Logo *Update* The Logo Foundation Newsletter ▲ Volume 5, Number 2 – Winter 1997

In This Issue

In the previous issue of Logo *Update* Celia Hoyles and Richard Noss wrote about using Logo with bank employees. ("Understanding the Mathematics of Banking" Logo *Update* Vol. 5 No. 1, Fall 1996.) In this issue, José Valente discusses the use of Logo in another non-school setting, a factory. He argues that the "Logo aesthetic" works with adults as well as with children.

Valente is explicit about what Hoyles and Noss suggest: Schools have failed to educate people in a way that leads them to have an understanding of what they do. He asks whether or not such understanding is necessary for productivity in today's job market.

There has been a recent flurry of new Logo products, both software and books. Look at "What's New?" on page 12, and the list of items available from the Logo Foundation on page 14.

Finally, it's time to make arrangements for summer professional development activities. The center insert of this Logo *Update* gives you full information about the Logo Foundation's Summer Institutes in New York, Colorado, and Minnesota. Other summer events include The Stonington Retreat (see page 7), and Eurologo '97 (see page 12.)

Also, look at the back page for information about Logosium '97 in Seattle. This annual gathering is sponsored by the Logo Foundation and ISTE's LogoSIG as a NECC pre-conference activity.

I hope to see you at one or more of these very worthwhile summer Logo events.

Michael Tempel

LEGO Logo in a Lean Factory

by José Armando Valente

To what extent is "training, in the traditional sense appropriate in a lean factory where workers accomplish tasks but do not understand what they do? What do workers on an automated assembly line comprehend about the concepts of automation? Is such knowledge necessary to increase productivity?

The distinction between being able to do things with success (*savoir faire*) and the comprehension of what is achieved is presented by Piaget (1974). He observed that a child can do complex actions successfully without necessarily comprehending all the concepts involved in the activity. This can also occur with adults.

Comprehension is particularly necessary if we want people to be completely involved in what they are doing, a level of involvement which is required in a lean factory.

The term "lean production" was used by Womack, Jones, and Roos (1990) to refer to a production process with no waste of energy, materials, stock, or human effort. Lean production is one production paradigm. The first was craft production, followed by mass production, and more recently, by lean production.

Lean production is an attempt to solve some of the excesses identified in mass production. It produces only what the consumers want, the defects are identified during the production process rather than at the end of the assembly line, and production processes are constantly improved in order to eliminate excesses of time, labor, materials, and supervision. The whole production chain is aware of the need to eliminate waste, thus the term "lean production."

Mass production allowed more people to have access to less expensive products than was possible with craft production. But this was accomplished at the expense of product quality and the economy of human and material

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José Valente, seated, in a LEGO Logo workshop with workers from the Delphi-Harrison factory in Piracicaba, São Paulo, Brazil.

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LEGO Logo in a Lean Factory

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resources. As a result of the expansion of the mass production system, the level of waste – material and human – has reached massive proportions.

An alternative production system must be adopted if democratic access to goods and services is to continue. Lean production is a possible solution. However, it demands several changes that have been hard to incorporate into our society. Production will need fewer, but more highly skilled workers. These workers must be capable of creating solutions for the problems that emerge during the production process. They need to be constantly thinking, involved, and understanding what they are doing. They no longer can be robots following orders from superiors. Rather, they need to be part of the production process so they can improve it, find bugs in the product being assembled, and be constantly thinking about how to eliminate waste of all kinds.

Schools today are not able to prepare professionals with the competencies that are required in the lean factory. Eventually schools will be able to catch up with the production system as they did in the shift from an education system based upon mentors – typical of the craft paradigm – to the mass education we have today – typical of the mass production paradigm. Meanwhile, during the transition period we have to provide workers with some kind of training that will allow them to acquire the competencies necessary to be able to function according to the lean paradigm (Mazzone, 1993).

