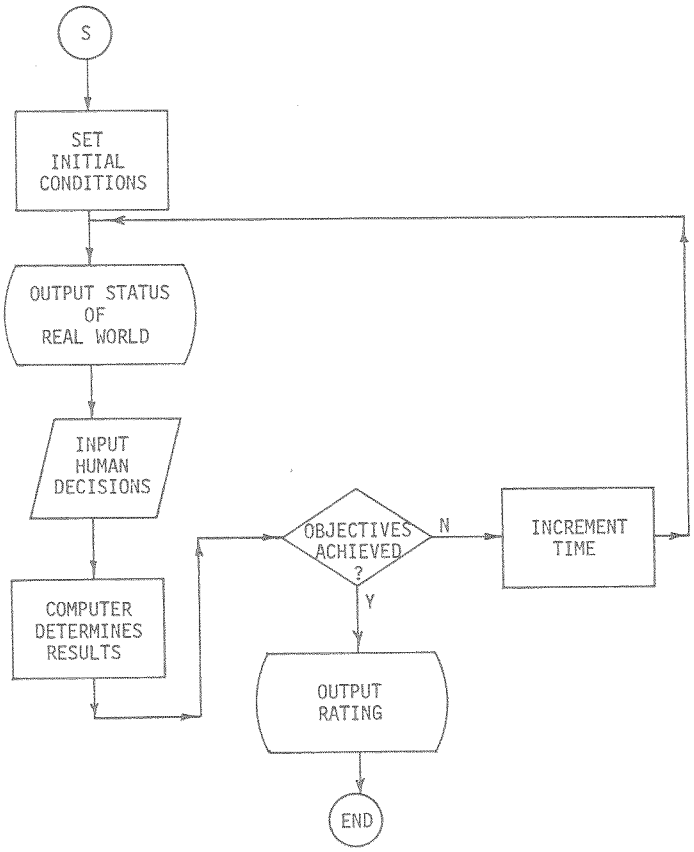
Published by
Engel Enterprises
Box 16612
Tampa, Florida 33687

CONTENTS

INTRODUCTION

Simple number games and puzzles are used frequently by beginning computer hobbyists. While some computer enthusiasts develop computer systems that monitor environmental conditions, compute income tax, or serve as expensive burglar alarms, most continue to use their computers primarily for recreation. This booklet is designed for the person who is beyond the simple number-game stage of software development and would like to develop some interesting simulations.

The programs are written so that the computer does not do all the "thinking" but forces the player to develop strategies for achieving the objectives. A general overview of a simulation is illustrated in the flowchart below.



The simulations presented in this booklet are written in BASIC and can be easily adapted to almost any system. The programs vary from 500 to 2,000 bytes or 40 to 100 lines of BASIC. Some of the lines have multiple statements; but, since the line numbers are multiples of ten, it would be easy to modify the program to operate with single statements. All of the line numbers with a unit's digit of five can be deleted without affecting the program.

Each simulation begins with a scenario describing the rules, conditions and objectives to be achieved. The rules have been written in third person, because some programmers like to condense the rules and place them in a subroutine for access by the operator. A sample run and a general flowchart with line numbers provide additional information about each program. A description of the variables precedes the program listing. Some program modifications are suggested. The minor modifications require only adjustments of variables in specific lines, while major modifications require additional programming. In some cases, supplemental playing boards, graphs, and charts are supplied for recording information on the progress of the simulation.

A brief description of each program is given below.

1. Art Auction (48 lines)
   One buys and sells paintings to make a maximum profit. This is a fast simulation and does not require extra materials.

2. Monster Chase (48 lines)
   A monster is chasing a victim in a cage. The victim must elude the monster for ten moves to survive. It is a fairly quick simulation that doesn't require too much thinking.

3. Lost Treasure (74 lines)
   A map of an island that contains treasure is presented. The adventurer travels over different terrain with a compass that isn't very accurate in an attempt to find the treasure. This is a short simulation that requires about 15 moves. A map is provided.

4. Gone Fishing (83 lines)
   The objective is to catch a lot of fish during a fishing trip. Half of the catch spoils if the time limit is exceeded, time is lost in a storm, and the boat sinks if it is guided off of the map. There are also sea gulls and sharks to watch. A chart is needed to keep track of good fishing spots.

5. Space Flight (68 lines)
   The task is to deliver medical supplies to a distant planet while trying to stay on course without running out of fuel. Graph paper is required to plot the course.

6. Forest Fire (77 lines)
   The objective is to subdue a forest fire with chemicals and backfires. Because the output is a 9X9 grid, a fast baud rate to the terminal is desirable. The success of a firefighter is based on the time needed to control the fire and completely extinguish it.

7. Nautical Navigation (70 lines)
   This simulation requires the navigation of a sailboat to three different islands, using a radio direction finder. The wind direction is an important variable. Graph paper, protractor and ruler are needed to plot the course.

8. Business Management (92 lines)
   In this simulation, raw materials are bought and finished products are produced and sold. The cost of materials and production and the selling price vary each month. The objective is to maximize the profits. No extra materials are required.

9. Rare Birds (75 lines)
   This is a bird watching simulation. The objective is to identify as many different birds as possible. A record of those identified is helpful and a bird watching chart is provided.

10. Diamond Thief (83 lines)
    One assumes the role of a detective in this simulation. A thief has just stolen a diamond from a museum. Five suspects must be questioned to determine the thief. A floor plan of the museum and a chart indicating suspects and times are provided.

In addition to extending the simulations in this booklet, one might try combining some of them. For example: one could take the money earned in Art Auction to start the Business Management simulation. After twelve months of business, the profits could be used to buy a boat to use in the Gone Fishing simulation. A large boat could survive storms, hold more fish, and allow fishing in deeper water. The ultimate objective could be to catch the most fish.

The computer hobbyist is limited only by the imagination in simulating real events. It is the author's desire that this booklet provide some fun and, at the same time, stimulate further development of creative simulations. Some additional ideas for simulations are suggested below:

1. Hunt Big Foot
2. Race a Sailboat
3. Inhibit the Andromeda Strain
4. Stop the African Bee Invasion
5. Climb Mountains
6. Survive in the Wilderness
7. Find Gold or Oil
8. Swim from Jaws
9. Dispatch Airplanes, Trains, or Trucks
10. Herd Sheep
11. Explore Caves
12. Catch Butterflys

ART AUCTION

Scenario

In this simulation, you will be given an opportunity to buy and sell up to five paintings. The objective is to make a large profit by buying the paintings for as little as possible and selling them for as much as possible.

In order to buy a painting, you must bid against a secret bid made by another buyer. When a painting is offered for sale, three numbers will be given that represent the mean and range of bids for this particular painting. For example, "200 300 400" indicates that the mean bid price for the painting is 300, and about 70% of the time the price will be between 200 and 400. (Note that higher priced paintings tend to have a larger range of prices.)

After you buy your paintings, you will be given an opportunity to sell them. You will receive from one to five offers, but you do not know in advance how many offers will be made. The offers will be, on the average, 50 higher than the bids made during the buying phase. If you do not accept an offer, and it is the last one, then the offer will be automatically processed. Sometimes it will be wise to accept an offer that is less than the purchase price rather than gamble on a higher offer that does not materialize.

When all of the paintings that you have bought have been sold, you will be given your total profit for all of the transactions.

Sample Run

```
BUY PAINTING  1
PRICES:  546  553  560
YOUR BID?  560
OPPONENT BID  565.
YOU WERE OUT BID.

BUY PAINTING  2
PRICES:  336  449  562
YOUR BID?  400
OPPONENT BID  440.
YOU WERE OUT BID.

BUY PAINTING  3
PRICES:  213  288  363
YOUR BID?  300
OPPONENT BID  324
YOU WERE OUT BID.

BUY PAINTING  4
PRICES:  403  514  625
YOUR BID?  600
OPPONENT BID  497.
YOU BOUGHT IT.

BUY PAINTING  5
PRICES:  274  346  417
YOUR BID?  350
OPPONENT BID  311.
YOU BOUGHT IT.

SELL PAINTING  4
YOU BOUGHT IT FOR  600.
AVERAGE OFFER IS  564.
OFFER 1 IS  649.
ACCEPT?  Y

SELL PAINTING  5
YOU BOUGHT IT FOR  350.
AVERAGE OFFER IS  396.
OFFER 1 IS 365.
ACCEPT?  N

YOUR PROFIT IS  64.
PLAY AGAIN?
```

ART AUCTION PROGRAM

Variables

P(5)	Prices
S(5)	Price range
F(5)	Set flag if painting is bought
CB	Opponent's bid
YB	Your bid
I,J,K	Indices
P	Profit
N	Number
D	Dividend
Q	Quotient

Program Listing

```
5       REM SET PRICES AND RANGES
10      DIM P(5),S(5),F(5)
20      FOR I=1 TO 5
30      P(I)=100+INT(900*RND(1))
40      S(I)=INT(P(I)*RND(1))
50      IF P(I)<500 THEN S(I)=INT(P(I)*.7*RND(1))
60      F(I)=0
70      NEXT I

95      REM BUY PAINTINGS
100     FOR I=1 TO 5
110     GO SUB 500
120     PRINT: PRINT "BUY PAINTING"; I:PRINT:PRINT
130     PRINT "PRICES:"; INT(P(I)-.5*S(I)); P(I); INT(P(I)+.5*S(I))
140     PRINT: PRINT: INPUT "YOUR BID"; YB
150     PRINT "OPPONENT'S BID"; CB; "."
160     IF YB>CB THEN PRINT "YOU BOUGHT IT.": F(I)=YB: GO TO 180
170     PRINT "YOU WERE OUT BID."
180     NEXT I

195     REM SELL PAINTINGS
200     FOR I=1 TO 5
210     IF F(I)=0 THEN 310
220     FOR K=1 TO INT(5*RND(1))
230     GO SUB 500: CB=CB+INT(100*RND(1))

240     PRINT "SELL PAINTINGS"; I
250     PRINT "YOU BOUGHT IT FOR"; F(I): PRINT "AVERAGE OFFER IS";
        P(I)+50
260     PRINT "OFFER"; K; "IS"; CB; "."
270     INPUT "ACCEPT"; Y$
280     IF Y$="Y" THEN 300
290     NEXT K
300     P=P+CB-F(I)
310     NEXT I
320     PRINT: PRINT "YOUR PROFIT IS"; P; "."
330     INPUT "PLAY AGAIN"; Y$
340     IF Y$="Y" THEN RUN
350     END
```



```
495     REM NORMAL DISTRIBUTION SUBROUTINE
500     D=0
510     N=INT(65536*RND(1))
520     FOR J=1 TO 16
530     Q=INT(N/2)
540     D=D+2*(N/2-Q)
550     N=Q
560     NEXT J
570     CB=P(I)+S(I)*(D-8)/8
580     CB=CB+20*RND(1)
590     CB=INT(CB)
600     RETURN
```

ART AUCTION MODIFICATIONS

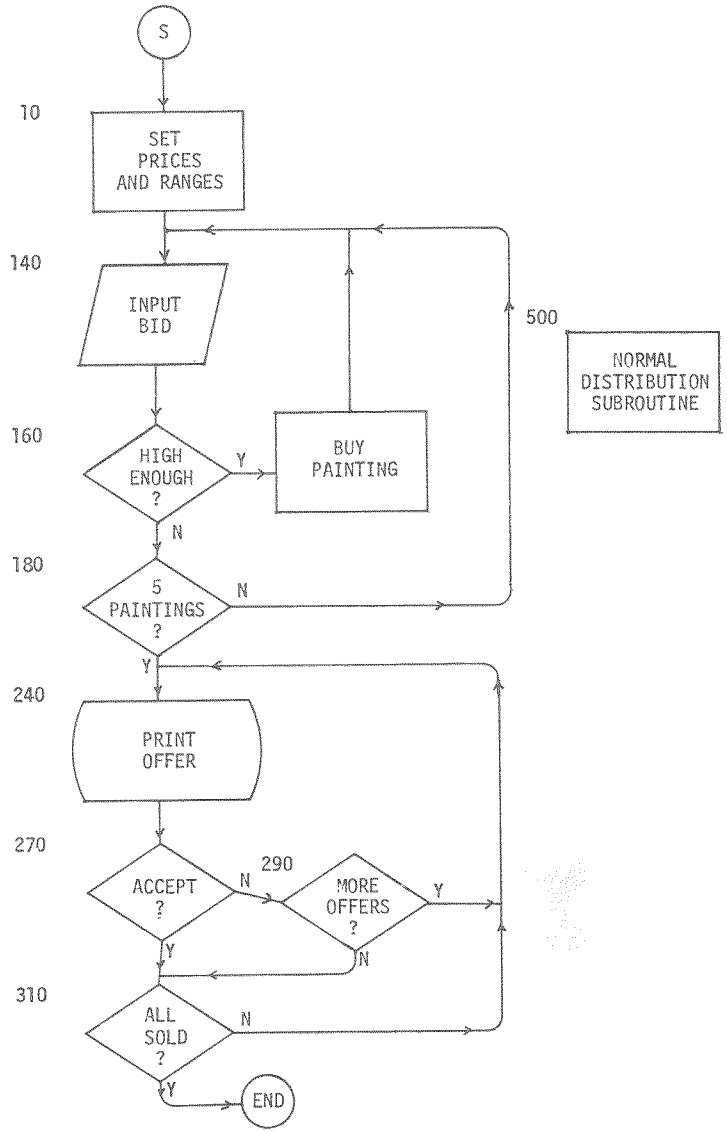
Minor

1. Number of paintings -- lines 10, 20, 100, 200
2. Starting prices -- line 30
3. Price spread -- lines 40, 50
4. Built-in profit -- lines 230, 250
5. Error in price range -- line 580
6. Number of offers -- line 220

Major

1. Have one or more of the paintings a forgery that is worth nothing.
2. Have one or more of the paintings that have a low purchase price be very valuable.
3. Have more opponents bid against you.

