

# The **LOGO** Exchange

Volume 2 Number 9

FORWARD 100!

May 1984

## Speaking of Logo, Now Tracy Can

by Kendall Young  
and Glen Bull

Seymour Papert explores the conventional role of computers in education by asking,

"What if there were only  
one pencil per classroom?"

One pencil in a classroom is better than none at all. But how would it change the classroom if every child had one? He then asks the same question about computers. What if every child in a classroom had a computer?

### ONE CHILD, ONE COMPUTER

The effect of a personal computer can be even more striking if a child is disabled. Tracy Fewell of Crozet, VA, is 14 years old. He has spastic cerebral palsy and a speech disorder. In January, Tracy received an Apple computer with Logo. One day in class a month later, he presented his first oral report ever.

The muscles of Tracy's mouth are partially paralyzed. They are abnormally weak, slow, and uncoordinated. He can only produce five consonants. His longest phrase is four to five words in length. He can be understood only with difficulty, and only by those who have known him for a long period of time.

Tracy was able to deliver his first oral report because he had received a Votrax speech synthesizer for his computer, purchased with funds donated by a local Kiwanis Club.

The speech synthesizer is as easy to use as a printer, and is even less expensive. It attaches to the computer through a printer port. When the computer sends a line of the text to the printer port, the speech synthesizer speaks the sentence instead of printing it.



Photo by Jim Carpenter  
Daily Progress, Charlottesville, Va.

### LOGO AND SPEECH

A short Logo procedure allows Tracy to say anything he can type:

```
TO SAY :SENTENCE
  OUTDEV 1
  PRINT :SENTENCE
  OUTDEV 0
  END
```

Since his sixth grade classmates were learning Logo, the very first thing Tracy did was to type in instructions so they all could hear what their names sounded like with his new "voice."

For his first report, Tracy used the Logo editor to type in his homework. He used the synthesizer to present a social studies report the next day, with a procedure called TELL.STORY.

Before he had his computer, Tracy had to write each word laboriously by hand. He tended to write telegraphically, and leave out articles such as "the". Verbs such as "is" and "are" were used interchangeably. Spelling was irregular. Word endings such as "ed" were left off.

## Speaking continued

Now he uses the TELL.STORY procedure to scan his work line by line. As he listens, he detects and corrects over half of all his errors without prompting. He has learned that things he "says" simply do not sound right when words such as "the" are left out.

### PLEASE CALL ON ME

The import of Tracy's new-found oral capability is difficult to estimate. In previous years, Tracy has not been able to answer aloud in class. With a Logo program called QUICK.ANSWER, developed by educational specialist Cheryl Wissick, he can raise his hand and press a single key to select from a bank of answers for that day's work.

### LOGO WHIZ

Tracy also has a learning disability. He is older than most of his classmates, because he has not advanced as quickly as they have in reading and spelling. With the combination of these physical and learning disabilities, it might be expected that Tracy would also lag behind in the computer curriculum.

Instead, other children have come to Tracy with their computer problems. He has been given the tag of "whiz kid" by his classmates. This has been good for Tracy's self-esteem. It also demonstrates the truth underlying Papert's observation about the advantages of giving every child unlimited access to computers.

Now that Tracy has his own "pencil", he can erase some of his educational barriers. Let us learn how to use Logo to do the same for others.

Note: For more information on the Votrax Personal Speech System, write to Votrax, 500 Stephenson Highway, Troy, MI 48084.

Kendall Young is a speech-language pathologist in the Albemarle County VA School System, and uses Logo regularly in her programs. Glen Bull is a professor in the University of Virginia School of Education's Department of Speech Pathology and Audiology, and is a regular columnist for The National Logo Exchange.

## From The Editor

It is difficult to believe that another school year is drawing to a close. This time, the realization comes in a new way for us. Our son, Kyser, will celebrate his first birthday in May. It seems as if we brought him home from the hospital just a couple of weeks ago!

As I thought about Kyser's development, I began to see parallels with Logo. At first, everyone was excited at his arrival. He was the new kid on the block, "practically perfect in every way."

Logo also started off with the excitement of a new baby. Now that it has been around for a while, perhaps some of the excitement is wearing off. Articles are appearing which ask thoughtful penetrating questions. We are seeing that there are limitations and inappropriate uses. There are ineffective ways to teach Logo, and ineffective ways to teach with Logo.

Perhaps we are seeing a sort of maturing process. Preliminary research has not yielded all the glowing results expected. Yet, the potential and promise of Logo remain nearly undiminished. Why?

The use of Logo as a teaching tool in content areas beckons. Once students have some familiarity with the language, they can use it to study and learn other subjects.

Logo applications, such as with special populations, have begun to be reported. The need for such applications is critical. Logo can fill a vital part of the void.

Creative Logo people, such as you, our readers, continue to find new ways to use this language to help students extend their boundaries.

As we follow another year of Logo development, let us each do our part to take full advantage of this educational tool, for our students' sakes.

Best wishes for a rewarding summer! Don't forget to set aside time for reading, thinking, and writing. Here's hoping our paths cross.

FD 100!



# TIPPS for TEACHERS

by  
Steve Tipps

## How Now, Output

OUTPUT is a Logo command which people tend to avoid. Perhaps it frightens us after the simple English words (FORWARD, BACK) which introduce Logo.

OUTPUT is really much simpler than it may seem. Demystifying OUPUT hinges on getting it to do something meaningful for us.

### WHICH COLOR IS WHAT NUMBER

I have a terrible time remembering whether blue or orange or green is 1 or 5 or 10. Switching from computer to computer and Logo version to Logo version compounds my confusion. I didn't want to look up the colors each time. What I really wanted was to set the pencolor with the name of the color.

Procedures with OUTPUT are good for remembering what numbers go with which colors. Each color procedure has one simple OUTPUT statement.

```
TO GREEN      TO ORANGE      TO BLUE
  OUTPUT 2    OUTPUT 4      OUTPUT 5
  END        END        END
```

For the Apple, pencolors and background colors could be set with the same color procedures (discounting the color interference problem.) Each procedure does only one thing - it outputs the number for that color. PENCOLOR uses that number, and I only have to type which color I want by name.

I can draw a green line or a blue square or an orange circle.

```
PENCOLOR GREEN FD 100      MIT
SETPC GREEN FD 100        LCS
```

```
PENCOLOR BLUE SQUARE 100  MIT
SETPC BLUE SQUARE 100    LCS
```

```
PENCOLOR ORANGE CIRCLE 5  MIT
SETPC ORANGE CIRCLE 5     LCS
```

The numbers for colors change according to the version and machine, of course. You can also change the name of the color. PURPLE may be a better name than VIOLET or MAGENTA. IBM "brown" is actually a mustard yellow color. Make a file of color procedures for a tool kit.

### ALL AHEAD GREEN

Since GREEN is a procedure which OUTPUTs the number 2, GREEN also can give the number 2 to other commands and procedures. That command or procedure can use the 2 the way it uses other numbers.