With this challenge in mind, in 1993, the Nucleus of Informatics Applied to Education of the State University of Campinas – NIED/UNICAMP – began to investigate the new industrial processes and the state of learning in industry. In these studies one of the subjects under discussion was the possibility of using the "Logo aesthetic" in the training of industrial personnel.

The Logo Aesthetic and Its Application to Industry

The Logo aesthetic consists of learning through the process of "teaching" the computer how to solve a particular problem. This activity requires someone to describe a problem solution through a computer programming language – in this case, Logo – reflect upon the results presented by the computer, and to debug the original ideas (Valente, 1995). Learning occurs during the debugging process.

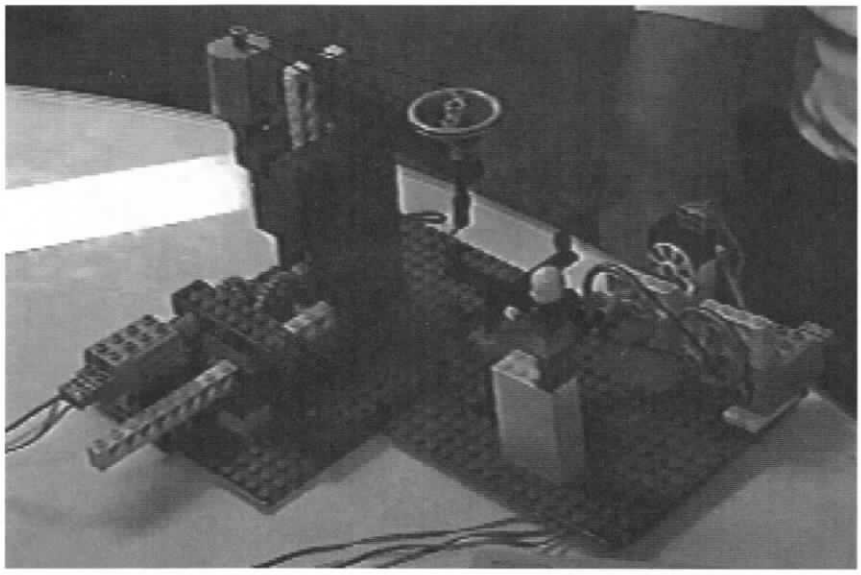
The Logo aesthetic has been used in educational research projects and schools. Our discussions with executives and businessmen alerted us to the possibility that companies, like schools, could benefit from a training program based on the Logo aesthetic.

The Logo aesthetic facilitates the acquisition of concepts involved in the problem being solved as well as the acquisition of lean production concepts more generally. In the process of describing, reflecting, and debugging, the users can exercise their creativity (selecting problems and problem solutions) pull out the information needed (just-in-time knowledge) be critical about the results presented by the computer, and develop debugging strategies for improving their ideas and actions. Thus, in the Logo computer-based learning environment users acquire lean production ideas because they have a chance to experience them rather than be instructed about them.

We realized that the methodology, processes, and especially the Logo aesthetic, that were already being used by NIED in schools, might be adapted for use in industry. The creation of learning environments in the factory using the Logo aesthetic should not be restricted to the Logo language as it is used in schools today. We decided to propose approaches such as LEGO-Logo which are more closely related to the activities in industry, and to develop other software that has the characteristics which facilitate the Logo aesthetic's cycle of description, reflection, and debugging.

The Logo aesthetic approach was introduced at Delphi-Harrison, a division of General Motors Corporation that produces radiators and air conditioners for GM cars as well as for other car companies. It is a small factory with 75 workers located in Piracicaba, São Paulo. This company was recently set up using the lean production approach, with a new general manager who was very involved with these ideas and was receptive to the research proposal. We also found the workers on the floor to be young, interested, and open to new ideas. LEGO-Logo and the Target Game, a program developed to explore concepts about statistical control processes (Fernandes et al, 1996) are currently in use by the workers. Enxuto (the Portuguese word for "lean") a manufacturing modeling and simulation program (Borges et al, 1995) and Jonas, an expert system for supporting training in the manufacturing process (Borges et al, 1995) are in the process of being adapted to real factory situations.

