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This month we depart from our regular Growing Up Literate format for a special comparison of Logos, a topic that should interest educators and parents alike. Next month we will return to our regular format.—EBS

A Comparison of Logos: Today's Turtle Is No Slowpoke

Turtles and mice are the "in" animals in the personal computer field this year. As in nature, microcomputer mice have both supporters and detractors, but almost everyone agrees that turtles are beneficial beasts—on the screen as well as in the stream.

The main role that computerized turtles play these days is in the Logo language, a language that has journeyed from the Artificial Intelligence Lab at MIT where it was developed to the classrooms of the world in just a few years.

The main difference between Logo and other languages is that Logo is intended to encourage learning by using the power of the computer, rather than being designed for writing programs. The child learns what a computer can do while working with familiar concepts from the world around him. The language demonstrates concepts by ignoring them and allowing the user to cause results immediately and understand them later.

The original Logo work done at MIT has evolved, through use, into an effective core language. Two main categories of enhancements, sprites and advanced programming features, distinguish the various current versions of the language from one another.

Since Papert's work was financed with NSF grant money, early versions can be licensed through MIT. Most of the advanced versions of Logo have been developed by Papert's associates at Logo Computer Systems, Inc. (LCSI). Let's have a look at some of the enhancements that have been added by this and other companies.

Sprites and Demons

A sprite is very much like one of Stephen Speilberg's Gremlins. It is something to which you give the initial impetus and which then continues on its own. Fortunately, you can interrupt it from time to time to give it new instructions.

Sprites add to Logo the ability to set events in action and watch the results. The child can define a rule or a series of rules and then sit back and watch them at work.

A demon is an "event" or action that is triggered by a timer, an input device (such as a joystick or paddle), or the collision of two sprites. An example is a procedure in which two trucks travel back and forth across the screen. A cat runs on a path perpendicular to the path of the trucks, and when either truck collides with the cat (don't worry, the cat never seems the worse for the wear), it meows loudly. The trucks and cat are sprites, and the cat's voice is a demon triggered by the collision of the sprites.

Logos that offer sprites are all based on a specific graphic chip, the TI 9918/9928 which was developed by Texas Instruments just for Logo. Therefore, sprites are found only in Logos for the Apple with an add-on sprite board and the Coleco Adam and TI 99/4A which have sprite hardware built in. There is no reason that a sprite Logo could not be developed for a high powered machine like the IBM PC or PCjr, but as yet no one has done it.

Advanced Programming Features

The advanced programming features offered by some versions of Logo can bring the language into the realm of Artificial Intelligence programming previously dominated by Lisp. As a replacement for Lisp, Logo has some advantages because of its clearer syntax

and better support environment.

In addition to the standard list processing features of Logo, Digital Research's Dr. Logo and LCSI's Logo offer good string and variable manipulation capabilities. So far, however, Logo has been used mainly in the lower grades and the real power of these capabilities has been lost on most of the teachers using it. While the physical connection of turtles and sprites is clear, the list processing power of Logo seems to be obscure to many users.

Features to Compare

The basic feature of all Logos is the turtle. In addition, some Logos offer multiple turtles, either as static objects or as sprites. All Logos allow you to change the color of the turtle and its track, and some even allow you to change the shape of the critter.

The programming features of all Logos are based on a procedure called the TO, as in TO SQUARE—to draw a square. The basic language features are loops (REPEAT) and tests (IF). As a Logo becomes more advanced, variables are added using MAKE and then lists with such operators as FIRST, BUTFIRST (all but first), LAST, and BUTLAST. And since lists can contain both words and sublists, the concept of a sentence—a simple list of only words—can be introduced.

The real power of any language is demonstrated in the way it interacts with the machine on which it is running. For Logo, this interaction starts with the color screen and extends to the keyboard and other input devices. The ability to save and print procedures is a requirement for any serious use. Unfortunately, most Logos lack the ability to print the graphic screen.

The other important feature to consider in assessing the sophistication of a Logo is disk operation. Complexity of disk function ranges from simple text "stream" files to full file system access.

The Reviews

In trying to order the following collection of product reviews, I settled on the price of the hardware system as an impartial order that would be of at least casual interest to most users. The result is a mixture of descriptions of Logos of different levels and ages, and should be read accordingly.