You can have the turtle move GREEN ahead.

```
FORWARD GREEN
or
REPEAT 100 [FORWARD ORANGE]
```

The turtle can "turn" BLUE or ORANGE.

```
RIGHT BLUE
or
REPEAT 360/ORANGE [FORWARD GREEN LEFT
ORANGE]
```

Colorful geometry yields to colorful arithmetic with new OUTPUT procedures for other colors. The values of other colors could be set according to your Logo, or arbitrarily, for number games.

```
TO YELLOW      TO RED
  OUTPUT _____  OUTPUT _____
  END          END
```

```
TO BROWN
  OUTPUT _____
  END
```

```
TO COLOR,NUMBERS
TEXTSCREEN CLEARTEXT SETCURSOR [0 0]
  or use NODRAW (MIT versions)
PRINT [ YELLOW TIMES RED IS ...]
PRINT YELLOW * RED
PRINT [ RED TIMES BROWN IS ...]
PRINT RED * BROWN
PRINT [ BROWN TIMES YELLOW IS ...]
PRINT BROWN * YELLOW
PRINT [CAN YOU FIGURE OUT THE]
PRINT [NUMBERS FOR THE COLORS?]
END
```

When you have guessed what the color numbers are, you can check them by typing

```
PRINT YELLOW
PRINT RED
PRINT BROWN
```

## Tips continued

Other mystery numbers games could be made with procedures named for flowers or cars or stars.

### A TRIVIAL QUIZ

Use OUTPUT in a procedure when you want it to tell another procedure or command something. The information could be a number or a word or a list. You can make a trivia game or quiz with OUTPUT (the short form, OP, can be used also).

```
TO TEXAS.CAPITAL?   TO FONZIE.ACTOR?
  OP "AUSTIN         OP [HENRY WINKLER]
  END                END

TO SAREK.SON?       TO PRESIDENT.AFTER.NIXON?
  OUTPUT "SPOCK      OUTPUT [GERALD FORD]
  END                END
```

POTS becomes a menu of questions to be chosen.

```
POTS
TO TEXAS.CAPITAL?
TO FONZIE.ACTOR?
TO SAREK.SON?
TO PRESIDENT.AFTER.NIXON?
```

When an answer is guessed, you can check it by typing PRINT and the OUTPUT procedure.

```
PRINT SAREK.SON?
SPOCK
```

### WHY INDEED?

You might ask, "Why OUTPUT instead of PRINT?" In the example, PRINT would do as well because we only need the information at the TOPLEVEL in Logo. However, when information is passed between procedures below TOPLEVEL, OUTPUT is required.

Convert the quiz to a procedure with questions and answers.

```
TO QUIZ
  PRINT [ANSWER ONE OF THE FOLLOWING
  QUESTIONS.]
  PRINT [1 WHO WAS SAREK'S SON?]
  PRINT [2 WHAT IS THE CAPITAL OF
  TEXAS?]
  PRINT [3 WHO WAS PRESIDENT AFTER
  NIXON?]
  PRINT [4 WHAT IS THE MOTTO OF THE
  USA?]
```

```
PRINT [5 WHAT ACTOR PLAYS FONZIE?]
PRINT []
WAIT 50
PRINT [WHICH ANSWER DO YOU WANT?]
PRINT [CHOOSE A NUMBER 1 THROUGH 5.]
PRINT CHOOSE.ANSWER
QUIZ
END
```

### TO CHOOSE.ANSWER

```
MAKE "NUMBER READCHAR
IF :NUMBER = 1 [OUTPUT "SPOCK]
IF :NUMBER = 2 [OUTPUT "AUSTIN]
IF :NUMBER = 3 [OUTPUT [GERALD FORD]]
IF :NUMBER = 4 [OUTPUT [E PLURIBUS
UNUM]]
IF :NUMBER = 5 [OUTPUT [HENRY
WINKLER]]
IF :NUMBER > 5 [OUTPUT [ PLEASE
CHOOSE A NUMBER 1 THROUGH 5.]]
END
```

The answers are in CHOOSE.ANSWER. Depending on the question chosen, CHOOSE.ANSWER supplies the correct answer to PRINT in QUIZ. (You may want a more effective trap for numbers not 1 through 5.)

Compare how PRINT and OUTPUT were used with the instructions about choosing a number. The phrase was used immediately with PRINT, but was to be passed up a level from CHOOSE.ANSWER. This illustration also shows another feature of OUTPUT. As soon as OUTPUT is executed, the procedure automatically stops. If the number is 4, the procedure outputs [E PLURIBUS UNUM] and stops.

### NOT SO TRIVIAL

A slightly fancier trivia quiz can also be made using a list of answers rather than the cumbersome CHOOSE.ANSWER procedure. This version is also more modular. Here are the questions.

```
TO QUESTIONS
  TEXTSCREEN CLEARTEXT SETCURSOR [0 0]
  PRINT [ANSWER ONE OF THE FOLLOWING
  QUESTIONS.]
  PRINT [1 WHO WAS SAREK'S SON?]
  PRINT [2 WHAT IS THE CAPITAL OF
  TEXAS?]
  PRINT [3 WHO WAS PRESIDENT AFTER
  NIXON?]
  PRINT [4 WHAT IS THE MOTTO OF THE
  USA?]
  PRINT [5 WHAT ACTOR PLAYS FONZIE?]
  PRINT []
  END
```

## Tips continued

The answers are organized into a list.

```
TO ANSWER.LIST
MAKE "ANSWERS [SPOCK AUSTIN [GERALD
FORD]][E PLURIBUS UNUM][HENRY WINKLER]]
END
```

A separate module for answering has several parts. First, the cursor moves to a new location and asks you to pick a question.

```
TO ANSWER
SETCURSOR LIST 15 4
PRINT [WHICH QUESTION DO YOU WANT TO
ANSWER?]
MAKE "NUMBER READCHAR
PRINT CHOOSE.ANSWER2
WAIT 20
END
```

CHOOSE.ANSWER2 gives instructions and waits until you are ready to check your answer. Then it picks out the answer from the list which goes with the question you picked. This answer is picked with the command ITEM and OUTPUT to PRINT in ANSWER. If a number more than five is picked, additional instructions are given. (ITEM is a primitive in LCSI, Commodore, and new Terrapin 2.0. See Logo for the Apple II, Harold Abelson, McGraw-Hill, for information on writing ITEM for Terrapin 1.0 and Krell).

```
TO CHOOSE.ANSWER2
SETCURSOR [20 10]
PRINT [TOUCH ANY KEY WHEN YOU WANT TO
CHECK YOUR ANSWER.]
MAKE "GO.ON READCHAR
IF :NUMBER > 5 [OUTPUT [PLEASE CHOOSE
A NUMBER 1 TO 5.]]
OUTPUT ITEM :NUMBER :ANSWERS
END
```

All the parts of the quiz are then organized into QUIZ.2, which is recursive.

```
TO QUIZ.2
ANSWER.LIST
QUESTIONS
ANSWER
QUIZ.2
END
```

A challenge would be to expand the questions and answer lists. You could also make the program more interactive by actually reading the answer from the keyboard. Try to eliminate the questions which have already been asked and answered. Then see if you can

replace the used up questions with new questions. Soon you will have an electronic trivia game.