The aim of these programs is to help factory workers comprehend concepts they already use. With the software the user can build a model of a phenomenon, propose an experiment, execute the experiment, and observe



A LEGO Logo model of an automated soldering machine

and analyze the result. Based on the observed results, the user can make adjustments in the model and re-execute it, continuing the cycle of actions until the concept involved in the activity being developed is more fully comprehended . The use of the software also helps to emphasize the development of "lean production" concepts, such as productivity, pull production, zero defects, continuous improvement, and elimination of waste. In this article I describe only the LEGO-Logo part of the project.

Lego-Logo at Delphi-Harrison

LEGO-Logo was introduced to Delphi-Harrison workers through a two-day workshop at the company facility. Two LEGO-Logo stations were set up in a room at the factory floor. João Vilhete, a NIED researcher in charge of the LEGO-Logo activities in schools, and I functioned as facilitators in the workshops. Two participants were from quality control, two from engineering, four from the automated assembly line, and eight from the equipment maintenance section. Each session took four hours and we worked with four people at a time.

First we showed a device that we built with LEGO-Logo and talked about how it was constructed and how it worked. Following this brief demonstration we showed the LEGO parts, the interface and the Logo commands used. Next we asked the group to construct a LEGO-Logo device. In general the group would describe an idea for a device and we would help them to reach a final proposal of something that could be constructed in four hours and that was meaningful to them. Finally there was a reflec-

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LEGO Logo in a Lean Factory

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tion about the constructed device in which we raised issues such as safety and production improvement. We discussed whether or not such a device could be implemented on the factory floor.

Among the machines they built were a safety control system for a clinch machine, a press, two soldering systems, two carts, and a conveyor belt. One of the groups, consisting of workers who were in charge of implementing automated processes in the factory, used Logo to define the behavior of a washing machine that we had already constructed with LEGO. This task was very similar to what they do in the factory using a different computer language. Our objective was to observe how they would approach the automation task and how Logo would compare to the computer language they used.

All the devices the workers built had some connection to the actual work the group performed on the factory floor. The devices built could be divided into two categories: those that would improve the work they performed, such as carts and the soldering systems; and those that would allow the group to understand how a particular mechanism worked, such as the presses and the safety control system. For example:

- The carts were devices used to transport parts to the assembly line. The existing carts were moved by hand. The LEGO-Logo carts were controlled by a light sensor in one case and a touch sensor in another.

- The soldering devices suggested an automated soldering system to replace the current manual method. One device consisted of a system to hold a part to be soldered, and the soldering tool that would come down, touch the part for a while (simulating the soldering time) and then return to the original position. A second soldering device had a circular platform which held four parts. The platform would turn 90 degrees, positioning the next part to be soldered. The soldering tool would come down, touch the part for a while and come up. The platform would turn 90 degrees, repeating the soldering process.

- The safety control device for the clinch machine was constructed by two workers who usde the existing machine. It had a safety system that stopped the machine if their hands entered the danger zone. The group wanted to understand how this control system worked. Their device had a motor turning a rotor (simulating the clinch machine) that would stop if something crossed in front of a light sensor.

- The conveyor belt and the presses were implementations of systems that existed on the factory floor. The idea was to build equivalent LEGO-Logo models. The conveyor belt would start its movement when