ART AUCTION FLOWCHART

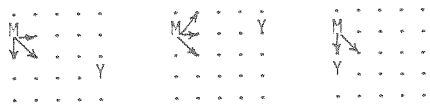


MONSTER CHASE

Scenario

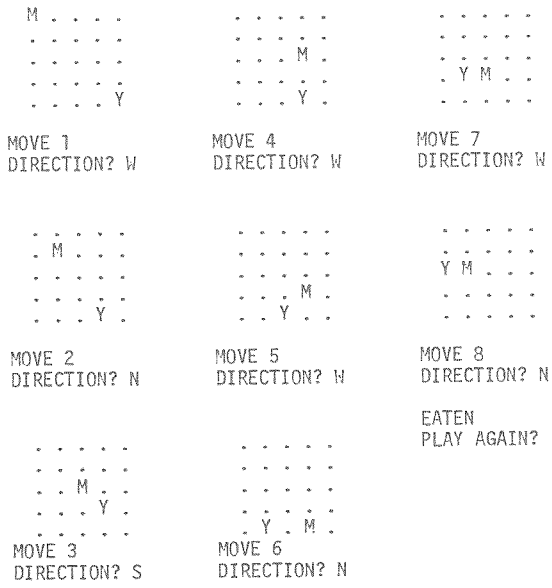
In this simulation you are locked in a cage with a hungry monster who has a life span of ten turns. Your movement and that of the monster takes place on a 5X5 grid. You may move north, east, south, or west by entering N, E, S, or W. If you enter any other letter, you will remain in the same place.

The monster is programmed to move along one of the arrows toward you as shown below :



Your only means of survival is to outwit the monster for ten turns.

Sample Run



MONSTER CHASE PROGRAM

Variables

L(I,J)	Grid location
R,C	Your row and column
X,Y	Monster's row and column
L,M	Temporary variables
M$	Your move (N,E,S,W,O)
D	Direction of the monster (1-8)
T	Turns (1-10)

Listing

```
5     REM SET CONDITIONS
10    X=1: Y=1
20    R=5: C=5
30    FOR T=1 TO 10

35    REM DISPLAY GRID
40    FOR I=1 TO 5
50    FOR J=1 TO 5
60    PRINT TAB(8)
70    IF I=X AND J=Y THEN PRINT "M";: GO TO 100
80    IF I=R AND J=C THEN PRINT "Y";: GO TO 100
90    PRINT ".";
100   NEXT J
110   PRINT
120   NEXT I

210   ?:?:? "MOVE NUMBER"; T
220   INPUT "DIRECTION (NESWO)"; M$
240   IF M$="N" THEN R=R-1
250   IF M$="E" THEN C=C+1
260   IF M$="S" THEN R=R+1
270   IF M$="W" THEN C=C-1
280   IF R*C=0 OR R>5 OR C>5 THEN PRINT "OUT OF BOUNDS": GO TO 520
290   IF R=X AND Y=C THEN PRINT "EATEN": GO TO 520
300   IF X=R AND Y<C THEN D=1
310   IF X>R AND Y<C THEN D=2
320   IF X>R AND Y=C THEN D=3
330   IF X>R AND Y>C THEN D=4
340   IF X=R AND Y>C THEN D=5
350   IF X<R AND Y>C THEN D=6
360   IF X<R AND Y=C THEN D=7
370   IF X<R AND Y<C THEN D=8
380   D=D+INT(3*RND(1)-1)
390   IF D=0 THEN D=8
400   IF D=9 THEN D=1
410   IF D>1 AND D<5 THEN X=X-1
420   IF D>5 THEN X=X+1
430   IF D>3 AND D<7 THEN Y=Y-1
440   IF D<3 OR D=8 THEN Y=Y+1
450   IF X=0 THEN X=X+1
460   IF Y=0 THEN Y=Y+1
470   IF X=6 THEN X=X-1
480   IF Y=6 THEN Y=Y-1
```



```
490   IF X=R AND Y=C THEN PRINT "EATEN": GO TO 520
500   NEXT T
510   PRINT "YOU SURVIVED!"
520   INPUT "PLAY AGAIN"; Y$
530   IF Y$="Y" THEN RUN
540   END
```

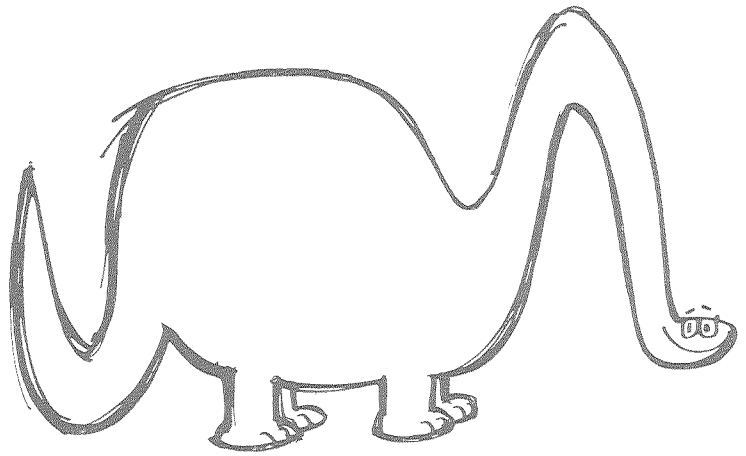
MONSTER CHASE MODIFICATIONS

Minor

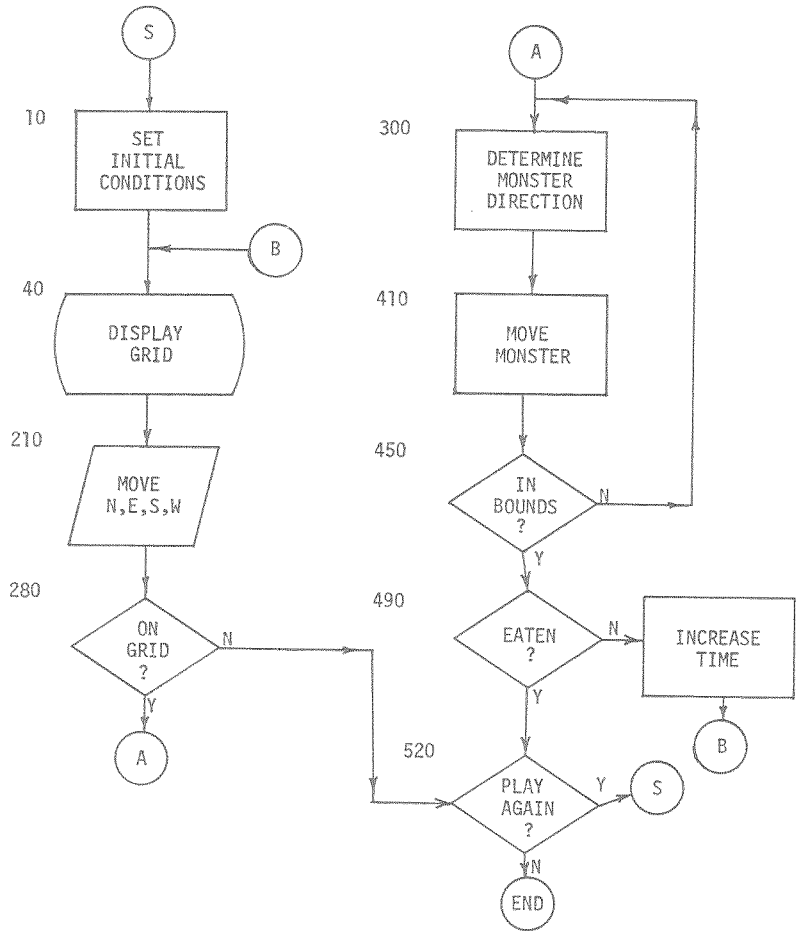
1. Grid size -- lines 20, 40, 50, 280, 470, 480
2. Turns to win -- line 30

Major

1. Have more than one monster.
2. Chase a little monster while a big monster tries to get you.
3. Have the monster fall in quicksand.
4. Require food in order to maintain energy.



MONSTER CHASE FLOWCHART



LOST TREASURE

Scenario

You have landed somewhere on an island that has treasure, woods, mountains, a cave, a bluff, an oak tree, and, of course, sea water all around. Your objective is to find the treasure as quickly as possible without falling into the shark-infested water.

You can move north (N), east (E), south (S), or west (W) one square at a time. Your compass, however, is not very accurate. There is only an 80% chance that you will move in the intended direction. There is a 20% chance you will move diagonally to the left or to the right. Each time that you move you will receive feedback regarding the type of terrain on which you are traveling.

If you fall into the sea, you will be placed back on the square occupied prior to your unfortunate move, unless you disturb the sharks. The chance that the sharks will eat you the first time you fall in is 20%. The second time you fall in the chance of being eaten is 70%. The third time you fall in will be your last!

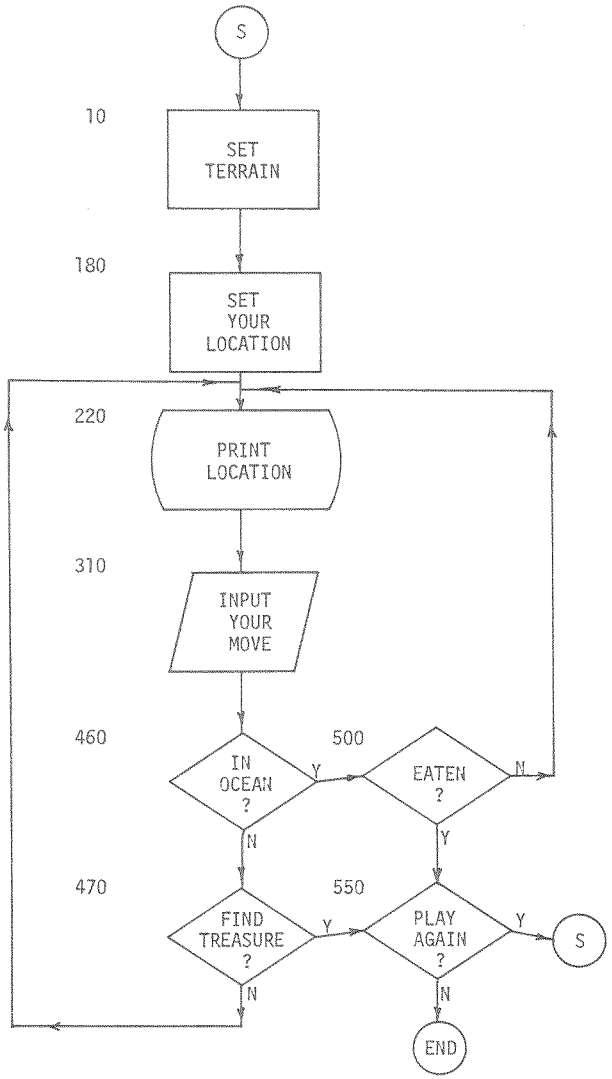
Since you have a map of the island, you will be able to determine your approximate position. For example, if you are in the woods and you move east two squares and find that you are in mountains, then you are most likely located in the north-east corner of the island. The reason you can't be sure of the exact location is that you may have veered off to the right or left. With practice, you should be able to find the treasure in less than fifteen moves.