### CLOSE ENCOUNTERS OF THE OUTPUT KIND

The quiz and game could be done with PRINT and without OUTPUT. However, they demonstrate how OUTPUT works in a tangible way. OUTPUT tells an outside procedure something an inside procedure knows. Sophisticated uses of OUTPUT capitalize on its ability to pass information between procedures in ways that PRINT cannot.

Creating procedures which do calculations is one example. Perhaps the total of the boys and girls in a class are needed. You could write a procedure which would add the variable :BOYS to the variable :GIRLS for a TOTAL.

```
TO TOTAL :BOYS :GIRLS
OUTPUT :BOYS + :GIRLS
END
```

```
PRINT TOTAL 15 10
25
```

This total procedure would be used to calculate percentage.

```
TO PERCENTAGE :BOYS :GIRLS
PRINT [THE PERCENT OF BOYS IS ...]
PRINT :BOYS * 100 / TOTAL :BOYS
:GIRLS
PRINT [THE PERCENT OF GIRLS IS ...]
PRINT :GIRLS * 100 / TOTAL :BOYS
:GIRLS
END
```

```
PRINT PERCENTAGE 15 10
THE PERCENT OF BOYS IS ...
60
THE PERCENT OF GIRLS IS ...
40
```

Notice that the variables :BOYS and :GIRLS are input to PERCENTAGE and are given to TOTAL where they are added. Then the TOTAL is used in calculating the percent. In this case, OUTPUT is absolutely necessary. Try doing this with PRINT in TOTAL. You will see that PRINT will put the information on the screen, but will not let PERCENTAGE use it in calculations.

## Tipps . . .

### OUTPUT ANONYMOUS

You have already encountered several Logo commands which are natural outputters. HEADING outputs the current direction of the turtle, XCOR and YCOR output the current location of the turtle, BACKGROUND and PENCOLOR (LCSI) output the current background and pencolor, and TURTLESTATE (MIT) or DRAWSTATE (Commodore Logo) outputs a list of information about the current state of the turtle.

All of these natural outputters want to be told what to do with the information they are holding. Without PRINT (or some other command), the outputters are incomplete. The LCSI versions of Logo have a rather nasty complaint:

```
HEADING
I DON'T KNOW WHAT TO DO WITH 90
```

The MIT versions have a milder complaint:

```
XCOR
RESULT: 10
```

Both versions prefer to use the information in some way such as with PRINT.

```
TO WHERE?
  PRINT HEADING
  PRINT XCOR
  PRINT YCOR
END
```

If you need to remember where the turtle is and which way it is pointing so that it can get back, the natural outputters are perfect.

```
TO REMEMBER.WHERE
  MAKE "START.DIRECTION HEADING
  MAKE "START.X XCOR
  MAKE "START.Y YCOR
END
```

After moving around the screen, the turtle can get back to its starting place.

```
TO GO.BACK
  PU
  SETX :START.X
  SETY :START.Y
  SETHEADING :START.DIRECTION
END
```

## DON'T BE PUT OFF BY OUTPUT

OUTPUT is really not mysterious or frightening, although it can be tricky. When you are working on Logo this summer take a little time for experimenting with OUTPUT. The examples here only hint at some of the powerful things which OUTPUT allows you to do.

Being comfortable with this handy little command will enable you to move into list processing and list structure which are at the heart of Logo.

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## NLXionary

A lectionary of selected Logo readings  
compiled by Griff Wigley

Welcome to the NLXionary! Each month, we will present a lectionary of articles on Logo from other publications for your reading pleasure.

### RECENT

inCider Magazine, March 84, "Logo - Where is the Pony?" by Molly Watt

>Watt describes the extreme positions of the Logo optimists and the Logo pessimists, validating and discounting some of the claims made by each. Her advice? Since Watt's title is a puzzle until you read the article, my answer will be cloudy as well: the story of Icarus from Greek mythology gives a hint - "In medio tutissimus ibis." Latin lives like Logo!

Antic, The Atari Resource Magazine, March 84, "Logo's Lineage, The Canadian Connection," by Ian Chadwick

>Great Material for a Logo trivia contest. Who studied with Papert under Piaget, had a computer company that went bankrupt, and was one of the founders of LCSI? What school in Canada was a site for Logo experimentation in the early seventies? When and where was LCSI formed? Who was the main technical genius behind LCSI's Logo development? Who provided the business skills? The article also updates Logo development within the Canadian educational system.

## NLXionary continued

Home Computer Magazine, Volume 4,  
Number 1, 3 Logo articles

>Formerly 99'er Magazine, devoted entirely to Texas Instruments, HCM now covers Apple, Commodore, IBM, and still TI. Its regular Logo section, "Logo Times," sticks to Terrapin's version of Logo for the Apple and the Commodore 64, LCSi's Logo for the IBM PC and PCjr, and, of course, TI Logo. The three articles are project oriented, and provide a challenging glimpse of three different worlds within Logo.

>"What is Logo," by Robert Ackerman, describes Logo in the framework of a turtle graphics project building a city. "Lyrical Logo," by Logo veteran Henry Gorman, shows the list handling abilities of Logo in building a poetry generator. Gorman uses the sprites of TI and Commodore Logo in the third article, "Logo Shoots for the Moon."

Electronic Learning, March 84, "Word Processing in a Logo Environment," by Sharon Kramer

>A description of the author's method for teaching word processing to high school dropouts. Logo as a learning philosophy, not computer language, is the basis for her approach. I liked hearing how teaching Logo can influence a teacher's style in other subjects. Although I think we should be careful about calling any process-oriented approach to learning a "Logo approach", if the metaphor fits and can make dents in our product-oriented schools, let's use it.

### ANCIENT GEM

Creative Computing, October 1982, "What is Logo?" by Molly Watt

>Not so much an article on what Logo is, but an account of the many processes that occur and roles that are played in a Logo class. It contains many hints about teaching Logo, and a novel listing of what students say they learn in a Logo class.