TRS-80 Color Logo

As the lowest priced system for which Logo is available, the 16K TRS-80 Color Computer 2, is of more than passing interest to many schools. The cartridge version of Logo for this machine is the basis for a full education-oriented teaching system which includes student, teacher, and parent manuals and a full set of transparencies for use in the classroom.

The package concentrates on the turtle graphics functions of Logo with a couple of interesting twists. Because it is intended for a very small machine and beginning educational use, the package provides a good set of turtle manipulation functions. Going far beyond the single turtle provided by most of its competitors, this Logo offers the sprite-like ability to define up to 255 turtles, each of which can have a different shape and be controlled independently.

An additional feature, which is clearly aimed at very young users, is the doodle mode. In this mode, the child can control the turtle with single keystrokes. The resulting picture can be captured as a Logo procedure and then edited as the child's familiarity with the language increases.

Commands in Color Computer Logo are limited to those that control the motion of the turtle complemented by SEND, MAIL, NEAR, and ME to control multiple turtles. The SHAPE command sets the shape of the turtle.

Users who have peripherals will be glad to note that this Logo reads the paddles and allows procedures (but not graphics) to be printed.

The language as implemented by Tandy has a few minor oddities, the most significant of which is the use of parentheses instead of square brackets in statement lists. This change was made in deference to the Color Computer keyboard, which has no brackets, but it detracts somewhat from the ability to generalize Logo concepts from one system to another.

The language is well complemented with manuals for the student and the teacher. Particularly notable are the Color Logo Guide for Teachers, Book One, and The Color Logo Guide for Parents, Book One. Both books are co-authored by computer education pioneer Bob Albrecht and offer excellent step-by-step pictorial lessons.

Disk Version

The only difference between the cartridge and disk versions of Color Computer Logo is that using the disk is far easier than loading and storing procedures from and to audio tape.

The only drawback to the disk version is that the disk operating system occupies a great deal of memory, so the language cannot be used on a 16K system. The addition of the extended memory option and disk drive changes the nature of the system, removing it from the realm of truly low cost computing.

The Teacher's Package offered by Tandy may be a cost-effective solution for schools that want the convenience of disk access for multiple computers.

A boon to users of the larger 64K Color Computer II would be an advanced version of Logo that has been hinted at by Tandy. Some Tandy watchers speculate that the new version will work with the company's recently released color printers—a delightful thought.

Teacher's Package

The Teacher's Package offered by Tandy may be a cost-effective solution for schools that want the convenience of disk access for multiple computers. The Package is actually a system which uses the Radio Shack Network 2 Controller to connect up to 16 16K Color Computers to one disk drive.

Also included in the package are a teacher's manual, overhead transparencies, and individual student handbooks.

This is a very impressive package, and if the Logo it supported were just a bit more sophisticated, I believe it would capture the hearts of teachers on all levels. As it is, it does an excellent job of supporting the first level Logo class, but falls short for more advanced users.

Coleco Adam

Smart Logo for the Coleco Adam is one of the latest versions of Logo from LCSI and benefits from all this venerable organization has learned about building and packaging Logo systems. It comes on an Adam tape cartridge and begins with a very complete interactive tutorial. The tape also includes demo programs and tools for advanced users.

Smart Logo benefits from an accident of fate which makes it one of the best Logos I have seen. The basic

ColecoVision game machine upon which the Adam is based, uses the TI 9918 graphics chip described above, and just as this chip gives ColecoVision games a great deal of extra pizzazz, so it adds a whole new dimension to the Logo language, including sprites and demons.

Smart Logo is a full implementation of Logo with all of the functions described in the introductory section of this article. Its only faults can be attributed to the fact that the Adam is a 64K Z80 system that suffers from the basic memory and speed limitations of an 8-bit processor, limitations that will escape the notice of all but the most ardent and advanced programmer.

For graphics and sound, this Logo offers support of the Adam game controllers and a set of functions to control the four-channel sound generator built in to the computer. Procedures and graphics can be saved, but only procedures can be printed on the character printer.

The Coleco system uses tape cartridges for storage, and although it does take two minutes to get the system up and running, the matter turns out to be of little concern because the tape is accessed only rarely. My only real complaint about the tape system is that the command SAVE can not be used to replace an old file nor to create a backup.

The various Apple versions of the language have been the driving force behind the widespread acceptance of Logo in the educational community.

In my test situation, this meant that children had to be taught about backup filenames and deletion of old files, a process that lead to lost files and some tears before it was understood.

The disk drive, which Coleco has promised for the fourth quarter of 1984, will support all the functions now available with the tape drive at considerably improved speed.