Sample Run

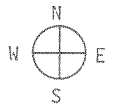
```
RUN

YOU ARE IN THE CLEAR.
MOVE(NESW)?  S
YOU FELL INTO THE OCEAN.
EATEN BY SHARK.
PLAY AGAIN Y OR N?  Y

YOU ARE IN THE CLEAR.
MOVE(NESW)?  S

YOU ARE IN THE WOODS.
MOVE(NESW)?  N

.
.
.
```

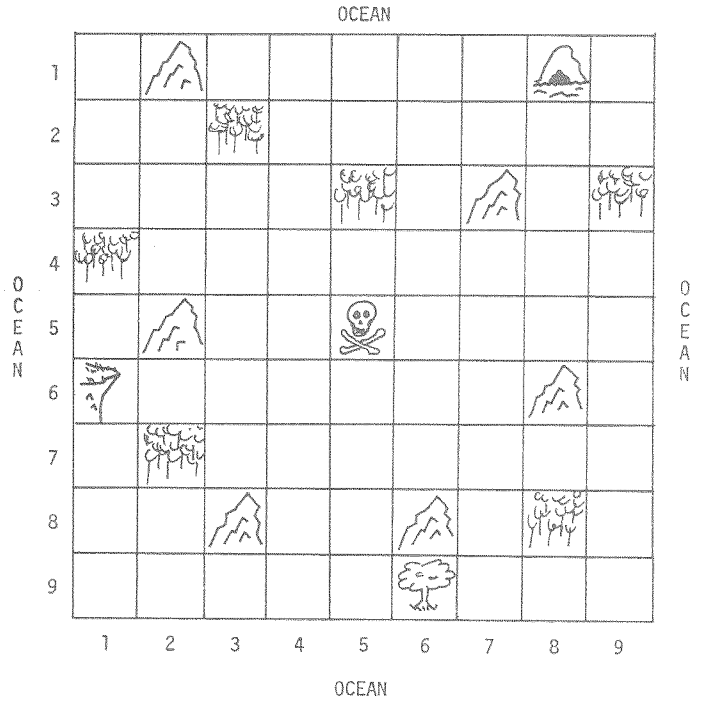
```
.
.

YOU ARE IN THE MOUNTAINS.
MOVE(NESW)?  E

.
.
.

YOU ARE IN THE WOODS.
MOVE(NESW)?  S

.
.
.

YOU ARE IN THE CLEAR.
MOVE(NESW)?  E
YOU FOUND THE TREASURE IN 9 MOVES.
PLAY AGAIN Y OR N?
```

LOST TREASURE FLOWCHART

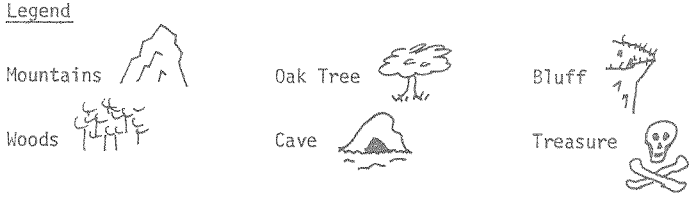


LOST TREASURE MAP





Legend



LOST TREASURE PROGRAM

Variables

L(R,C)	Locations
S	Probability of being eaten by shark
R	Your row
C	Your column
RT, CT	Temporary storage
T	Number of turns

Listing

```
5    REM SET TERRAIN
10   DIM L(9,9)
20   S=.2
30   FOR I=1 TO 9: FOR J=1 TO 9
40   L(I,J)=0
50   NEXT J,I

60   FOR I=1 TO 6
70   READ R,C
80   L(R,C)=1
90   NEXT I

100  FOR I=1 TO 6
110  READ R,C
120  L(R,C)=2
130  NEXT I

140  L(1,8)=3
150  L(6,1)=4
160  L(9,6)=5
170  L(5,5)=6

175  REM YOUR LOCATION
180  R=INT(9*RND(1)+1)
190  C=INT(9*RND(1)+1)
200  IF SQR((R-5)↑2+(C-5)↑2)<2 THEN 180

205  REM START MAIN LOOP
210  FOR T=1 TO 100
220  PRINT "YOU ARE ";
230  J=L(R,C)+1
240  ON J GO SUB 250,260,270,280,290,300:  GO TO 310
250  PRINT "IN THE CLEAR.": RETURN
260  PRINT "IN THE WOODS.": RETURN
270  PRINT "IN THE MOUNTAINS.": RETURN
280  PRINT "NEAR A CAVE.": RETURN
290  PRINT "ON A BLUFF.": RETURN
300  PRINT "NEAR AN OAK TREE.": RETURN

310  INPUT "MOVE(NESW)"; M$
320  RT=R: CT=C
330  IF M$="N" THEN R=R-1 : GO SUB 380
340  IF M$="E" THEN C=C+1: GO SUB 420
350  IF M$="W" THEN C=C-1: GO SUB 420
360  IF M$="S" THEN R=R+1: GO SUB 380
```



```
370  GO TO 460

375  REM MOVE SUBROUTINE
380  J=INT(10*RND(1)+1)
390  IF J>2 THEN RETURN
400  IF J=1 THEN C=C+1: RETURN
410  C=C-1: RETURN
420  J=INT(10*RND(1)+1)
430  IF J>2 THEN RETURN
440  IF J=1 THEN R=R+1: RETURN
450  R=R-1: RETURN

455  REM IN OCEAN, FOUND TREASURE?
460  IF R<1 OR R>9 OR C<1 OR C>9 THEN 490
470  IF L(R,C)=6 THEN PRINT "YOU FOUND THE TREASURE IN"; T: GO TO 550
480  NEXT T

490  PRINT "YOU FELL INTO THE OCEAN."
500  IF RND(1)<S THEN PRINT "EATEN BY SHARKS!": GO TO 550
510  S=S+.5: R=RT: C=CT: IF S>1 THEN S=1
520  PRINT "THE PROBABILITY OF BEING EATEN"
530  PRINT "BY A SHARK NEXT TIME IS"; S; "."
540  GO TO 480

550  INPUT "PLAY AGAIN"; Y$
560  IF Y$="Y" THEN RUN
570  END

580  DATA 2,3,3,5,3,9,4,1,7,2,8,8
590  DATA 1,2,3,7,5,2,6,8,8,3,8,6
```

LOST TREASURE MODIFICATIONS

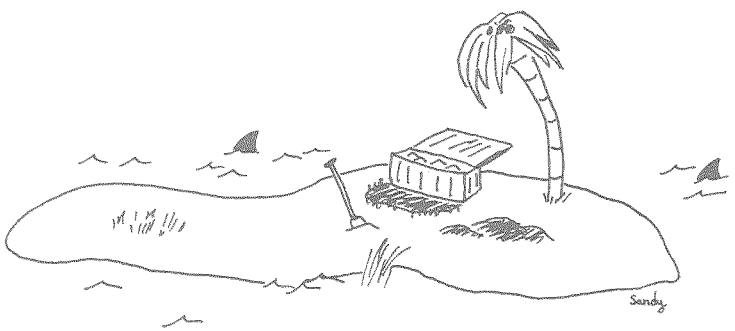
Minor

1. Probability of first shark attack -- line 20
2. Grid size -- lines 30, 180, 190, 460
3. Number of woods -- lines 60, 580
4. Number of mountains -- lines 100, 590
5. Landmarks' locations -- lines 140, 150, 160
6. Location of the treasure -- line 170
7. Movement error -- lines 380, 420
8. Amount you disturb shark -- line 510

Major

1. Vary number and amount of treasure.
2. Add parameters of water and/or food to maintain your energy level.
3. Hunt a moving treasure.
4. Modify direction of movement.
5. Add quicksand.
6. Include landmarks placed at random that are not on the map.
7. Randomly place treasure before each hunt.

NOTES



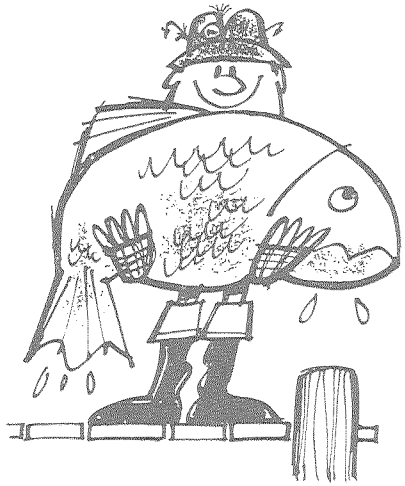
GONE FISHING

You are going on a fishing trip. The sea is an 8X8 grid, forming 64 fishing locations. You will start at the dock, square (1,1), and try to catch as many pounds of fish as you can. You may move one square at a time horizontally or vertically by entering a north(N), south(S), east(E), or west(W). Entering an F allows you to fish in the same place again, and a B allows you to start another fishing trip immediately. If you select a direction that takes you off the grid, your ship will sink. You must return to the dock in sixty moves, which is equivalent to six hours. If you don't return in time, half of your catch will spoil.

The chance of catching fish is different for each square and is determined at the beginning of the trip. The chance of catching fish in a given square will remain the same throughout the trip or will decrease if the fish are scared by a shark. The maximum number of fish that can be caught in each square (density) is also determined at the beginning of the simulation. This number varies from 1 to 5. The maximum number of fish you can catch in a square will decrease only if sea gulls eat some of the bait. The maximum weight of a fish in a particular square is the product of the row and column; therefore, the further out you go, the bigger the fish.

The longer you fish, the greater the chance of an afternoon storm occurring. If you hit a storm, you will lose .5 hour. One of the more difficult manuvers of the trip is to fish as long as necessary to accumulate a large catch without getting lost in a storm. Also, there is a 4% chance that you will experience some unexpected event during each move of the trip. Be sure you return to the dock before six hours have elapsed. Your rating as a fisherman will be the number of pounds of fish you catch divided by five.

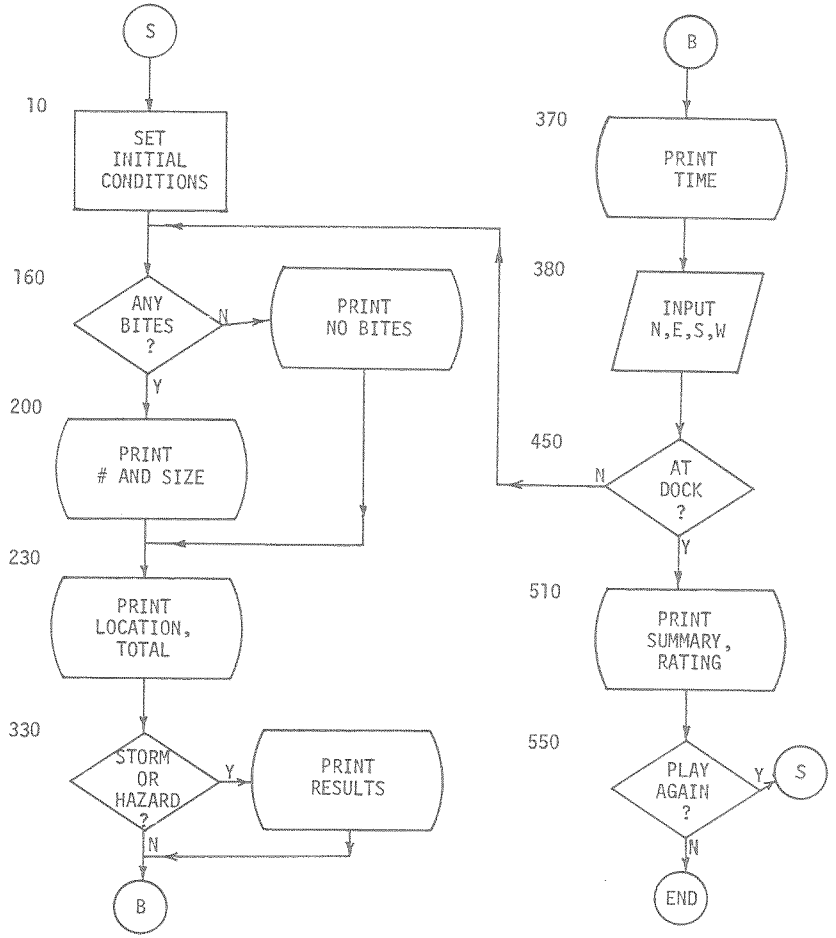
You may wish to use the fishing grid on page 4.6 to record the best fishing spots. A small marker can be used to keep track of your location on the grid.