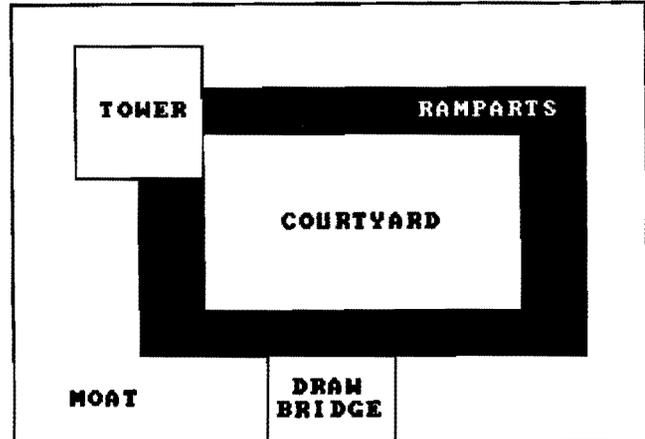
Griff Wigley is a co-owner of Family Computing, Inc., a facilitator in the Faribault (MN) Public Schools, and a school board member of Prairie Creek Community School.

# MICROWORLDS

by  
Glen Bull

## ETV: Educational TurtleVentures Part II

The turtle is exploring an enchanted castle - over the drawbridge, into the courtyard, and up a tower overlooking a moat.



Where is the turtle? Let's ask.

TELL WHERE?  
TOWER

What is in the TOWER with us? We can ask that too.

TELL WHAT?  
CANDLE KEY MIRROR

The CANDLE may be magic. (This is an enchanted castle.) But there are no matches. Wait. We may have noticed some on the RAMPARTS. The turtle moves from the TOWER to the wall overlooking the moat. We ask where the turtle is.

TELL WHERE?  
RAMPARTS

TELL WHAT?  
MATCHES SWORD BUCKET

We can take the MATCHES back to the tower to light the CANDLE. We tell the turtle to pick up the matches.

CARRY MATCHES

This type of adventure can be written in Logo.

## Microworlds continued

### LOOKING BACK

Last month, the screen was divided into a 10 by 10 grid of 100 blocks, labeled 0 through 99 with a procedure called SETUP, and made into the floorplan of a home. The numbers for the width and height of your screen may be different from 320 and 250.

```

TO SETUP
  MAKE "SCREEN.WIDTH 320
  MAKE "SCREEN.HEIGHT 250
  MAKE "NO.OF.ROWS 10
  MAKE "NO.OF.COLS 10
  MAKE "SQUARE.WIDTH :SCREEN.WIDTH /
:NO.OF.COLS
  MAKE "SQUARE.HEIGHT :SCREEN.HEIGHT /
:NO.OF.ROWS
  MAKE "VERTICAL.OFFSET :SCREEN.HEIGHT
/ 2 - 1
  MAKE "HORIZONTAL.OFFSET :SCREEN.WIDTH
/ 2 - 1
  END
  
```

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22							29
30	31	32	33	34	35	36	37		39
40	41		43	44	45	46	47		49
50	51		53	54	55	56	57		59
60	61		63	64	65	66	67		69
70	71								79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

The procedure BLOCK? was created to find out what block the turtle was sitting on .

```

TO BLOCK?
  LOCAL "X,Y
  MAKE "X,Y GRID.LOCATION
  OUTPUT WORD LAST :X.Y FIRST :X.Y
  END

TO GRID.LOCATION
  LOCAL "X LOCAL "Y
  MAKE "X INT (XCOR + :HORIZONTAL.OFFSET)
/ :SQUARE.WIDTH
  MAKE "Y INT (YCOR + :VERTICAL.OFFSET) /
:SQUARE.HEIGHT
  MAKE "Y 9 - :Y
  OUTPUT LIST :X :Y
  END
  
```

When the turtle is sitting on block 37, the result looks like this:

```

PRINT BLOCK?
37
  
```

### WHERE IS THE TURTLE?

Notice that the castle TOWER sits on these six blocks:

```

11 12 21 22 31 32
  
```

If we make a list of the blocks occupied by each place, we can find out where the turtle is.

The procedure NAME.PLACES names the blocks which make up the various parts of the castle. You must add the statements for the blocks in the COURTYARD, the RAMPARTS, and the MOAT before this procedure is complete.

```

TO NAME.PLACES
  MAKE "TOWER.SPACE [11 12 21 22 31 32]
  MAKE "DRAWBRIDGE.SPACE [84 85 94 95]
  .
  .
  .
  END
  
```

Next, we can find out where the turtle is by asking if the block the turtle is on is a member of that place. MEMBERP is the command which allows us to ask this question. You must run the completed NAME.PLACES procedure before you can use the WHERE? procedure.

```

TO WHERE?
  LOCAL "LOCATION
  MAKE "LOCATION BLOCK?
  IF MEMBERP :LOCATION :TOWER.SPACE [OP
"TOWER]
  IF MEMBERP :LOCATION :DRAWBRIDGE.SPACE
[OP "DRAWBRIDGE]
  IF MEMBERP :LOCATION :MOAT.SPACE [OP
"MOAT]
  IF MEMBERP :LOCATION :COURTYARD.SPACE
[OP "COURTYARD]
  IF MEMBERP :LOCATION :RAMPARTS.SPACE [OP
"RAMPARTS]
  OP [LOCATION NOT IDENTIFIED]
  END
  
```

The procedure works like this:

```

PRINT WHERE?
COURTYARD
  
```

Personally, I prefer TELL WHERE? in place of PRINT WHERE? as an instruction.

## More Microworlds

Here is a Logo procedure which allows us to use TELL instead of PRINT:

```
TO TELL :INPUT
  PRINT :INPUT
END
```

### WHAT IS THERE?

Now that we can find out where the turtle is, we can make a list of the things in each place. Here is how.

```
TO NAME.THINGS
  MAKE "TOWER [CANDLE KEY MIRROR]
  MAKE "DRAWBRIDGE [HORSESHOE ROPE]
  MAKE "MOAT [BOOT CAN SHIELD]
  MAKE "COURTYARD [MOP CHEST GRANOLA]
  MAKE "RAMPARTS [MATCHES SWORD BUCKET]
  MAKE "TURTLE []
END
```

You can place anything you want in the brackets after the name of each place. In the last line I have added a list of the things the turtle is carrying. Right now, the turtle is not carrying anything, so nothing is between the brackets after the word TURTLE.

After describing the things in each place, the procedure must be run by typing NAME.THINGS. After doing that, we can find out what those things are by entering:

```
PRINT THING "TOWER
CANDLE KEY MIRROR
```

If we want to know what is in the place where the turtle is, the word WHERE? can be substituted for the name of the place.

```
TO WHAT?
  OUTPUT THING WHERE?
END
```

With this procedure, we can ask what is in the place where the turtle is. If the turtle is on the DRAWBRIDGE we would find:

```
TELL WHAT?
HORSESHOE ROPE
```

### TURTLE PICKUP

The turtle needs a way to carry things from one place to another. If the turtle picks up a box of matches on the RAMPARTS and carries it to the TOWER, we should no longer

see matches in the list of things on the RAMPARTS. Two steps are necessary to accomplish this:

(1) We must be able to add to the list of things the turtle is carrying.

(2) We must be able to delete from the list of things attached to a place.