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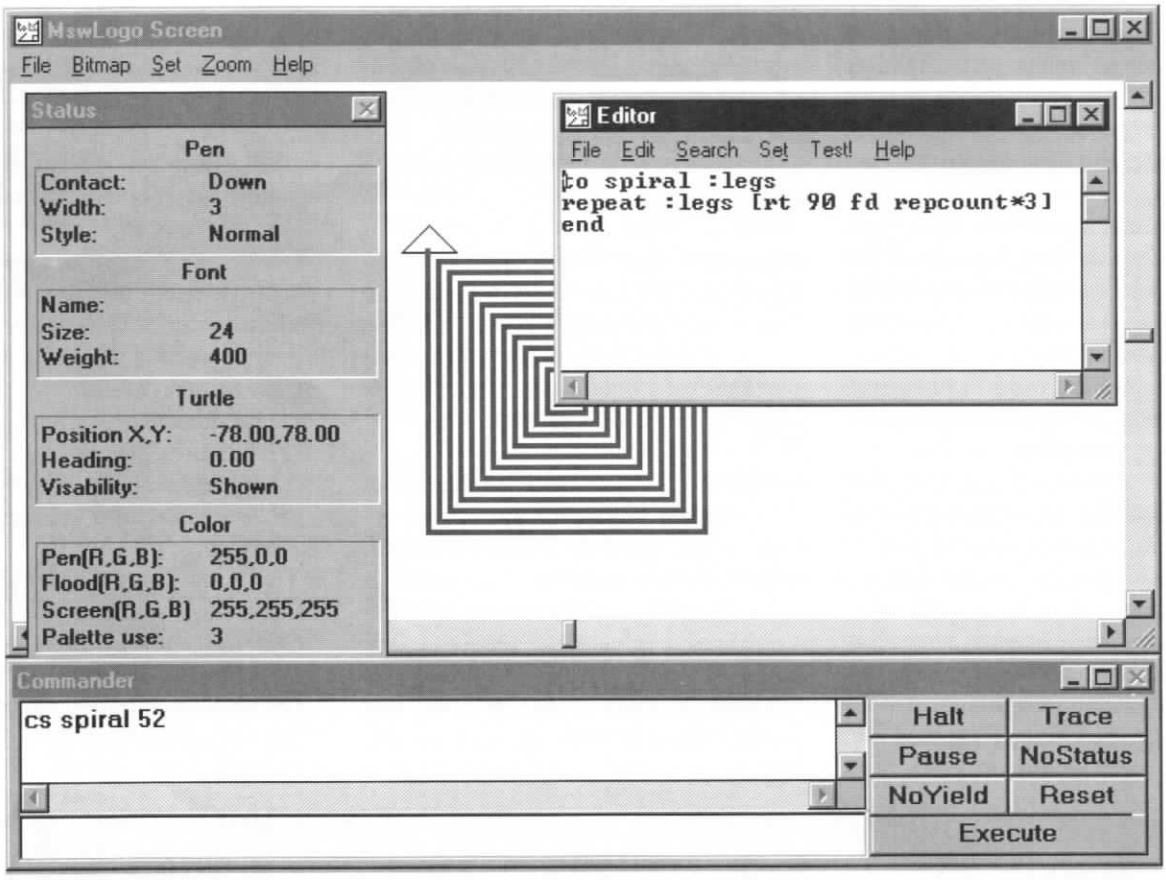
MSWLogo Version 5.2



- Students can learn event driven programming to prepare them for the real world of programming (Visual Basic, Delphi, Java, Visual C++).
- Use the power of Brian Harvey's 2nd Generation Logo Interpreter Engine (including Tail Recursion, Arrays, Error Handling and Variable Number Arguments).
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a LEGO brick was placed in front of a light sensor positioned at the beginning of the belt. As this brick passed in front of a second sensor placed at the end of the belt, it would stop. The press had a motor moving the pressing tool up and down and a conveyor belt that moved the object into position to be pressed. The movement of the pressing system was very precisely controlled by several counting disks.

The groups built the devices and then defined the Logo procedures to control their behavior. The construction of the LEGO devices was very straightforward. The workers were familiar with all the mechanical parts and their function and thus, were able to build sophisticated devices in a short period of time. Problems arose when they had to describe the devices' behaviors. In the beginning we thought this was related to the fact that they were not familiar with Logo or even with the idea of programming. We decided to ask the group to write down how they would like the machine to operate. We found that their descriptions were also not very clear. We worked with the participants in order to debug their descriptions. Once these were clarified, it became easy to define the corresponding Logo procedures. Later we found out that the ability to describe processes was a highly desired skill in modern factories. In order for a factory to get the Quality Standard (a quality procedure validated by the International Standard Organization) it was necessary to describe and document all the processes used.