Sample Run

```
RUN

NO BITES
AT LOCATION  1  1
TOTAL LBS. THIS TRIP IS 0.
YOU HAVE FISHED FOR 0 HOURS.
MOVE(N,S,E,W,F,B)?  E

NO BITES
AT LOCATION  1  2
TOTAL LBS. THIS TRIP IS 0.
YOU HAVE FISHED FOR .1 HOURS.
MOVE(N,S,E,W,F,B)?  S

YOU CAUGHT 1 FISH,
EACH WEIGHING 2 LBS.
AT LOCATION  2  2
TOTAL LBS. THIS TRIP IS 2.
YOU HAVE FISHED FOR .2 HOURS.
MOVE(N,S,E,W,F,B)?  S

NO BITES
AT LOCATION  3  2
TOTAL LBS. THIS TRIP IS 2.
YOU HAVE FISHED FOR .3 HOURS.
MOVE(N,S,E,W,F,B)?  E

YOU CAUGHT 4 FISH,
EACH WEIGHING 2 LBS.
AT LOCATION  3  3
TOTAL LBS. THIS TRIP IS 10.
YOU HAVE FISHED FOR .4 HOURS.
MOVE(N,S,E,W,F,B)?  E

.
.
.
NO BITES
AT LOCATION  4  6
TOTAL LBS. THIS TRIP IS 10.
SEA GULLS ATE SOME OF YOUR BAIT.
CATCH WILL BE SMALLER THIS TRIP.
YOU HAVE FISHED FOR .8 HOURS.
MOVE(N,S,E,W,F,B)?  S

.
.
.

YOU CAUGHT 4 FISH,
EACH WEIGHING 15 LBS.
AT LOCATION  4  8
TOTAL LBS. THIS TRIP IS 155.
YOU CAUGHT A 50 LB. SHARK.
TOTAL LBS. THIS TRIP IS 205.
YOU HAVE FISHED FOR 1.8 HOURS.
MOVE(N,S,E,W,F,B)?  W

.
.
.

YOU CAUGHT 1 FISH,
EACH WEIGHING 3 LBS.
AT LOCATION  3  3
TOTAL LBS. THIS TRIP IS 208.
WATER SPOUT DISPLACES YOU.
YOU ARE NOW AT LOCATION  4  5
YOU HAVE FISHED FOR 2.6 HOURS.
MOVE(N,S,E,W,F,B)?  W

.
.
.

NO BITES
AT LOCATION  1  2
TOTAL LBS. THIS TRIP IS 211.
YOU HAVE FISHED FOR 3.2 HOURS.
MOVE(N,S,E,W,F,B)?  W

YOU ARE BACK AT THE DOCK
AFTER 3.2 HOURS OF FISHING
CLEAN 211 LBS. OF FISH.
YOU RATE 42 AS A FISHERMAN.
```


GONE FISHING FLOWCHART



GONE FISHING PROGRAM

Variables

P(I,J)	The probability of catching a fish
D(I,J)	The maximum number of fish in square (I,J), from 1 to 5
W	Weight of each fish caught, from 1 to RXC
P	The total number of pounds of fish caught at a given time
R	Row in which you are fishing
C	Column in which you are fishing
N	Number of fish caught in a given turn
T	Time in tenths of an hour, maximum 6 hours
M$	Move(N,E,S,W,F,B), where N,E,S, and W are directions, F allows you to fish again in the same square, and B allows you to start the fishing trip over again

Listing

```
5     REM SET PROBABILITIES AND DENSITY
10    DIM P(8,8),D(8,8)
20    FOR I=1 TO 8: FOR J=1 TO 8
30    P(I,J)=.7*RND(1)
40    D(I,J)=INT(RND(1)*5+1)
50    NEXT J,I
60    P(1,1)=0: P=0: R=1: C=1

145   REM MAIN LOOP
150   FOR T=0 TO 6 STEP .1
160   IF RND(1)>P(R,C) OR D(R,C)<1 THEN PRINT "NO BITES": GO TO 220
170   N=INT(RND(1)*D(R,C)+1)
180   W=INT(RND(1)*R*C)+1
190   P=P+N*W
200   PRINT "YOU CAUGHT"; N; "FISH,"
210   PRINT "EACH WEIGHING"; W; "LBS.,"
220   PRINT "AT LOCATION"; R; C
230   PRINT "TOTAL LBS. THIS TRIP IS"; P; "."

325   REM UNEXPECTED EXPERIENCES
330   IF RND(1)<T/60 THEN PRINT "STORM -- LOST 1/2 HOUR": T=T+.5
340   J=INT(100*RND(1))+1
350   IF J>4 THEN 370
360   ON J GO SUB 600,700,800,900

370   PRINT "YOU HAVE FISHED FOR"; T; "HOURS."
380   INPUT "MOVE (N,S,E,W,F,B)"; M$
390   IF M$="E" THEN C=C+1
400   IF M$="N" THEN R=R-1
410   IF M$="W" THEN C=C-1
420   IF M$="S" THEN R=R+1
430   IF M$="B" THEN RUN
440   IF R<1 OR R>8 OR C<1 OR C>8 THEN PRINT "GROUNDED--SUNK!":  GO TO 550
450   IF R=1 AND C=1 THEN GO TO 500
460   NEXT T

470   PRINT "TIME UP. THE SUN HAS SET."
480   PRINT "HALF OF YOUR CATCH HAS SPOILED."
490   P=P/2
```



```
495   REM SUMMARY OF TRIP
500   IF T=0 THEN PRINT "STILL AT DOCK": GO TO 10
510   PRINT "YOU ARE BACK AT THE DOCK"
520   PRINT "AFTER"; T; "HOURS OF FISHING."
530   PRINT "CLEAN"; P; "LBS. OF FISH."
540   "YOU RATE"; INT(P/5); "AS A FISHERMAN."
550   INPUT "ANOTHER FISHING TRIP(Y,N)"; X$
560   IF X$="Y" THEN RUN
570   END

595   REM SUBROUTINES
600   IF R+C<9 THEN RETURN
610   PRINT "FISH SCARED BY SHARK."
620   PRINT "NOT BITING AS OFTEN."
630   FOR I=1 TO 8: FOR J=1 TO 8
640   P(I,J)=P(I,J)-.1
650   NEXT J,I
660   RETURN
700   PRINT "SEA GULLS ATE SOME OF YOUR BAIT."
710   PRINT "CATCH WILL BE SMALLER THIS TRIP."
720   FOR I=1 TO 8; FOR J=1 TO 8
730   D(I,J)=D(I,J)-1
740   NEXT J,I
750   RETURN
800   PRINT "WATER SPOUT DISPLACES YOU."
810   R=INT(8*RND(1)+1)
820   C=INT(8*RND(1)+1)
830   PRINT "YOU ARE NOW AT LOCATION"; R; C
840   T=T+.2
850   RETURN
900   PRINT "YOU CAUGHT A 50 LB. SHARK."
910   P=P+50
920   PRINT "TOTAL LBS. THIS TRIP IS"; P; "."
930   RETURN
```

GONE FISHING MODIFICATIONS

Minor

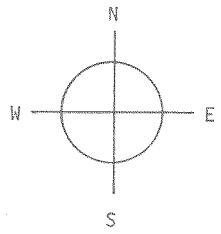
1. Grid size -- lines 10, 20, 440, 630, 720, 810, and 820
2. Maximum probability of catching fish in a square -- line 30
3. Maximum density of fish in a square -- line 40
4. Maximum time of fishing -- line 150
5. Storm probability -- line 330
6. Rating scale -- line 540

Major

1. Catch different kinds of fish, such as, sharks, whales, or mermaids.
2. Change the goal to catching the biggest fish.
3. Use fuel to run the boat.
4. Add a choice of hook sizes and fishing depth.
5. Add different kinds of hazards, such as whales, reefs, UFO's.
6. Let fishing success depend on time of day.
7. Fix weather conditions and fishing conditions at the beginning of the trip.
8. Utilize sonar devices to help locate fish.
9. Allow ship to move in a diagonal direction.

FISHING MAP

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



SPACE FLIGHT

Scenario

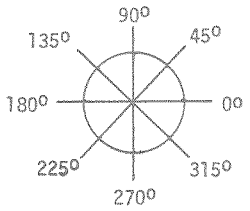
In this simulation, you are living in the year 2062 as the captain of a space ship. Your orders are to deliver medical supplies from Alpha at coordinates (10,10) to Beta at coordinates (80,80). Your rating as a space pilot will depend upon how fast you can make the trip.

During each time interval, you will be able to determine the following information:

1. Total time elapsed
2. Location in terms of X and Y coordinates
3. Amount of fuel left
4. Speed
5. The angle at which you are moving
6. Your distance from the planet.

To change direction or to increase or decrease speed, you can fire one of two kinds of rockets: main (M) and half (H). These rockets take one unit and 1/2 unit of fuel, respectively. A "C" will allow you to coast for five time intervals.

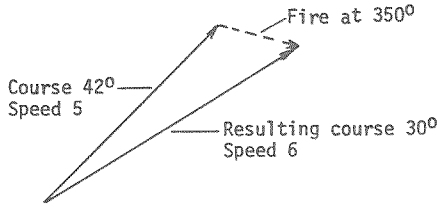
Once you decide how much fuel you are going to burn, you must decide on the direction in which you will be firing the rockets. You are able to rotate your space ship with small thrusters as it drifts in space. The directions are shown below:



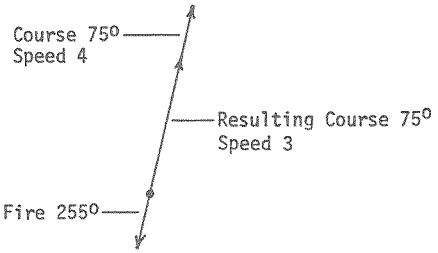
Once you fire your main rocket for three or four turns to increase your speed, you can conserve fuel by drifting through space. You must start to fire in the opposite direction to slow down before arriving at Beta. In order to meet arrival conditions, you must be within a distance of one and at a speed of less than one.

You may wish to make copies of the grid at the end of this section to aid in plotting your course. If you find that you are off course, you may have to fire a "correction" rocket. In order to estimate the angle of firing, you can use a force diagram as shown below.

Example 1: Correction



Example 2: Retrofire

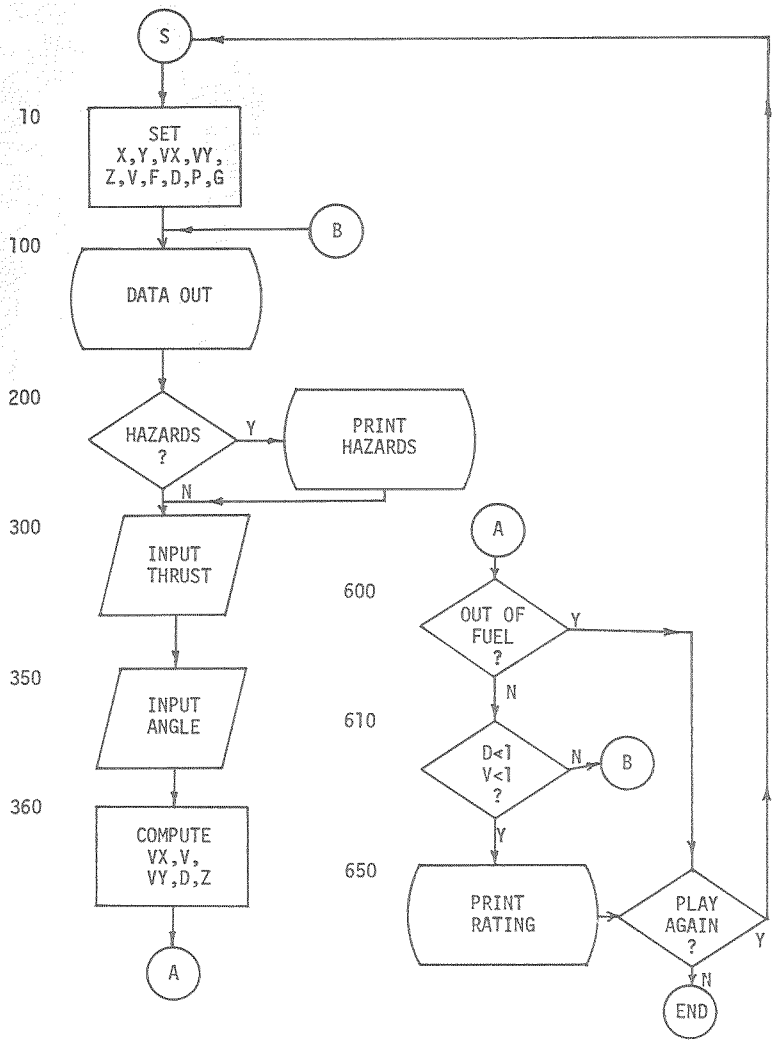


Sample Run

```
            DATA READOUT
0 HOURS      10 LITERS
LOCATION  10  10
VELOCITY:  0
DEGREES:  0
D=98.995
COMMAND(O,M,H,C)?  M
ANGLE?  45

            DATA READOUT
.01 HOURS    9 LITERS
LOCATION  10.6776  10.67
VELOCITY:  .952905
DEGREES:  45
D=98.942

              .
              .
              .
```

```
            DATA READOUT
.05 HOURS    5 LITERS
LOCATION  20.1487  20.8211
VELOCITY:  5.0035
DEGREES:  50
D=84.1685
PROBLEM SUPPORT SYSTEM
COMMAND(O,M,H,C)?  O

              .
              .
              .
            DATA READOUT
.33 HOURS    1 LITERS
LOCATION 79.1844  81.0019
VELOCITY:  .023181
DEGREES:  58
D=1.29189
COMMAND(O,M,H,C)?  H
ANGLE?  315
ARRIVED!
THE TRIP TOOK .33 HOURS.
YOUR RATING IS 66.
PLAY AGAIN?  N
OK
```