The manual is a small format looseleaf binder. It includes a tutorial section and a reference section that provides detailed examples and a good index. At the back of the manual are a reference card and an errata sheet.

Apple II+, IIe, and IIc

Even though the original work on Logo for microcomputers was done on the TI 99/4A, the various Apple versions of the language have been the driving force behind the widespread acceptance of Logo in the educational community. Logo was first implemented on the Apple through an NSF grant at MIT, and MIT has since licensed the software and manual to two suppliers, Terrapin and Krell. Both companies offer basically the same Logo with vastly different levels of documentation and

support for their customers.

In addition, the version of Logo developed by LCSI for the Apple and Atari computers has been adopted as the official Apple version and has been enhanced, resulting in two more versions—one with an add-on hardware board for sprites.

MIT Logo

MIT Logo is a combination of turtle graphics functions and list processing functions. The turtle uses an Apple shape table and so may be changed by more sophisticated users.

Other features of the Apple that lend themselves to Logo are the Apple graphics screen which offers six colors and a nice work area for the turtle, and the disk drive which can be used to save procedures and pictures, either of which can be printed in black and white.

The MIT version of Logo has a full set of statements for turtle graphics and procedure writing. There are also list and sentence processing operations and the ability to add assembler primitives.

The screen editor works smoothly except for the problem of square brackets for enclosing lists on older computers. Like the Color Computer, the Apple II and II+ lack brackets on the keyboard, and to get them on the screen, you must press Shift-N and Shift-M, which can be a bit awkward. The problem does not exist on the Apple IIe and IIc, both of which have square brackets on the keyboard.

You can interact with MIT Logo procedures by using primitives for either the keyboard or the game paddles.

Utilities included with MIT Logo can aid the beginning programmer with examples and provide the advanced programmer with an assembler that saves 6502 machine code directly. The exact set of utilities varies with the supplier; however, both include the assembler and sample programs like Rocket, the game of Animal, a single key doodle mode called Instant, the music interface to the Apple speaker, and a general file utility.

Terrapin has enhanced both the usefulness and the friendliness of MIT Logo with a complete user tutorial and two unusual peripherals for its language.

Krell Logo

Krell Logo is the original MIT Logo with some interesting but not very significant additions. Included in the package is a wall chart that is useful for experienced programmers but can be confusing for the beginner.

The introduction of the language is handled in a disk called Alice in LogoLand. The package is a good introduction, but has some awkward features that make it less effective. The documentation itself is a reprint of the original MIT technical manual and is a bit of a hodge-podge.

In sum, the Krell package is reminiscent of the state of the art in 1981 when it was first released. The intention is good, but it comes off poorly. The main advantage of this package is the backup copy of the boot disk that comes with the original.

Terrapin Logo

The Terrapin version of MIT Logo is a considerably more advanced product than the Krell version. Terrapin has enhanced both the usefulness and the friendliness of MIT Logo with a complete user tutorial and two unusual peripherals for its language.

The first peripheral, the Terrapin robot turtle, is a mechanical turtle that can be controlled using Logo commands just as the graphic turtle can. It is fascinating to experiment with a three-dimensional object under program control. Unfortunately, the $300 price tag tends to keep the turtle out of the hands of most children.

The second peripheral offered in conjunction with Terrapin Logo is the Micro Mint Sprite Board, the first attempt to make sprite graphics available on the Apple. While the attempt is less than completely successful, it does demonstrate what can be done with sprites on the Apple. The main problem with the system is that it requires two monitors—one for the video from the Apple and one for the video from the sprite graphics processor. For the hobbyist or experimenter, the product is challenging and fun to use; for the classroom, it is just doesn't make it.

Apple Logos from LCSI

Apple Logo—The Original

The LCSI Logo that became the official Logo for the Apple is a smoother language than either of the two versions

of MIT Logo. The package comes with a reference manual and a tutorial that are as good as or better than the best parts of both the Terrapin and Krell versions.

The LCSI language lacks some of the more interesting features of the MIT version, including the ability to save pictures to disk, and call assembler routines. Also lacking is the utility disk. These are all features that are of use primarily to the advanced user.

On the other hand, LCSI has added some features that will be welcomed by users who plan to write lessons in the language. These include cleaner syntax for logical operators like AND/OR, packages and buried packages, property lists, and error THROWing and CATCHing.