Adding things to a list is straightforward. To add an item to a list, LPUT can be used to put it into the list as the last item.

```
TO ADD :ITEM :LIST
  MAKE :LIST LPUT :ITEM THING :LIST
END
```

Let's use this procedure to add a flute to the list of items on the DRAWBRIDGE.

```
TELL WHERE?
DRAWBRIDGE
```

```
TELL WHAT?
HORSESHOE ROPE
```

```
ADD "FLUTE "DRAWBRIDGE
TELL WHAT?
HORSESHOE ROPE FLUTE
```

Deleting an item from a list is a little more tricky. It would be nice if this were a built-in command. Since it is not, you may find this procedure useful for other Logo programs.

```
TO DELETE :ITEM :LIST
  MAKE :LIST DELETE.LOOP :ITEM THING :LIST []
END
```

```
TO DELETE.LOOP :ITEM :OLD.LIST :NEW.LIST
  IF EMPTY? :OLD.LIST [PRINT SE :ITEM [NOT FOUND] OUTPUT :NEW.LIST]
  TEST :ITEM = FIRST :OLD.LIST
  IFTRUE [OUTPUT SE :NEW.LIST BUTFIRST :OLD.LIST]
  OP DELETE.LOOP :ITEM BF :OLD.LIST SE :NEW.LIST FIRST :OLD.LIST
END
```

Let's use the DELETE command to remove ROPE from the list of things on the DRAWBRIDGE.

```
TELL WHAT?
HORSESHOE ROPE FLUTE
```

```
DELETE "ROPE "DRAWBRIDGE
TELL WHAT?
HORSESHOE FLUTE
```

## Microworlds concluded

When the turtle selects an item to carry, we must add the item to the list of things the turtle is carrying, and delete it from the list of things where the turtle is. Before doing this, the procedure CARRY checks to make sure the item is present.

```
TO CARRY :ITEM
  TEST MEMBERP :ITEM WHAT?
  IFFALSE [PRINT SE :ITEM [NOT FOUND] STOP]
  ADD :ITEM "TURTLE
  DELETE :ITEM WHERE?
  END
```

### TURTLE DROPOFF

The procedure DROP reverses this process. It removes the item from the list of things the turtle is carrying, and adds them to the place where the turtle is.

```
TO DROP :ITEM
  TEST MEMBERP :ITEM :TURTLE
  IFFALSE [PRINT SE :ITEM [NOT CARRIED]
  STOP]
  ADD :ITEM WHERE?
  DELETE :ITEM "TURTLE
  END
```

Here is how the the turtle would carry the KEY from the TOWER to the CHEST in the COURTYARD. The turtle must begin in the TOWER.

```
TELL WHERE?
TOWER
```

```
TELL WHAT?
CANDLE KEY MIRROR
```

```
CARRY "KEY
TELL WHAT?
CANDLE MIRROR
```

After the turtle carries the KEY, it will no longer be found in the list of items in the TOWER. Now we can use turtle commands to move the turtle to the COURTYARD.

```
TELL WHERE?
COURTYARD
```

```
TELL WHAT?
MOP CHEST GRANOLA
```

```
DROP "KEY
TELL WHAT?
MOP CHEST GRANOLA KEY
```

At this point we might like to tell the turtle to unlock the chest, or to find out what else the turtle is carrying. Alas, that must be a summer project.

## GETTING INTO LISTS

Teachers find that the transition from turtle graphics to the list processing commands of Logo is not always smooth. The turtle is concrete and visible, while lists are more abstract.

I believe that, as we experiment with list processing commands in the classroom, natural ways of introducing lists will be identified. This adventure project was developed to suggest some ways that lists can be employed.

You could have a timed scavenger hunt to see who could use the turtle to collect specified items the fastest. In a spelling word hunt, the turtle could be used to collect the week's spelling list from different parts of the castle. In a message hunt, a message could be formed from correctly spelled words scattered among incorrectly spelled words.

In language arts, the items could be related to categories. For example, the instructions could be "Collect all the verbs" (or nouns or adjectives). Products of Argentina could be collected in a social studies lesson.

\*\*\*In the March issue, I included the following line:

```
MAKE "NUMBER COUNT FIRST :LIST + :NUMBER
```

The line should be:

```
MAKE "NUMBER (COUNT FIRST :LIST) + :NUMBER
```

Have a good summer. See you next fall.

---

Glen Bull is a professor is the University of Virginia's School of Education, and teaches Logo courses at both the graduate and undergraduate level.

---

## Oops

The review of Sprite Logo in the April NLX incorrectly referred to the product as "Apple Sprite Logo." The correct name is "Sprite Logo for the Apple II Family." We apologize for any misconceptions this may have caused.

# Give Me a Sine: Lissajou Logo

by  
Tom Lough

Come with me on the second leg of an odyssey I began last year when a member of the audience at a Logo demonstration I was giving asked, "Can the turtle draw a sine wave?" I wrote an admittedly incomplete article for the January 1983 NLX which examined this question in some detail.

After working with parabolas and the acceleration which produces them (see "Parabologo," NLX April 1984), the sine question came back to me. I wondered whether the acceleration idea could be used to produce a sine wave.

## IMAGINE

Imagine a mass connected to a spring hooked to a firm support. Eliminate all gravity and friction. When the mass is moved away from the support, the spring will pull it back. The force (or acceleration) due to the spring is directly proportional to the distance from the mass to the support.

When the mass has moved only a short distance from the support, the restoring force is small. When the mass is ten times as far away, the restoring force is ten times as large. (See information on Hooke's Law for more details.)

Set the mass in motion from rest. The force of the spring increases, slowing the mass until it stops momentarily and reverses its direction. Can you imagine the force of the spring now causing the mass to speed up as it goes back toward the support?

By the time the mass reaches the support, its speed has increased to the original value. After it moves past the support, the mass feels the force of the spring pulling it backwards, slowing it down. The force builds; the mass comes to a halt and reverses its direction once more.

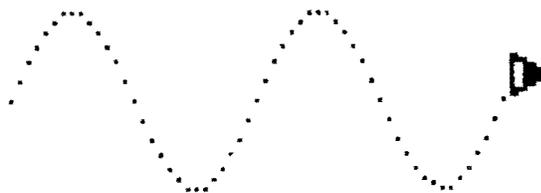
This back and forth pattern continues in a regular manner. If the mass moves sideways at a constant speed as it oscillates, its path is a sine wave!

## WRITE A PROCEDURE

Once I understood how this all worked, the next step was to try to write a procedure to simulate the motion. I added a self imposed limitation - to use only FD, RT, and LT. After a number of attempts, I constructed the WAVE procedure listed at the end of the article.

I moved the turtle to the left side of the screen, set its heading to 90, and entered

```
WAVE 2 -5 .05 -5
```



The first input number sets the horizontal speed. The last three inputs are related to the vertical movement.

In the example, -5 is used to start the mass on an upward path. It represents the initial speed of the mass.