SPACE FLIGHT FLOWCHART



SPACE FLIGHT PROGRAM

Variables

X,Y	Location
VX,VY	Speed
Z	Angle of coast
V	Velocity
T	Time
D	Distance to planet
J	Index for hazards
F	Fuel
A	Angle input
L,M	Temporary Variables
R	Rating
F1	Coast count
G	Accuracy of gyros

Listing

```
10    X=10: Y=10: VX=0: VY=0: Z=0: V=0
20    F=10: D=98.995: P=3.1416: G=1
30    FOR T=0 TO 10 STEP .01

100   PRINT "     DATA READOUT:": ?
110   PRINT T; "HOURS          "; F; "LITERS"
120   PRINT "LOCATION:"; X; Y: PRINT "VELOCITY:"; V
130   PRINT Z; "DEGREES"
140   PRINT "DISTANCE:"; D

200   J=INT(50*RND(1)+1)
210   IF J<6 THEN PRINT "PROBLEMS: ";
220   ON J GO SUB 230,240,250,260,270: GO TO 290
230   PRINT "GYROS  ANGLE ERROR": G=G+1: RETURN
240   PRINT "FUEL LINE": F=F-.5: RETURN
250   PRINT "LIFE SUPPORT": T=T+.05: RETURN
260   PRINT "ALIENS": VX=0: VY=0: RETURN
270   PRINT "METEORS.": VX=VX+RND(1)-.5: VY=VY+RND(1)-.5
280   RETURN

290   IF F1>0 THEN F1=F1-1: GO TO 450
300   INPUT "COMMAND(0,M,H,C)"; C$
310   IF C$="M" THEN B=1: GO TO 350
320   IF C$="H" THEN B=2: GO TO 350
330   IF C$="C" THEN F1=5
340   GO TO 450
350   INPUT "ANGLE"; A: A=A+(20*G*RND(1)-10*G)
360   A=A*P/180
370   L=COS(A): M=SIN(A): F=F-1/B
380   VX=VX+(1+.4*RND(1)-.2)*L/B
390   VY=VY+(1+.4*RND(1)-.2)*M/B
400   IF VX=0 AND VY>=0 THEN Z=90: GO TO 450
410   IF VX=0 AND VY<0 THEN Z=270: GO TO 450
420   Z=ATN(VY/VX): Z=Z*180/P
430   Z=Z+INT(10*RND(1)): Z=INT(Z)
440   IF VX<0 THEN Z=Z+180
450   X=X+VX: Y=Y+VY
```



```
530   V=SQR(VX+2+VY+2)
540   D=SQR((X-80)+2+(Y-80)+2)

600   IF F<0 THEN PRINT "OUT OF FUEL": GO TO 660
610   IF D<1 AND V<1 THEN PRINT "ARRIVED": GO TO 630
620   NEXT T
630   PRINT "THE TRIP TOOK"; T; "HOURS."
640   R=200*T
650   PRINT "YOUR RATING IS"; R; "."
660   INPUT "PLAY AGAIN"; Y$
670   IF Y$="Y" THEN RUN
680   END
```

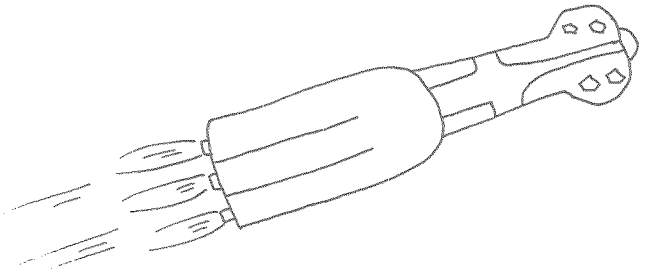
SPACE FLIGHT MODIFICATIONS

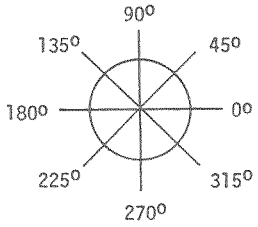
Minor

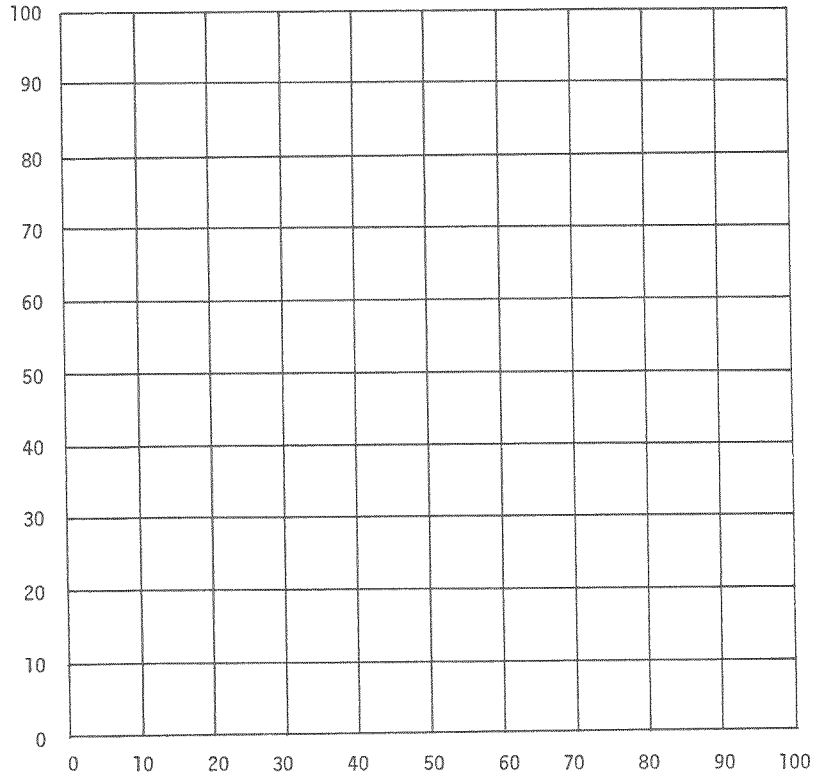
1. Starting position -- lines 10,20
2. Amount of fuel -- line 20
3. Time limit -- line 30
4. Planets location -- lines 540, 20
5. Arrival conditions -- line 610
6. Probability of problems -- line 200

Major

1. One must fire small thruster rockets to rotate ship.
2. Have meteors hit ship.
3. Use meteor shields.
4. Fight aliens.
5. Visit more than one planet.
6. Provide planets with gravitational force.
7. Have refueling stations.







FOREST FIRE

Scenario

A lightening storm has ignited fires in a forest. Your task is to put out the fires and save as many trees as possible. The forest is divided into 81 sectors formed by a 9X9 grid. Each sector is identified by the number of its row and column. The symbol, ".", represents woods, an "*" represents fire, and a blank space represents burnt out woods.

The chance of an existing fire spreading to adjacent wooded areas is 70%. Fires last for nine turns before burning out.

You have two weapons with which to fight the fire. You can drop chemicals that are designed to extinguish the fires in a specified sector. The chance that the drop will affect the fires in this sector and its eight adjacent sectors is 50%. For example, if there are six fires burning in a nine-square area, approximately three will be affected by the chemicals. The effect of chemicals is to reduce the number of turns before the fire burns out by three. Since a fire lasts only nine turns, three successful chemical hits will be needed to extinguish a fire. If the fire has been burning for six turns, then one hit will suffice.

The second weapon available to you is a backfire. To start a backfire, you must respond to the row input with a zero. You will then be asked for a backfire row and column. The sector in which a backfire is started must be wooded. This backfire will not spread and will burn out in the next turn, forming a barrier against the spread of fire.

Your rating will be the number of trees remaining after all the fires are out, plus 30.

Sample Run

#1

```
  1 2 3 4 5 6 7 8 9
1 . . . . . . . . .
2 . . . . . . . . .
3 . . . . . . . . .
4 . . . . . . . * .
5 . . . . . . . * .
6 . . . * . . . . .
7 . . . . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
```

```
ROW? 0
BACKFIRE ROW? 4
BACKFIRE COLUMN? 7
```

#2

```
  1 2 3 4 5 6 7 8 9
1 . . . . . . . . .
2 . . . . . . . . .
3 . . . . . . . . .
4 . . . . . . * * .
5 . . . . . . . * .
6 . . . * . . . . .
7 . . * . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
```

```
ROW? 0
BACKFIRE ROW? 5
BACKFIRE COLUMN? 7
```

#3

```
  1 2 3 4 5 6 7 8 9
1 . . . . . . . . .
2 . . . . . . . . .
3 . . . . . . . . *
4 . . . . . . . * .
5 . . * . . . * * .
6 . . . * . . . * .
7 . . * . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
```

```
ROW? 0
BACKFIRE ROW? 6
BACKFIRE COLUMN? 7
```

#4

```
  1 2 3 4 5 6 7 8 9
1 . . . . . . . . .
2 . . . . . . . . .
3 . . . . . . . . *
4 . . . . . . . * .
5 . . * . . . . * *
6 . . . * . . * * .
7 . . * . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
```

```
ROW? 6
COLUMN? 3
```

#11

```
  1 2 3 4 5 6 7 8 9
1 . . . . * * . * *
2 . . . . * * * . .
3 . . . . . . . . .
4 . . . . . . . . .
5 . * . . . . . . .
6 * . . . . . . . .
7 . * . . . * . . .
8 . . . . . . * . .
9 . . . * . . * . .
```

```
ROW? 6
COLUMN? 2
```

#12

```
  1 2 3 4 5 6 7 8 9
1 . . . . * * . . *
2 . . . . . * * . .
3 . . . . . . . . .
4 . . . . . . . . .
5 . * . . . . . . .
6 . . . . . . . . .
7 . . . . . * . . .
8 . . . . . * . . .
9 . . . * . . * . .
```

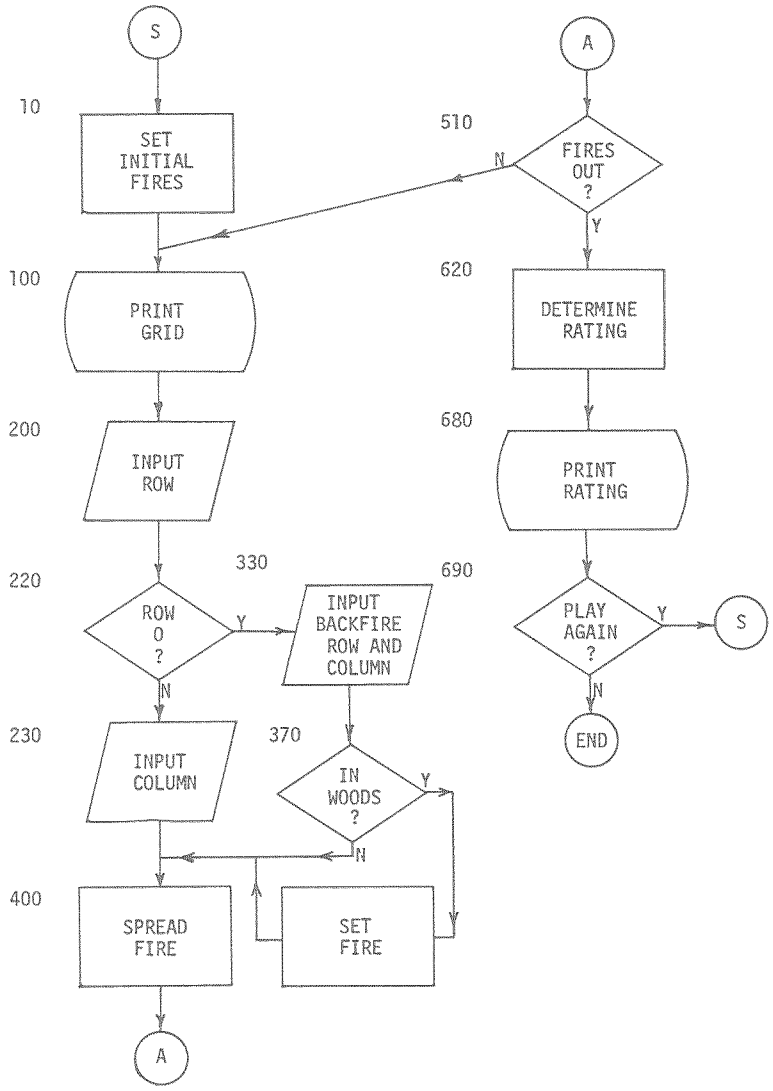
```
ROW? 8
COLUMN? 7
```

#16

```
  1 2 3 4 5 6 7 8 9
1 . . . . . * . . .
2 . . . . . . . . .
3 . . . . . . . . .
4 . . . . . . . . .
5 . . . . . . . . .
6 . . . . . * . . .
7 . . . . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
```

```
ROW? 6
COLUMN? 6

YOUR RATING IS 69.
PLAY AGAIN?
```