The LEGO-Logo activities allowed us to discuss several concepts of physics, engineering, mathematics, design, and automation, confirming the observations made by Resnick and Ocko (1991). The automation concepts were of particular interest, especially for the workers who operate automated processes. These workers knew how to work with automation, but the principles behind these processes might not have been clear. For example, the group that built the safety control device for the clinch machine operated an automatic system, but the workers did not know what was involved in making the machine stop if their hands moved into the danger zone. After this system was constructed, and the concept involved was made explicit and accessible, it was easy for the group to think about other safety systems that could be installed on their clinch machine. Also the group observed that after this experience they would be able to communicate much better with the equipment maintenance people and to discuss with them possible safety solutions and how to implement safety control devices.

The LEGO-Logo activities also allowed us to discuss the lean ideas with the participants of the workshop. We pointed out to them that in order to get the constructed devices to produce a desired behavior they used the Logo aesthetic cycle: create the mechanism and procedures, observe their behavior, and then criticize and debug them in terms of concepts and strategies used. As I mentioned before, some of the lean concepts were imbedded in this cycle, such as continuous improvement, just in time knowledge, solving problems under demand, and teamwork. These concepts were not just talked about. The workers used them while constructing their LEGO-Logo devices.

With respect to the interactions among the group members it was clear who were the planners and who were the executors. The difference in working styles was another subject of our discussion. Being explicit about the way the group worked and the role of each participant helped the workers to understand more about their ways of doing things and how they operated on the factory floor.

This workshop showed that LEGO-Logo could be used to set up an effective training program for factory workers. It can help to improve process description, acquisition of concepts involved in everyday activity, and exploration of other concepts that were very important, but often difficult to address as they came up in a real production line. LEGO-Logo creates a learning environment simi-

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lar to the factory floor with the advantage that we can stop the activity and talk about the concepts without interrupting the production process.

Implementation of a Training Program in the Factory

Based on the results of the workshop, it was decided to establish an ongoing training program in the factory using LEGO-Logo. A team of two workers was formed. They learned about LEGO-Logo and about how to use it with their colleagues. The training team, by knowing LEGO-Logo, the concepts involved, and the factory problems, is functioning as a bridge between the learning environment and the factory situation. This is helping their colleagues to learn concepts and how to apply them, not only in the LEGO-Logo context, but in situations that arise in the factory as well.

This training program is just now being implemented. We trained the training team and they have had the opportunity to work with two groups of colleagues so far. This gave us an opportunity to debug the team methodology. We hope that in the next few months additional workers will be able to join the training program and show the real impact of this program in actual job performance. We want to understand whether comprehension of what is involved in their part of the production process will increase productivity in the factory, or whether *savoir faire* is sufficient in a lean factory. ▲

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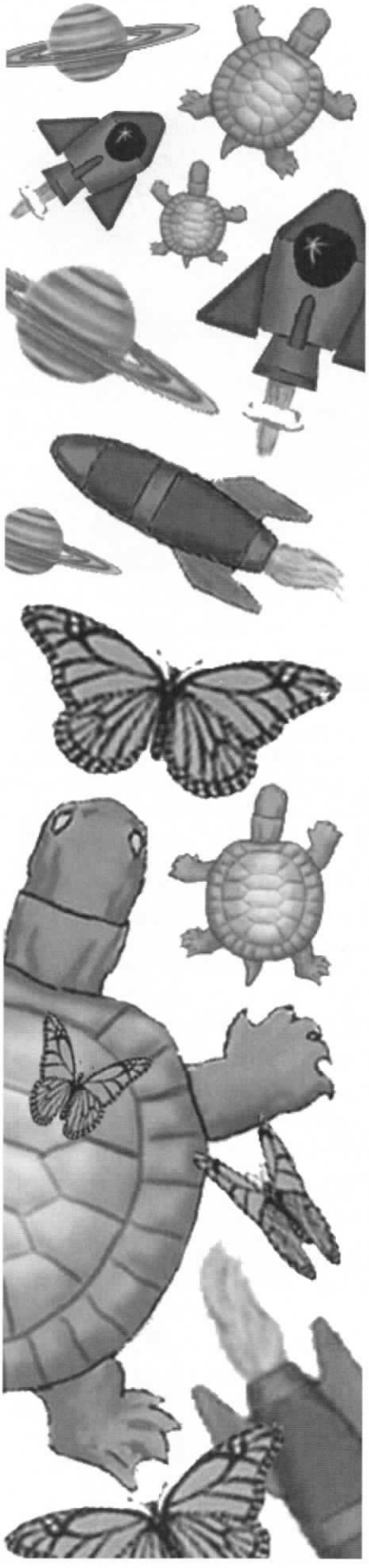