Apple Logo II

Logo is not a static or stagnant language, and LCSI continues to enhance and improve it. The latest official Apple Logo offers a revised set of manuals and a set of file operations (called primitives) that allow it to be used with ProDOS on a 128K Apple IIe or IIc. The only problem I observed was that a system this large begins to tax the speed of the Apple disk drives when loading initially or using the disk heavily. With a hard disk, of course, this problem vanishes.

The new, improved Apple Logo from LCSI is excellent for beginners and more than adequate for advanced AI applications.

A second improved version of Logo from LCSI comes with a sprite board that can be used with the Apple II + and IIe. Since the language itself was designed to take advantage of the sprite board, all graphics and text appear on the same video display.

The package includes extensive examples that demonstrate how to control sprites and redefine the shapes of existing characters. The only function not provided by the TI 9918 chip on the add-on board is the use of demons. There are, however, similar functions that test for collisions between turtles and/or sprites.

IBM PC

As with every other category of software, the market presence of IBM has inspired a large assortment of Logo packages for that machine. The graphics capability of the PC ensures that all versions score well in that area. Much to my surprise, however, none of the available Logos for the IBM offers sprites, even though the 8088 processor can support them through software. Instead, the PC Logos have concentrated on advanced programming features.

IBM Logo

As the official IBM Logo, this LCSI package is matched only by its sister product for the Apple. It features both a complete manual with reference and tutorial sections and the most complete language available.

As mentioned above, this Logo lacks sprites, but its full file system access makes it the implementation of choice for advanced users in both AI and teaching situations. For beginning users, the only drawback—and it is a small one—is the depth of the supplied example material.

The language is all there; it is hard to say more without being repetitious. All the turtle graphics commands are supported as are the programming and list processing features. Graphics are supported by the standard IBM hardware without low level access, and hackers will appreciate an assembler call facility that resembles Basic.

The only feature that advanced programmers will miss is subdirectory support, a lack attributable to the fact that IBM Logo is not yet available in a DOS 2.0 version.

Despite the fact that it is an official IBM product, I had difficulty obtaining a copy of IBM Logo. So if your local store denies all knowledge of the product, persevere; it does exist and is well worth the effort once you find it.

PC Logo

PC Logo from Harvard Associates is a good version of a turtle graphics Logo with all the extended features needed for advanced programming. The package makes good use of the PC function keys and is well adapted for the IBM machine.

Extra primitives allow for very simple and complete control over the PC screen and other hardware devices. Again, hackers will appreciate direct access to PC DOS and the BIOS ROM as well as many other low level features. The only thing missing is an assembler call.

At the same time, PC Logo can be used with ease by a child or relatively inexperienced grade school teacher.

The manual has an easy to read tutorial and a complete reference section packed in an IBM-sized binder. A good set of examples is included on the disk, and a reference card completes the package.

Harvard Associates offers a complete Logo package to schools, which includes a volume licensing plan and price incentive.

PC Logo from Harvard Associates is a good version of a turtle graphics Logo with all the extended features needed for advanced programming.

Not part of the package, but a peripheral that schools should consider buying is the Turtle Tot, a robot turtle that accepts its commands from PC Logo. Also available for the Apple, the device is a favorite among children of all ages.

Waterloo Logo

The University of Waterloo, long known for such favorites of computer science majors as the WatFor and WatFive fast Fortran compilers, has lately been working on a set of microcomputer tools, including a networking system and a language set to complement it. With this background, it is easy to understand the role of Waterloo Logo, an implementation that would probably not survive on its own.

The package is well done, but terse. It includes a reference card and a manual "written for people who already have programming experience using a high level language."

The language as implemented here is a good basic Logo system which is well adapted for the IBM PC, but as a competitive product it just cannot hold its own.

LadyBug Logo

One of the most impressive Logos for the PC is impressive not because of its fancy packaging or its great manual or even its fantastic features. It has no packaging; its manual is only fair; and its features are complete, but not fantastic. No, the package is impressive because of its price: it is free.

LadyBug Logo is freeware, and unfortunately, while people seem willing to pay $35 for a copy of PC-Talk, PC-Write, or PC-File, they are reluctant to pay for an educational package. Dave Smith, the author of LadyBug Logo, re-

quested that users make a donation toward further development work. Sadly, he reports that barely 1% of the 500 people to whom he has sent copies have sent him any money. I promised him I would challenge the readers of *Creative Computing* to prove that educational freeware can pay. Copies are available from the Young People's Logo Association and on many PC bulletin boards.