FOREST FIRE FLOWCHART



FOREST FIRE PROGRAM

Variables

L(R,C)	Burnt woods: 0, fire: 1-9, woods: 10, temporary variable: 11
R	Row
C	Column
I	Row number increment
J	Column number increment
A	Adjacent row
B	Adjacent column
F	Count
T	Temporary variable
R	Rating

Listing

```
10    DIM L(9,9)
20    FOR R=1 TO 9: FOR C=1 TO 9
30    L(R,C)=10
40    NEXT C,R
50    FOR I=1 TO 3
60    R=INT(9*RND(1)+1)
70    C=INT(9*RND(1)+1)
80    L(R,C)=9
90    NEXT I

95    REM PRINT GRID
100   PRINT "    1 2 3 4 5 6 7 8 9"
110   FOR R=1 TO 9
120   PRINT R; " ";
130   FOR C=1 TO 9
140   IF L(R,C)=10 THEN PRINT ".";: GO TO 170
150   IF L(R,C)>0 AND L(R,C)<10 THEN PRINT "*";: GO TO 170
160   PRINT " ";
170   NEXT C
180   PRINT: NEXT R

195   REM INPUT ROUTINE
200   INPUT "ROW"; R
210   IF R<0 OR R>9 THEN 200
220   IF R=0 THEN 330
230   INPUT "COLUMN"; C
240   IF C<1 OR C>9 THEN 230
250   FOR I=-1 TO 1: FOR J=-1 TO 1
260   A=R+I: B=C+J
270   IF A<1 OR A>9 OR B<1 OR B>9 THEN 310
280   IF L(A,B)<1 OR L(A,B)=10 THEN 310
290   IF RND(1)>.5 THEN 310
300   L(A,B)=L(A,B)-3
310   NEXT J,I
320   GO TO 400

330   INPUT "BACKFIRE ROW"; R
340   IF R<1 OR R>9 THEN 330
350   INPUT "BACKFIRE COLUMN"; C
360   IF C<1 OR C>9 THEN 350
```



```
370   IF L(R,C)=10 THEN L(R,C)=2

395   REM SPREAD FIRE
400   FOR R=1 TO 9: FOR C=1 TO 9
410   IF L(R,C)<1 OR L(R,C)>9 THEN 500
420   IF L(R,C)<3 THEN 500
430   I=INT(3*RND(1)-1)
440   J=INT(3*RND(1)-1)
450   A=R+I: B=C+J
460   IF A<1 OR A>9 OR B<1 OR B>9 THEN 500
470   IF L(A,B)<>10 THEN 500
480   IF RND(1)<.3 THEN 500
490   L(A,B)=11
500   NEXT C,R

505   REM BURN FIRE AND COUNT
510   F=0
520   FOR R=1 TO 9
530   FOR C=1 TO 9
540   T=L(R,C)
550   IF T=11 THEN T=9
560   IF T>0 AND T<10 THEN T=T-1: F=F+1
570   L(R,C)=T
580   NEXT C,R
590   IF F<1 THEN 620
600   GO TO 100

615   REM COUNT WOODS RATING
620   C=0
630   FOR R=1 TO 9: FOR C=1 TO 9
640   IF L(R,C)=10 THEN W=W+1
650   NEXT C,R
660   R=W+30
670   IF R>100 THEN R=100
680   PRINT "YOUR RATING IS"; R; "."
690   INPUT "PLAY AGAIN"; Y$
700   IF Y$="Y" THEN RUN
710   END
```

FOREST FIRE MODIFICATIONS

Minor

1. Number of beginning fires -- line 50
2. Location of beginning fires -- lines 60, 70
3. Probability of putting out fire -- line 290
4. Amount fire burns out each turn -- line 300
5. Size of backfire -- line 370
6. Probability of spread -- line 480
7. Size of spread fires -- line 550
8. Rating scale - lines 660, 670

Major

1. Change grid size.
2. Randomly choose location of beginning fires.
3. Add time to move from one place to another.
4. Have wind speed and direction affect the spread of the fire.
5. Include barriors such as lakes and roads.
6. Have some of the sectors burn faster than others.

NAUTICAL NAVIGATION

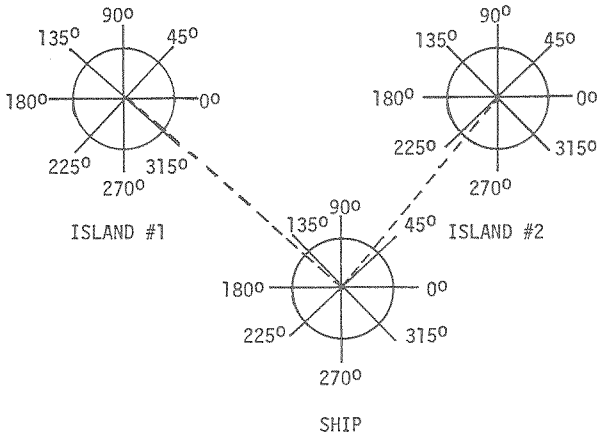
Scenario

Your task is to navigate a sailboat that has an electronic direction finder to three different islands in the South Pacific. You do not have to dock at the islands, but only come close enough to make a visual sighting. The minimum sighting distance will vary from five to ten miles, depending upon weather conditions.

The islands are located at coordinates (200,300), (600,300), and (300,100). Your starting location will be approximately (200,200). You will need graph paper and an inexpensive protractor and ruler in order to plot your course.

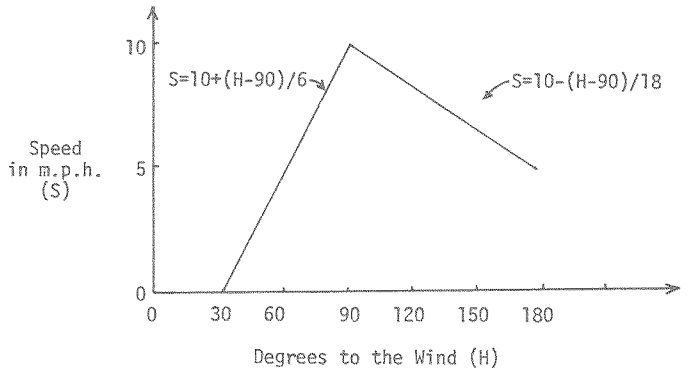
Each turn you will receive information about your bearings in degrees from each of the three islands. For convenience, you will also receive the bearings from the ship to each of the islands. The example below shows how the bearings are determined. If you know the bearing from two of the three islands, you can locate the ship; however, there are some random errors in the readings, so it might be wise to use the readings from all three islands.

Bearing from island #1: 317°; bearing to island #1: 138°.
Bearing from island #2: 230°; bearing to island #2: 50°.



After you locate your position, you must determine your heading and the length of time you wish to remain on this course. You can use the heading from the ship to the island of your destination to determine the ship's heading. Since you are in a sailboat, your speed will depend on your direction with respect to an easterly wind. In order to make any progress toward the East, you must tack at either 45° or 315°. The speed

of the sailboat as a function of its direction is shown in the graph below.



The fastest speed of ten miles per hour is acheived when the boat is perpendicular to the wind -- heading either directly north (90^{o}) or south (270^{o}). When the boat is running with the wind directly behind it, its speed is about half the maximum speed or five m.p.h.

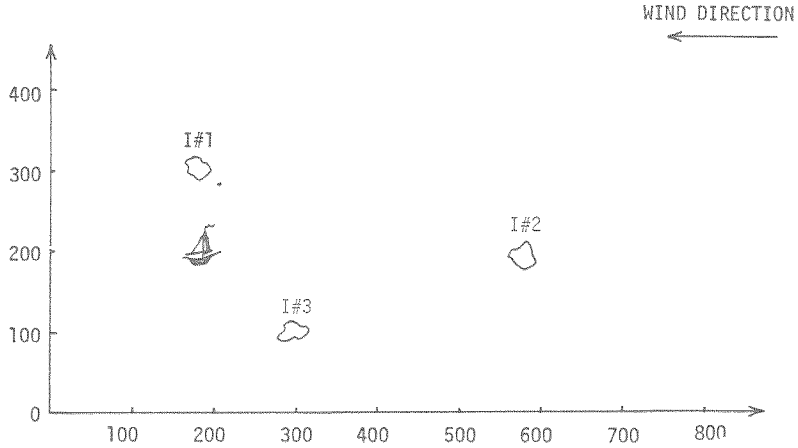
Once you determine the heading, you must determine the length of time you wish to remain on the heading or the length of time you wish to travel before the next navigational check. The speed at 70^{o} is about 6.7 m.p.h. In ten hours, you would travel about 67 miles. Of course, the wind speed varies; so you may wish to make one or two navigational checks on a long run.

You can visit the three islands in any order. You must compute the angle and time so the end of a run is within five to ten miles of an island. Since visibility conditions vary, you may have to wait for a turn to allow sighting conditions to improve.

Your rating as a navigator will depend on the number of navigational checks required and the amount of time for the trip. A good sailor should be able to complete the trip with a rating close to 100.

Sample Run

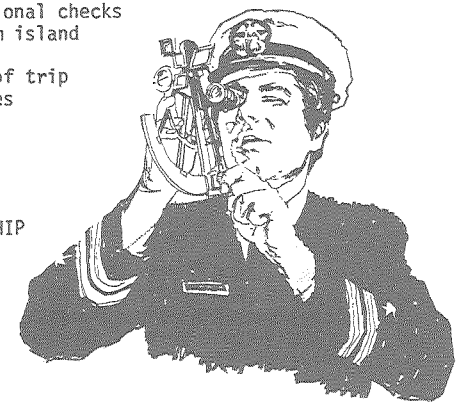
```
NAVIGATION CHECK  1
BEARING FROM 1: 279   TO: 99
BEARING FROM 2: 197   TO: 17
BEARING FROM 3: 136   TO: 316
ELAPSED TIME  0
HEADING?  99
TIME?  33

NAVIGATION CHECK  2
BEARING FROM 1: 97   TO: 277
BEARING FROM 2: 158  TO: 338
BEARING FROM 3: 108  TO: 288
ELAPSED TIME  32.9694
HEADING?  277
TIME?  20

NAVIGATION CHECK  3
VISITED  1
BEARING FROM 1: 84   TO: 264
BEARING FROM 2: 179  TO: 359
BEARING FROM 3: 115  TO: 295
ELAPSED TIME  52.9576
HEADING?  295
TIME?  30

NAVIGATION CHECK  4
VISITED  1
BEARING FROM 1: 296   TO: 116
BEARING FROM 2: 201   TO: 21
BEARING FROM 3: 117   TO: 297
ELAPSED TIME  82.9246
HEADING?  297
TIME?  10

NAVIGATION CHECK  5
VISITED  1
BEARING FROM 1: 296   TO: 116
BEARING FROM 2: 209   TO: 29
BEARING FROM 3: 114   TO: 294
ELAPSED TIME  92.8834
HEADING?  294
TIME?  3

NAVIGATION CHECK  6
VISITED  1
VISITED  3
BEARING FROM 1: 296  TO: 116
BEARING FROM 2: 212  TO: 32
BEARING FROM 3: 119  TO: 299
ELAPSED TIME  95.8568
HEADING?  60
TIME?  120

NAVIGATION CHECK  7
VISITED  1
VISITED  3
BEARING FROM 1: 35   TO: 215
BEARING FROM 2: 92   TO: 272
BEARING FROM 3: 58   TO: 238
ELAPSED TIME  215.833
HEADING?  272
TIME?  28

TRIP COMPLETED IN 243.859 HOURS
NUMBER OF NAVIGATIONAL CHECKS  7
YOUR RATING IS  66
PLAY AGAIN?
```