The number .05 represents the stiffness of the spring divided by the mass of the body. It is a constant which can be used to control the frequency of the motion. A stiff spring will not permit as wide a motion as one which is easy to stretch. Likewise, a large mass will not accelerate as quickly as a smaller one subjected to the same restoring force.

The last input number represents the distance of the mass from the support after each cycle of recursion. Since distance equals speed times time, we would expect this distance to be the initial speed times one (1) at the end of the first cycle. Thus, this input number is the same as that of the initial speed when the procedure is used to draw a sine wave.

## WHAT ABOUT COSINE?

Since the cosine has the same shape as that of the sine wave, the WAVE procedure should be able to draw it also. We need to realize that the cosine begins at a different point than the sine, however.

## Lissajou continued

Imagine pulling the mass out from the support a certain distance and releasing it. Its motion will describe the cosine path.

Just as the mass is released, its speed is zero. The restoring force is at a maximum value, since the mass is at its greatest distance from the support.

If we want to draw a cosine wave the same size as the sine wave drawn earlier with WAVE, what displacement do we use for the last input? You might be tempted to say  $-5$ . Try it and see what happens.

What is needed here is the approximate maximum displacement for a wave which will have a maximum speed of  $-5$  as it goes through the center. But how far is that distance?

Physics provides the answer. The maximum displacement is the maximum velocity divided by the square root of the spring/mass number. Thus,  $-5/\text{SQRT}(.05)$  could be used for the last input to WAVE to produce the desired cosine trace.



```
sine: WAVE 2 -5 .05 -5
cosine: WAVE 2 0 .05 -5/SQRT (.05)
```

Note the input value of zero for the initial speed for the cosine wave, and the term  $-5/\text{SQRT} (.05)$  as the final input.

Since the WAVE procedure uses only FD, RT, and LT, it is self referencing, and can be used to draw figures in any orientation.

### LET'S LISSAJOU

Particularly important are the so-called "Lissajou figures." (See Frequency Measurement in Van Nostrand's Scientific Encyclopedia, for example.)

Lissajou figures are drawn in the same way you draw with an "Etch-a-Sketch" type of toy. You turn one knob for up and down pen movements, and another for sideways movements. The two controls operate at an angle of 90 degrees to each other.

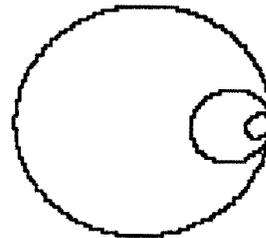
If you have ever tried to draw a circle with this type of toy, you have probably given up! It is very difficult, because ... you have to do a sine like motion on one knob while doing a cosine like motion on the other!

Aha! That means that we might be able to draw circles with our sine and cosine. The circle is a member of the Lissajou family. In fact, the entire family of figures can be drawn with sine and cosine in this manner.

The procedure FIGURE, listed at the end of the article, contains two WAVE procedures at 90 degrees to each other, and can draw Lissajou figures. When drawing them, I put the pen down, and use small inputs.

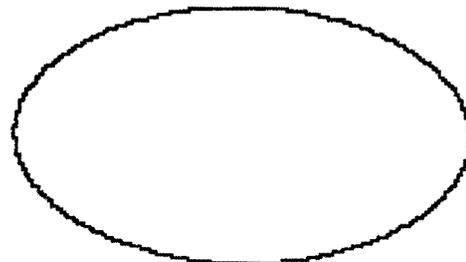
To draw a circle, the amplitudes of the sine and the cosine parts should be equal. For example, try

```
WAVE 1 .05 1 0 .05 1/SQRT (.05)
WAVE 1 .005 1 0 .005 1/SQRT (.005)
WAVE 1 .0005 1 0 .0005 1/SQRT (.0005)
```



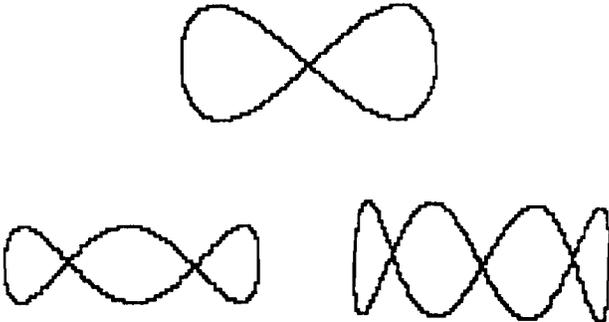
What would happen if the amplitudes were different? The result is an ellipse, another member of the Lissajou family. (By the way, this ellipse doesn't depend on the use of SCRUNCH or the location of a focus!)

```
WAVE 1 .0005 1 0 .0005 2/SQRT (.0005)
```



## Lissajou continued

What happens if we change the frequency of one wave relative to another by using different spring/mass numbers? We discover the incredible richness of the Lissajou. Many other forms are possible. But, don't let me spoil your fun. Discover them for yourself!



As an interesting comparison, R. W. Lawler's article, "Designing Computer Based Microworlds," in the August 1982 issue of *Byte* magazine, lists a Lissajou procedure on page 158, which makes direct use of the SIN and COS commands, in addition to many other Logo primitives. Photographs of several Lissajou figures appear on page 160.

I hope that you and your students will be able to make use of the ideas presented here. They seem to be suited best for the physical sciences. If you apply them or extend them, please share your work with me. Thank you in advance. FD 100!

```
TO WAVE :HOR :VERT :K :DISPLACEMENT
  PD FD 1 BK 1 PU
  (or DOT POS or PD DOT POS PU)
  FD :HOR RT 90 FD :VERT LT 90
  WAVE :HOR (:VERT-:K*:DISPLACEMENT) :K
  (:DISPLACEMENT+:VERT-:K*:DISPLACEMENT)
  END
```

```
TO FIGURE :X :KX :XTOTAL :Y :KY :YTOTAL
  PD FD 1 BK 1 PU
  (or DOT POS or PD DOT POS PU)
  FD :X RT 90 FD :Y LT 90
  FIGURE (:X-:KX*:XTOTAL) :KX (:XTOTAL+:X-
  :KX*:XTOTAL) (:Y-:KY*:YTOTAL) :KY (:YTOTAL
  +:Y-:KY*:YTOTAL)
  END
```

Tom Lough uses Logo in teaching undergraduate physics classes at Piedmont Virginia Community College near Charlottesville, VA, and is the editor of The National Logo Exchange.

## Teacher, Kids, and Logo

A review by Sue Mangiapane

Teacher, Kids, and Logo, written by Carolyn Green and Christi Jaeger, is one of the most comprehensive practical guides to Logo instruction I have seen. It is well written and well paced. The activities have been teacher tested. Teacher, Kids, and Logo shows teachers how to encourage children to draw on their creativity and gives them the opportunity to define their ideas in visual terms using the turtle's language.