As for the language, itself, it is a full turtle graphics language with disk procedure storage and a good set of examples. The 84-page manual is on disk and includes a good index.

Special features of this version of Logo are a PLAY function for music, access to joysticks, and a full screen procedure editor. Running under DOS 2.0, the language allows graphics screens to be printed and just fits on the PCjr.

For advanced users, there is a good debugging mode, but the package is slow—about half as fast as most of the other PC Logos—even though it is written in compiled Basic.

Logo for Other Computers

In addition to the products discussed above, there are also Logos for the TI 99/4A, Commodore 64, and Atari computers. Computers for which versions of Logo will soon be released include the DEC Professional, Macintosh, Sanyo MB550, and TI Professional.

Logo for the Future

I predict that we will continue to see enhanced and improved versions of Logo. Most will come from LCSI, which has established itself as the main supplier of the language and has used its relationship with Seymour Papert to enhance the language and encourage educational programs to use it.

I have even seen some evidence that disk versions of Logo are being aimed at a wider audience than just the parents, teachers, and children who make up the education market. It should be interesting to watch the language at work in AI applications that have heretofore been the province of Lisp, a language that is much more difficult to use and understand. Who knows? We may yet see business applications done in Logo.

Logo is definitely one of today's most popular languages for use in computer education—and rightly so. It is a language that allows the child's (and adult's) natural ingenuity to trigger learning without effort. What could better educational tool could there be? ■

Suppliers of Logo

TRS-80 Color Computer

Color Logo Disk version $ 99
Color Logo Cartridge Pak 50
Color Logo Teaching Lab 199
Available at Radio Shack stores

CIRCLE **420** ON READER SERVICE CARD

Coleco Adam

Smart Logo 80
Coleco Industries
999 Quaker Ln. South
Hartford, CT 94086
(203) 725-6000

CIRCLE **421** ON READER SERVICE CARD

Apple

Apple Logo (for Apple II) 100
Apple Logo II (for Apple 128K IIe/IIc) 100
Apple Computer
20525 Mariani Ave.
Cupertino, CA 95014
(800) 538-9696

CIRCLE **422** ON READER SERVICE CARD

Apple Sprite Logo 299
Logo Computer Systems Inc.
220 Fifth Ave., Suite 1604
New York, NY 10001
(212) 684-0710

CIRCLE **423** ON READER SERVICE CARD

Terrapin Logo 99
Terrapin Turtle 299
Terrapin, Inc.
380 Green St.
Cambridge, MA 02139
(617) 492-8816

CIRCLE **424** ON READER SERVICE CARD

Krell Logo 99
Krell Software Corp.
1320 Stony Brook Rd.
Stony Brook, NY 11790
(516) 751-5139

CIRCLE **425** ON READER SERVICE CARD

IBM PC

IBM Logo (6026076) 175
IBM
Personal Computer Division
P.O. Box 1328
Boca Raton, FL 33432
(800) 447-4700

CIRCLE **426** ON READER SERVICE CARD

PC Logo 125
Turtle Tot Robot 299
Harvard Associates
260 Beacon St.
Somerville, MA 02143
(617) 492-2999

CIRCLE **427** ON READER SERVICE CARD

Waterloo Logo 125
Waterloo Microsystems, Inc.
175 Columbia St. West
Waterloo, ON
Canada N2L 5Z5
(519) 884-3141

CIRCLE **428** ON READER SERVICE CARD

Ladybug Logo Free
Young People's Logo Assoc.
1208 Hillsdale
Richardson, TX 75081
(214) 783-7548

CIRCLE **429** ON READER SERVICE CARD

User's Groups and Journals

Friends of the Turtle
Box 1317
Los Altos, CA 94022

Friends of Lisp, Logo and Kids
436 Arballo Dr.
San Francisco, CA 94231

Logo and Education Computing Journal
Krell Software Co.
1320 Stony Brook Rd.
Stony Brook, NY 11790

Logophile
College of Education
MacArther Hall
Queen's University
Kingston, Ontario K7L 3N6

MIT Logo Group
545 Technology Square
Cambridge, MA 02139
(This group is associated with Papert.)

The National Logo Exchange
Posy Publications
Box 5341
Charlottesville, VA 22905

Young People's Logo Assoc.
1208 Hillsdale
Richardson, TX 75081
(offers a book listing all Logo Resources)