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What's New?

Logo software, books, and events

There have been a number of recent Logo software releases, especially for Windows. LCSI has announced **MicroWorlds 2.0 for Windows95**. See the ad on page 9 and a special discount offer on page 14.

Mach Turtles Logo 2.0 for Windows95 improves upon the original version 1.0 Look at the ad on page 10 and then turn to page 14 to order.

The public domain versions of Logo are constantly being updated. **UCBLogo** version 3.6 is the latest, available for Macintosh, DOS, Windows, and UNIX. The most recent **MSWLogo**, described on page 6, is version 5.2. Downloading and ordering instructions for both these Logos are on page 14.

LogoWriterWIN, an enhanced version of LogoWriter for Windows is now available from Logo Japan (http://www.logo.co.jp/, fax: 81 3 3593 6587.)

Terrapin Software has just published **Logo: Models and Methods for Problem Solving**, by William J. Spezeski. Find out more about this book on page 13 and then turn to page 14 for ordering information.

There are two new Logo releases from MIT Press. Mitchel Resnick's **Turtles, Termites, and Traffic Jams** has just been issued in paperback. Brian Harvey's classic trilogy **Computer Science Logo Style** has been reissued. The new Second Edition is also three volumes, but is rewritten and reorganized. Ordering information is on page 14.

There's a new book out by Richard Noss and Celia Hoyles, author's of *Understanding the Mathematics of Banking*, which appeared in the Fall 1996 Logo Update. **Windows on Mathematical Meanings: Learning Cultures and Computers** is published by Kluwer Academic Press.

The Logo Foundation is sponsoring three **Logo Summer Institutes** this coming June, July, and August in New York City; Grand Junction, Colorado; and St. Paul Minnesota. A special insert in the middle of this issue of Logo *Update* gives all the details. Registration is on a first come first served basis, so act now.

There will be another **Stonington Retreat** in Maine in June. See the ad on page 7.

Eurologo'97 will be held in Budapest, Hungary August 20-23, 1997. For more information contact:
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Logosium '97 will be held at the John Hay School in Seattle, Washington on June 29, as a NECC preconference activity. Look at the Call for Participation on the back cover of this issue of Logo *Update*.

LOGO
Models and Methods for Problem Solving

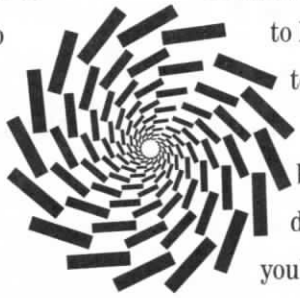
BY WILLIAM J. SPEZESKI
Associate Professor at North Adams State College, Massachusetts

Explore the world of fractals, design colorful string art, program stunning spirals and butterfly curves, develop a challenging dartboard game, create animation effects. These are only a few of the fun and challenging activities that are offered in this new book