Teacher, Kids, and Logo dedicates a separate chapter to each grade, K-6, and specifies techniques which may be used at each level. Each chapter contains objectives for the mathematical concepts, computer awareness, and programming concepts to be covered at that level. A step by step explanation follows to help teachers achieve the stated objectives with their children. This approach easily lends itself to individualized pacing.

The book contains advice on classroom demonstrations, provides concrete activities, and offers supplemental worksheets to help students transfer their programming skills. Many of the ideas help children view the computer as a tool to be used in the real world, and help them relate their experiences to other computer applications.

Teacher, Kids, and Logo includes commands for both MIT and Apple Logo and can easily be adapted to other variations of the language. It also includes appendices which offer teaching aids and practice exercises. Many of these pages present wonderful ideas for further development of the logical and structural ideas needed in any programming experience.

I recommend Teacher, Kids, and Logo as an excellent resource for teachers who are eager to enhance their computer program.

EduComp Publications, 14242 Wyeth Avenue, Irvine, CA, 92714. Spiral bound 8" x 11", illustrated, 160 pages. \$15.95 plus \$2.00 shipping (CA residents add 6% sales tax)

Sue Mangiapane is the owner of Computers with Class, an educational consulting firm in Anaheim, CA, and is a research consultant for the California State University at Fullerton.

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# NLX Notices

The NLX announces its Dissertation and Thesis Repository. This collection of publications is designed to assist researchers in identifying related Logo work, and will serve as an adjunct to the NLX Logo Research Directory. We are inviting the submission of all dissertations and theses which involve Logo. Please send complete copies if possible. Include abstracts and any identification numbers (such as a university number or the Dissertation Abstracts index number). If complete copies are not available, please send as much information as possible. Mail your documents to NLX Dissertation and Thesis Repository, Attn: Barbara Elias, PO Box 5341, Charlottesville, VA 22905.

How can one find out what is being done with Logo and special populations in schools? Glen Bull and Ralph Stoudt discussed the matter with Dr. Sylvia Weir of MIT's Laboratory for Computer Science. Dr. Weir suggested that a case registry might be a worthwhile mechanism for people using Logo with special populations to get in touch with one another.

They are adopting Dr. Weir's suggestion to establish such a case registry. If you are using Logo with a special population (including communication disorders, learning disabilities, cognitive impairment, sensory impairment, and disorders involving physical handicaps such as cerebral palsy), or know of someone who is, please send information about it. Glen and Ralph will abstract each submission, catalog and index the entries, and set up a mechanism for sharing information.

They are especially interested in informal accounts from teachers and clinicians, but would also like to include any controlled research reported. Case registry information should include name, institution, address, phone number, type of special population, ways Logo is being used, results, and thoughts for future actions.

Send your reports to:

Logo Case Registry for Special Populations  
Speech and Hearing Center  
109 New Cabell Hall  
University of Virginia  
Charlottesville, Virginia 22903

Thank you for sending in your blue cards! We were pleased to hear from so many of our subscribers. We especially appreciated the ideas and suggestions you sent for upgrading the NLX. As a result, starting in September, we will be adding several new features which we hope will aid you in your Logo teaching. We would like to invite your participation in them now.

The first is a column of Logo classroom activities and tips for elementary teachers. If you would like to contribute ideas or share activities which have worked in your classroom, send a brief description to Donna Lanyi and Jane Toth, 2620 Taylor, Wooster, OH 44691.

We are also planning to begin an answer column for readers with questions about Logo programming techniques and the thinking leading to programming. If you have ever written a procedure that "should have worked" but didn't, here is your chance to find out why. Jim McCauley will answer several questions in his column each month. If you have a question you would like to be considered, send it to NLX Q&A, PO Box 5341, Charlottesville, VA 22905. Be sure to include a full description of the situation which led to the question, and a listing of the procedure(s).

## NLXual Challenges

with Robs Muir

### Of Squares and Strings

Certainly the most well known feature of the Logo language is the turtle. This computational object has features which we can recognize as having real world parallels. As a purposefully anthropomorphic entity, the Logo turtle provides a powerful bridge between concrete objects and conceptual frameworks.

A turtle allows children to easily manipulate real world properties, i. e., distance and direction, to assist them in building mental models of the world.

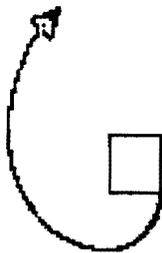
This month's problem, contributed by Tom Lough, starts with a real world situation, in which our goal will be to create a simulation of the concrete, using our computer monitor.

## Challenges continued

Have you ever seen a child with a length of rope and a tree? At some point in play, the child will usually tie the rope to the trunk of the tree, grasp the other end, and begin walking around the tree. As the rope winds or unwinds, it causes the child to walk in a definite path. Let's use the turtle to explore this path.

Imagine a square prism standing vertically upon a sheet of paper. Wrapped around this square dowel is a length of string, with a pencil attached. If the string is kept taut, what pattern will the pencil inscribe on the paper as it revolves around the dowel, unwinding the string? Clearly, the general shape will be that of an increasingly widening spiral.

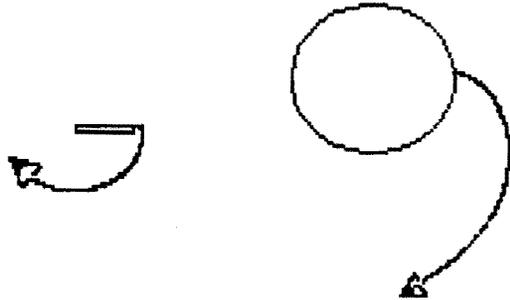
The first task is to write a program which will illustrate the path that the pencil will take as it unwinds from the square prism. You might begin with a small square, say, 20 by 20 turtle steps, in the center of the screen. Starting at the lower right corner of this square, have the turtle begin unwinding in a clockwise direction. Remember that our string must remain taut.



Notice the outwardly spiraling shape. Will the shape remain the same if, instead of a square, we used a triangular center of 20 turtle steps on each side? How might it differ?

Your complete challenge is to write a program of procedures that will draw the spiral created by centers of differing dimensions. For example, what would the spiral look like if the central core around which the string is attached was a rectangular prism of 3 by 20 turtle steps?

You may want to design an even more general solution, in which other shapes, such as hexagons, could be used at the center. In that case, examine the difference between the spiral you produced with the square, and one produced with a "circle."



As with all NLXual Challenges, if you would like to receive a possible solution, send me a copy of some of your work, along with a letter size self addressed stamped envelope. I'll send you a sample or two of the most interesting solutions submitted.

If you think of an interesting idea over the summer which could be developed into an NLXual Challenge, send me a brief description of it. See you in September.

NLXual Challenges, Attn: Robs Muir, 1688 Denver Avenue, Claremont, CA 91711.

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Robs Muir is a teacher in the Claremont CA Unified School District and Claremont Graduate School. He presents Logo workshops in the southern California area.