NAUTICAL NAVIGATION PROGRAM

Variables

D(3)	Set to 1 if arrived at destination
A(3),B(3)	Coordinates of islands
X,Y	Coordinates of ship
E	Total elapsed time
C	Number of navigational checks
L	Angle bearing from island
H	Heading of ship
T	Time for one leg of trip
A,B	Temporary variables
Y$	Play again



Listing

```
5     REM PLACE ISLANDS AND SHIP
10    DIM A(3), B(3), D(3)
20    E=0: P=3.14159
30    FOR I=1 TO 3
40    READ A,B
50    A(I)=10*A: B(I)=10*B
60    D(I)=0
70    NEXT I
80    DATA 20,30,60,20,30,10
90    X=175+50*RND(1): Y=175+50*RND(1)

95    REM START MAIN LOOP
100   FOR C=1 TO 100
110   PRINT "NAVIGATION CHECK"; C
120   FOR I=1 TO 3
130   IF D(I)=1 THEN PRINT "VISITED"; I
140   NEXT I

150   FOR I=1 TO 3
160   A=A(I): B=B(I)
170   GO SUB 600: L=L+2.5-5*RND(1)
180   L=L+180: IF L>360 THEN L=L-360
190   PRINT "BEARING FROM"; I; "IS"; INT(L);
200   IF L>=180 THEN L=L-180; PRINT " TO"; INT(L): GO TO 220
210   IF L<180 THEN L=L+180: PRINT " TO"; INT(L)
220   NEXT I

225   REM INPUT
230   PRINT "ELAPSED TIME"; E
240   INPUT "HEADING"; H
250   H=H+5-10*RND(1)
260   INPUT "TIME"; T: T=ABS(T)
270   CO=COS(H*P/180): SI=SIN(H*P/180)
280   IF H>180 THEN H=360-H
290   IF H<30 THEN S=0
300   IF H>=30 AND H<90 THEN S=10+(H-90)/6
310   IF H>90 THEN S=10-(H-90)/18
320   S=S+2*RND(1)-1
330   T=T+(.1*RND(1)-.05)
340   X=X+T*S*CO
```



```
350   Y=Y+T*S*SI
360   E=E+T

400   FOR I = 1 TO 3
410   D=SQR((X-A(I))↑2+(Y-B(I))↑2)
420   IF D<5+10*RND(1) THEN D(I)=1
430   NEXT I
440   IF D(1)+D(2)+D(3)=3 THEN GO TO 500
450   NEXT C
460   PRINT "EXCEED NAVIGATION CHECK": GO TO 530
500   PRINT "TRIP COMPLETED IN"; E; "HOURS."
510   PRINT "NUMBER OF NAVIGATION CHECKS IS"; C; "."
520   PRINT "YOUR RATING IS"; 170-(INT(E+10*C/3))
530   INPUT "PLAY AGAIN"; Y$
540   IF Y$="Y" THEN RUN
550   END

600   IF X=A AND Y>B THEN L=270: RETURN
610   IF X=A AND Y<B THEN L=90 : RETURN
620   N=ABS(Y-B)/ABS(X-A)
630   L=ATN(N) : L=180*L/P
640   IF X>A AND Y>=B THEN L=L+180
650   IF X<A AND Y>B THEN L=360-L
660   IF X>A AND Y<B THEN L=180-L
670   RETURN
```

NAUTICAL NAVIGATION MODIFICATIONS

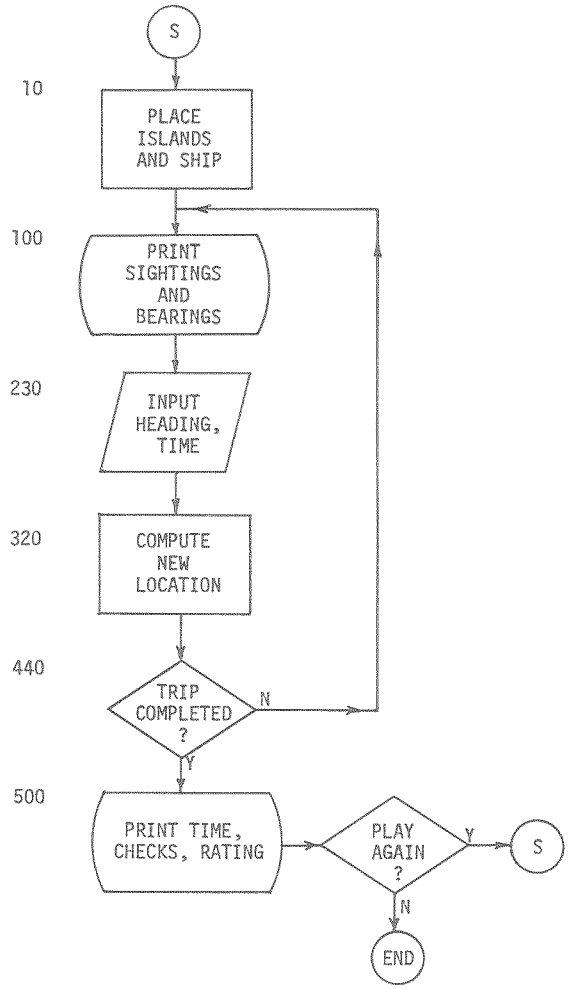
Minor

1. Location of islands -- line 80
2. Starting place of ship -- line 90
3. Error in angle -- line 170
4. Input error -- line 250
5. Speed error -- line 320
6. Time error -- line 330
7. Sighting criteria -- line 420
8. Rating -- line 520

Major

1. Change number of islands.
2. Have storms.
3. Have wind direction change.

NAUTICAL NAVIGATION FLOWCHART



BUSINESS MANAGEMENT

Scenario

In this simulation you manage a small factory that produces three different kinds of products (P1 - P3). Three different kinds of raw materials (R1 - R3) are required to produce the products. Each product requires exactly two raw materials with a different subscript. For example, to manufacture one unit of P2, you would need a unit of R1 and a unit of R3. To manufacture one unit of P3, you would need a unit of R1 and R2.

The cost of raw materials varies from $10 to $20 per unit. It costs from $1 to $9 per unit to manufacture a product from raw materials. The selling price of each finished product varies from $50 to $90 per unit. Prices of raw materials and manufacturing costs will vary by not more than $2 per turn. Prices of finished products will vary by not more than $5 per turn.

You will receive a data report at the beginning of each turn. This report will give you the number of units you have on hand, available cash, and the manufacturing costs. You can buy, manufacture, or sell each turn. In order to manufacture a given product, you must have enough of the correct kind of materials on hand.

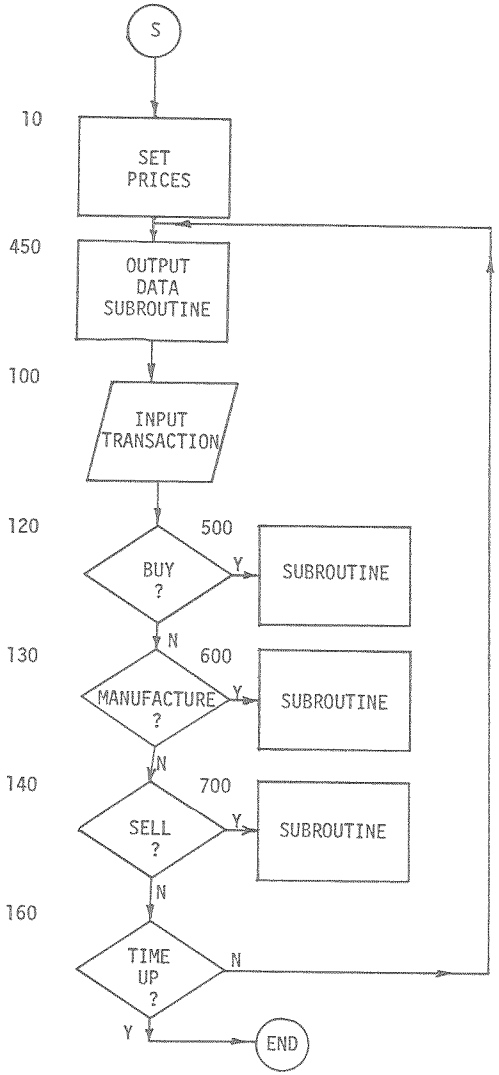
After twelve turns (months), the materials and/or products that you have on hand will be automatically sold at the current prices and your profit will be computed.

Sample Run

```
ITEM      MATERIALS      PRODUCTS
 1          $0-$16         $0-$72
 2          $0-$15         $0-$72
 3          $0-$17         $0-$73
MONTH 0  YOU HAVE $500
MANUFACTURING COSTS ARE $2
TRANSACTION 0,B,M,S?  B
AMOUNT OF MATERIALS?  10
ITEM#?  2


ITEM      MATERIALS      PRODUCTS
 1          $0-$16         $0-$67
 2          $10-$16        $0-$71
 3          $0-$16         $0-$73
MONTH 1  YOU HAVE $350
MANUFACTURING COSTS ARE $1
TRANSACTION 0,B,M,S?  B
AMOUNT OF MATERIALS?  10
ITEM#?  1
```

```
ITEM      MATERIALS      PRODUCTS
 1          $10-$18        $0-$63
 2          $10-$17        $0-$70
 3          $0-$18         $0-$68
MONTH 2  YOU HAVE $190
MANUFACTURING COSTS ARE $2
TRANSACTION O,B,M,S?  M
MANUFACTURE AMOUNT?  10
ITEM#?  3

ITEM      MATERIALS      PRODUCTS
 1          $0-$19         $0-$67
 2          $0-$15         $0-$72
 3          $0-$18         $10-$73
MONTH 3  YOU HAVE $170
MANUFACTURING COSTS ARE $2
TRANSACTION O,B,M,S?  S
AMOUNT TO SELL?  10
ITEM#?  3

ITEM      MATERIALS      PRODUCTS
 1          $0-$17         $0-$72
 2          $0-$17         $0-$76
 3          $0-$18         $0-$77
MONTH 4  YOU HAVE $900
MANUFACTURING COSTS ARE $3
TRANSACTION O,B,M,S?

    .
    .
    .

ITEM      MATERIALS      PRODUCTS
 1          $0-$18         $0-$71
 2          $0-$12         $0-$62
 3          $0-$10         $0-$68
MONTH 12  YOU HAVE $2380
MANUFACTURING COSTS ARE $8
TRANSACTION O,B,M,S?  O
END OF YEAR
YOUR PROFIT IS 1880.
PLAY AGAIN?
```


BUSINESS MANAGEMENT FLOWCHART



BUSINESS MANAGEMENT PROGRAM

Variables

R(I)	Number of raw materials
C(I)	Cost of one unit of raw material
F(I)	Number of finished products
P(I)	Price of one unit of finished product ($50-$90)
C	Cash on hand
M	Manufacturing costs ($1-$9) per unit
T	Time
N	Item number
A	Amount
T$	Input O,B,M,S