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Editor.....Tom Lough

# NLXTRA

We feel strongly that teacher training is an important issue in the effective use of Logo. To instructors of college, university, and school system Logo classes for teachers, we offer packets of NLX back issues for class use. For details, send your course description and schedule on your letterhead to: NLX Logo Class Support, PO Box 5341, Charlottesville, VA 22905.

Logo and physics are natural comrades. All physics teachers interested in establishing a Physics Logo group are invited to register with the NLX. Send your name, address, and a brief summary of your Logo interests and physics applications to: Physics Logo Group, NLX, PO Box 5341, Charlottesville, VA 22905.

Copies of the first NLX Logo Research Directory are nearly ready! Editor Regina Sapona has done a tremendous job of compiling your responses. There is a chance to include listings as late as May 10. If you conduct Logo research, please send a summary of your activity and interests to Regina Sapona, NLX Research Directory, PO Box 5341, Charlottesville, VA 22905. To obtain a copy, send \$3 US to the above address after May 25. The directory will be updated continuously. For the most complete copy, you are advised to wait until the end of the summer before ordering.

NECC '84, the 6th annual National Educational Computing Conference, will be held in Dayton, OH, June 13-15. One of the Logo activities featured will be a two-part panel presentation entitled, "Logo in the Schools: Are There Problems?" Sponsored by the International Council for Computers in Education and the National Logo Exchange, the panel will feature experienced Logo educators who will first focus on Logo in the areas of primary, elementary, and secondary schools, as well as teacher education. The panel will be joined by others who will present a geographical survey of Logo from all parts of the country, followed by a general question and answer session. The panel is scheduled for Friday morning, June 15. For more information on NECC '84, write Lawrence A. Jehn, Computer Science Department, University of Dayton, Dayton, OH 45469.

Computer Technology for the Handicapped, a national conference to be held in Minneapolis, MN, on September 13-16, will feature a major strand on using Logo in special education. This strand will offer an opportunity for those specifically interested in the use of Logo with special populations to meet and interact. Presentations will focus on specific applications of technology that can be "taken home" and put to use in schools. Proposals for Logo presentations are still being accepted. Contact Paula Barnhart, Closing the Gap, PO Box 68, Henderson, MN 56044. (612) 665-6573.

Hank Gorman offers his popular summer in-service computer workshop for the fourth year. Developed specifically for Logo teachers, the course earns 2 hours of graduate credit, and meets from July 16 through July 21, at Austin College in Sherman, TX, about 60 miles northeast of Dallas. Enrollment is limited to 20. Logo for the TI and Apple computers will be featured. During the course, a Logo curriculum guide will be developed and shared among the participants. For more information, write Dr. Henry Gorman, Austin College, Sherman, TX 75090, or call (214) 892-9101, ext. 481.

Steve Tipps and Glen Bull offer their popular three Logo courses again this summer at the University of Virginia. Microcomputers, Teaching, and Learning, a 6 credit hour course from June 11 through June 29, will focus on the use of microcomputers in school settings. The use of Logo will receive special emphasis.

Introduction to Logo, a 1 credit hour course, July 2 through July 9, is designed for beginning Logo teachers. Teaching Logo in the Classroom, a 3 hour course from July 9 through July 20, is designed for teachers with previous Logo experience. Additional programming skills in list processing and Logo curriculum development are important parts of this course.

For more information, write Steve Tipps, Department of Curriculum and Instruction, 206 Ruffner Hall, University of Virginia School of Education, Charlottesville, VA 22903, or call (804) 924 - 3738.

## Boston Logo News

reported by Beth Lowd

Theron Rockhill and Linda Northrop will conduct a five day Logo workshop for teachers June 25-29 in Brockport, NY. For more information, write to Dr. Theron Rockhill, SUNY College at Brockport, Brockport, NY 14420, or call (716) 395-2194.

Nola Sheffer will teach a 3 hour graduate course entitled "Introduction to Logo for Teachers and Educational Specialists," at Boston College July 9 - July 27. For more information, write to her at 8 Garden Court, Cambridge, MA 02138.

Software Concepts announces their Summer Computer Program in Educational Computing, featuring classes and workshops for teachers and students in Logo. For details, write to Karen Stewart, Software Concepts Associates, Inc., Slate Quarry Road, Rhinebeck, NY 12572, or call (914) 876 - 6448.

Jim Muller of the Young People's Logo Association is exploring the possibilities of producing a syndicated magazine style television program. The show would feature computers in general, and would include an emphasis on Logo. In order to "sell" the concept of the program to potential investors and sponsors, he must be able to tell them who is interested and why.

You can help by sending Jim your thoughts and suggestions. What type of program would you want? What would you like included? What time slot would be most appropriate? Should it be entertaining or educational or both? What mixture of Logo and other languages should be presented? What level of audience should be addressed? Please send your ideas and suggestions to Jim Muller, YPLA, PO Box 855067, Richardson, TX 75085.

Jim Fry, Steve Hodge, and William Beasley have written a set of BASIC programs which convert Logo procedure files on Apple diskettes from LCSII format to MIT format and vice versa. You still have to worry about putting in or taking out the brackets. But you save a lot of time. For a free listing, send a self addressed stamped envelope to Logo File Conversion, NLX, PO Box 5341, Charlottesville, VA 22905. Thanks to Jim, Steve, and William for sharing their work.

At its March 5, 1984 meeting, the Logo User's Group of the Boston Computer Society heard Ilse Schenk speak on "Logo and Visual Thinking." She augmented her presentation with slides and Logo program demonstrations.

As an artist, Ilse tries to find visual models to help people sense and project reality, especially some of the new realities of our technological society. Patterns of energy, energy exchanges, and patterns of motion and change were the topics for the first part of her demonstration.

The wonders shown in her slides are indescribable, but if you have Terrapin or Krell Logo (with PENCOLOR 6 - a reverse pen) you can get the idea by trying this simple SQUIRAL, which has us all mesmerized for many minutes:

```
TO SQUIRAL :SIZE
PENCOLOR 6
FORWARD :SIZE
RIGHT 90
SQUIRAL :SIZE + 3
END
```

Begin it by typing SQUIRAL 3. Ilse calls PENCOLOR 6 the magic pen, because it goes over itself and erases. Black becomes white (or green) and white becomes black. The effect is a visual metaphor for repeating cycles which involves renewal and change as well as symmetry and repetition.

Other procedures she showed used a growing and shrinking turtle to represent pulsation, arcs moving back and forth to suggest pendulum motion, and branching patterns to show economy in nature (honeycombs, snowflakes). One of her theories is that such visualizing can have an organizing effect on the concepts in people's minds.

The core of her message was that images in action can produce reality and stimulate people's imaginations, unlocking a new reality for them. She has used these techniques with the learning disabled, with both adults and kids, and with autistic children at the Cotting School in Boston. She is currently teaching a course at the Museum of Science in Boston on Logo as an Expressive Language.