Listing

```
5     REM SET PRICES
10    DIM R(3), C(3), F(3), P(3)
20    C=500: M=2
30    FOR I=1 TO 3
40    R(I)=0: F(I)=0
50    C(I)=INT(3*RND(1)+15)
60    P(I)=INT(10*RND(1)+70)
70    NEXT I
80    FOR T=0 TO 12
90    GO SUB 450

100   PRINT "MONTH"; T; "YOU HAVE"; C: PRINT: PRINT "MANUFACTURING
      COSTS ARE $"; M
110   INPUT "TRANSACTION O,B,M,S"; T$
120   IF T$="B" THEN GO SUB 500
130   IF T$="M" THEN GO SUB 600
140   IF T$="S" THEN GO SUB 700
150   GO SUB 300
160   NEXT T

165   REM SUMMARY
170   PRINT "END OF YEAR"
180   FOR I=1 TO 3
190   C=C+R(I)*C(I)
200   C=C+F(I)*P(I)
210   NEXT I

220   C=C-500
230   PRINT "YOUR PROFIT IS"; C; "."
240   INPUT "PLAY AGAIN"; Y$
250   IF Y$="Y" THEN RUN
260   END

295   REM CHANGE PRICE SUBROUTINE
300   FOR I=1 TO 3
310   J=INT(5*RND(1)-2)
320   J=C(I)+J
330   IF J<10 OR J>20 THEN 310
340   C(I)=J
350   J=INT(11*RND(1)-5)
360   J=P(I)+J
```



```
370   IF J<50 OR J>90 THEN 350
380   P(I)=J
390   NEXT I

400   J=INT(5+RND(1)-2)
410   J=M+J
420   IF J<1 OR J>9 THEN 400
430   M=J
440   RETURN

445   REM OUTPUT DATA
450   PRINT "ITEM     MATERIALS     PRODUCT": PRINT
460   FOR I=1 TO 3
470   PRINT I; "    "; R(I); " $"; C(I); "    "; F(I); " $"; P(I):PRINT
480   NEXT I
490   RETURN

495   REM BUY MATERIALS
500   INPUT "AMOUNT OF MATERIALS"; A
510   INPUT "ITEM#"; N
520   IF N<1 OR N>3 THEN PRINT "ERROR": RETURN
530   C=C-A*C(N)
540   IF C<0 THEN 570
550   R(N)=R(N)+A
560   RETURN
570   C=C+A*C(N)
580   PRINT "INSUFFICIENT FUNDS"
590   RETURN

595   REM MANUFACTURE
600   INPUT "MANUFACTURE AMOUNT"; A: INPUT "ITEM#"; N
610   IF N<0 OR N>3 THEN PRINT "ERROR": RETURN
620   C=C-A*M
630   IF C<0 THEN PRINT "INSUFFICIENT FUNDS": C=C+A*M: RETURN

640   FOR I=1 TO 3
650   IF I=N THEN 680
660   R(I)=R(I)-A
670   IF R(I)<0 THEN PRINT "MATERIALS GONE": R(I)=R(I)+A: C=C+A*M:
      RETURN
680   NEXT I: F(N)=F(N)+A: RETURN

695   REM SELL
700   INPUT "AMOUNT TO SELL"; A: INPUT "ITEM#"; N
710   IF N<0 OR N>3 THEN PRINT "ERROR": RETURN
720   F(N)=F(N)-A
730   IF F(N)<0 THEN 760
740   C=C+A*P(N)
750   RETURN
760   F(N)=F(N)+A
770   PRINT "PRODUCTS GONE"
780   RETURN
```

Variables

B(I,J)	I is bird (1-16); J is characteristic (1-14)
N$(I)	Name characteristic
P(I)	Probability of sighting
K,I,J,Q,N	Temporary variables
L$	Place
T$	When
A$	Where
I	Lapsed time for one sighting
H	Total time
B_1	Number of identifications
C_1	Number of birds identified

Listing

```
5     REM SET DATA
10    H=0: DIM B(16,14), I(16), N$(8), P(16)
20    PRINT "PLEASE WAIT": FOR I=1 TO 16
30    B(I,14)=0
40    P(I)=1/(17-I)
50    READ N
60    FOR J=12 TO 1 STEP -1
70    Q=INT(N/2)
80    B(I,J)=2*(N/2-Q)
90    N=Q
100   NEXT J
110   NEXT I

120   DATA 2128, 1121, 594, 355, 3220
130   DATA 2725, 2454, 1703, 1528, 1017
140   DATA 2042, 3067, 3516, 3773, 4030, 4031

150   FOR I=1 TO 8
160   READ N$(I): NEXT I
170   DATA BIG, SMALL
180   DATA BLUE, YELLOW
190   DATA LONG BEAKED, SHORT BEAKED, FEMALE, MALE

195   REM INPUT PLACE
200   FOR I=1 TO 16: I(I)=0: NEXT
210   INPUT "PLACE S,W,D,F"; L$
220   INPUT "WHEN M,E"; T$
230   INPUT "WHERE H,L"; A$

260   IF L$="S" THEN I(1)=1
270   IF L$="W" THEN I(2)=1
280   IF L$="D" THEN I(3)=1
290   IF L$="F" THEN I(4)=1
300   IF T$="M" THEN I(5)=1
310   IF T$="E" THEN I(6)=1
320   IF A$="H" THEN I(7)=1
330   IF A$="L" THEN I(8)=1
340   FOR I=1 TO 16: B(I,13)=0: NEXT I
350   FOR I=1 TO 16: FOR J=1 TO 8
```



```
360   IF B(I,J)<>I(J) AND B(I,J)=0 THEN 390
370   NEXT J
380   B(I,13)=1
390   NEXT I

395   REM FIND BIRDS
400   FOR I=1 TO 2 STEP .02
410   J=INT(16*RND(1)+1)
420   IF B(J,13)<>1 THEN 440
430   IF RND(1)<P(J) THEN 460
440   NEXT I
450   PRINT "NO SIGHTINGS": H=H+I: GO TO 200
460   H=H+I
470   K=INT(4*RND(1)+1)
480   N=B(J,K+8)
490   PRINT "THE BIRD IS"; N$(2*K-N): PRINT "TIME LAPSE:"; I: PRINT
      "TOTAL TIME:"; H

495   REM INPUT ID
500   INPUT "IDENTIFY 1-16"; I
510   IF I=J THEN 530
520   PRINT "NOT CORRECT IDENTIFICATION": C1=C1+1: GO TO 500
530   IF B(J,14)=1 THEN PRINT "ALREADY SPOTTED": GO TO 550
540   PRINT "A NEW ONE!": B(J,14)=1
550   IF H>10 THEN 570
560   GO TO 200

570   PRINT "TIME UP"
580   FOR I=1 TO 16
590   IF B(I,14)=1 THEN PRINT "YOU SAW BIRD #"; I: B1=B1+1
600   NEXT I
610   PRINT "YOUR RATING IS"; 10*B1-C1; "."
620   INPUT "PLAY AGAIN"; Y$
630   IF Y$="Y" THEN RUN
640   END
```

RARE BIRDS MODIFICATIONS

Minor

1. Probability of sighting -- line 40
2. Time interval per turn -- line 400
3. Total time -- line 550
4. Rating formula -- line 610

Major

1. Increase number of birds.
2. Increase characteristics of birds.
3. Allow a bird to be identified more than once.
4. Have some extremely rare birds.

Note: The birds' characteristics are stored in decimal format in statements 120, 130, and 140. Statements 50-100 convert the decimal numbers into binary and store the binary digits in B(I,J).

BIRD WATCHING CHART

BIRD	PLACE	WHEN	WHERE	SMALL BIG	YELLOW BLUE	SHORT-BEAK SNAKE-BEAK	MALE FEMALE
1	S	E	L	S	Y	S	M
2	W	E	H	S	Y	S	F
3	D	E	L	S	Y	L	M
4	F	E	H	S	Y	L	F
5	SW	M	L	S	B	S	M
6	S D	M	H	S	B	S	F
7	S F	M	L	S	B	L	M
8	WD	M	H	S	B	L	F
9	W F	ME	HL		Y	S	M
10	DF	ME	HL	B	Y	S	F
11	WDF	ME	HL	B	Y	L	M
12	S DF	ME	HL	B	Y	L	F
13	SW F	M	HL	B	B	S	M
14	SWD	M	HL	B	B	S	F
15	SWDF	M	HL	B	B	L	M
16	SWDF	M	HL	B	B	L	F

DIAMOND THIEF

Scenario

An expensive diamond is stolen from a museum. Your job, as the detective assigned to the case, is to determine who stole the diamond and at what time. You deduce the solution by studying the responses made by five different suspects, one of whom is guilty. Your rating is determined by how quickly you can identify the thief.

The five suspects were wandering through a nine room museum from one p.m. to twelve midnight. They never stayed in the same room for two consecutive hours, although they may have returned to the same room more than once.

You determine who you want to question and a specific time from one to twelve. The suspect responds by giving the following information:

1. Suspect's location at specified time
2. Whether or not the diamond was seen in room #5 at the specified time
3. Who was with the suspect
4. Who the suspect saw in adjacent rooms

There is a catch, however. The innocent suspects can forget the exact room they were in and may name adjacent rooms 5% of the time instead. There is also a 5% chance that innocent people will make errors in naming people in the room with them or people whom they saw. The thief makes errors 50% of the time. Any statement made about room #5 or any statement made about the diamond is always true.

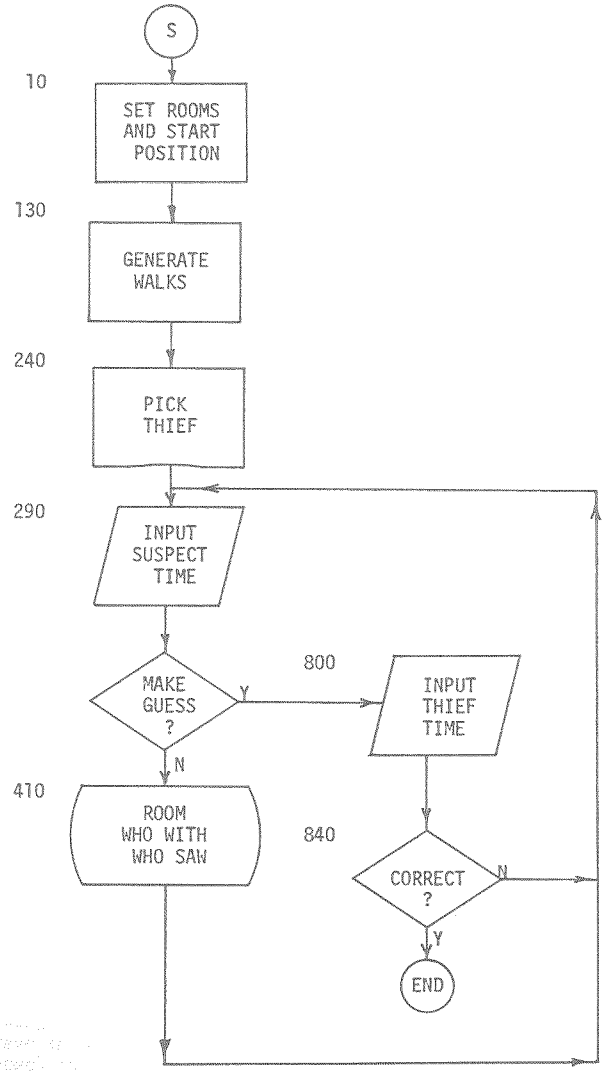
The diamond was stolen at the end of the time interval; therefore, the thief or people in room #5 with the thief will claim to have seen the diamond during the time it was stolen. Of course, after the diamond was stolen, suspects will not have seen it.

When you think you know who the thief is and the time it was stolen, then you should enter a zero in response to "suspect?". If you get either the thief or the time correct, you will get another chance, but will lose a ten question penalty on the final rating.

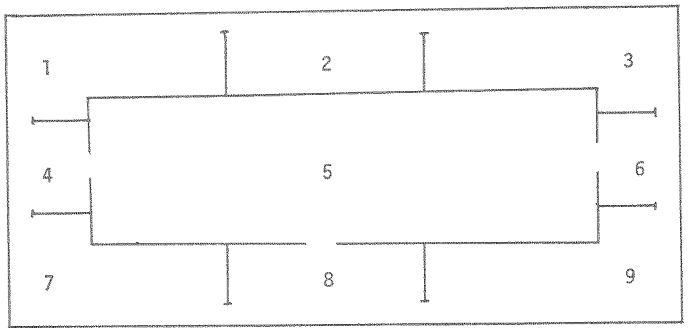
Sample Run

```
RUN
PLEASE WAIT
SOMEONE STOLE THE DIAMOND!!
QUESTION  1
SUSPECT (1-5)?  1
TIME?  6
SUSPECT 1 AT TIME 6
I WAS IN ROOM 8
I WAS WITH 3
I SAW 4

QUESTION 2
SUSPECT (1-5)?  4
TIME?  6
SUSPECT 4 AT TIME 6
I WAS IN ROOM 9
I SAW 1

QUESTION 3
SUSPECT (1-5)?  2
TIME?  6
I WAS IN ROOM 6
I SAW 4

QUESTION 4
SUSPECT (1-5)?  5
I WAS IN ROOM 1

QUESTION 5
SUSPECT (1-5)?  3
TIME?  7
I WAS IN ROOM 9
I WAS WITH 2
I SAW 4
.
.
.

QUESTION 15
SUSPECT (1-5)?  4
TIME?  4
I WAS IN ROOM 5
I SAW THE DIAMOND
I WAS WITH 3

QUESTION 16
SUSPECT (1-5)?  0
GUILTY SUSPECT?  4
TIME OF CRIME?  4

YOU GOT "EM
THE THIEF IS 4 AT TIME 4.
YOUR RATING IS 84
PLAY AGAIN?
```

DIAMOND THIEF FLOWCHART



MUSEUM FLOOR PLAN



TIME

SUSPECT	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												
4												
5												