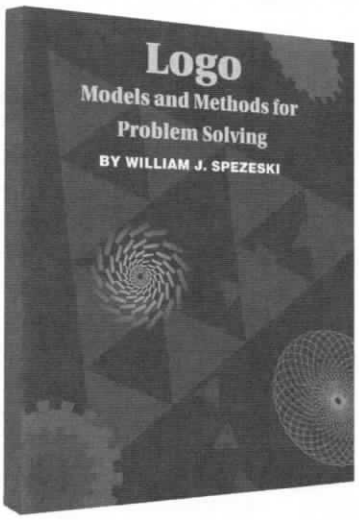
This fun approach to Logo uses a myriad of graphical activities to teach Logo and problem solving skills. Each chapter poses a variety of challenges, offers helpful tools, suggests enhancements, and exposes students to powerful problem solving strategies.

Both instructional and inspirational, *Logo: Models and Methods for Problem Solving* shows what can be done with Logo by providing specific examples and interesting demonstrations. Geared toward the novice and intermediate Logo user, the text is a springboard for developing a greater appreciation of Logo, for exploring new ideas, and for moving on to greater challenges.

High school and college students can use this book simply to have fun with the computer, or at a higher level, to learn programming techniques.



The focus of the book is "What can you do with Logo?" Here you'll find out, through interactive computer games, elegant geometric designs, eye-catching animations, detailed examples, and over 200 illustrations. See what fun you can have with Logo!



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Software and Books

Many of the items listed here are described elsewhere in this issue of Logo *Update*. Turn to the pages indicated for more information about these products.

Discount Prices

The Logo Foundation now offers commercial Logo software at below retail rates. The prices shown here reflect these discounts. Discounts are also available on lab packs and site licenses. Please contact us for current prices.

Even larger discounts apply when software is purchased by participants in Logo Foundation workshops and Summer Institutes, such as those described in the center insert of this issue of Logo *Update*, and in conjunction with workshops we conduct in your school or district. Contact us for details.

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MicroWorlds 2.0 (see page 9)

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Crystal Rain Forest (see page 5)

Macintosh	MSDOS		
LSCRM	LSCRD	Single Copy	$45.00
LSCRMS	LSCRDS	School Edition	$55.00

Ask about discount prices for Site Licenses.

UCBLogo may be downloaded for free from
http://http.cs.berkeley.edu/~bh/
If you can't get it that way, you may order it here.

Macintosh	MSDOS	
LSUCBM	LSUCBD	$10.00

MSWLogo is described on page 6. You may download it for free from
http://www.softronix.com/
If you can't get it that way, you may order it here.
LSMSW $10.00

Books:

Logo Models and Methods for Problem Solving
by William J. Spezeski
new
Turn to page 13 for a detailed description of this rich collection of Logo activities for high school and college students.
LB117 $49.95

Computer Science Logo Style *Second Edition*
by Brian Harvey
new
The best tutorial available for learning Logo has just been rewritten and reorganized. It's a good companion to UCBLogo and MSWLogo. See page 12.
Volume 1: Symbolic Computing
LB144 $35.00
Volume 2: Projects, Styles, and Techniques
LB145 $35.00
Volume 3: Beyond Programming
LB146 $35.00
The Complete Three Volume Set
LB143 $85.00

Turtles, Termites, and Traffic Jams
by Mitchel Resnick
The book about StarLogo is now available in paperback
new
LB116P $12.50 (paperback)
LB116 $24.95 (hard cover)

StarLogo may be downloaded for free from
http://el.www.media.mit.edu/groups/el/projects/starlogo/
If you can't get it that way, you may order it here.
LSSL $10.00

Roamer
Look at the description of this creature on page 11.
LROAM $279.00

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   The rest of the World: Inquire before ordering, stating whether you want us to ship by air or by sea.
   Rush Orders: We can ship overnight or second day delivery. Inquire about costs before ordering.
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New York NY 10024

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Purchase orders and inquiries may be faxed.
telephone: 212 579 8028 **fax: 212 579 8013**
http://el.www.media.mit.edu/groups/logo-foundation/

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Information and registration materials for the Logo Summer Institutes:
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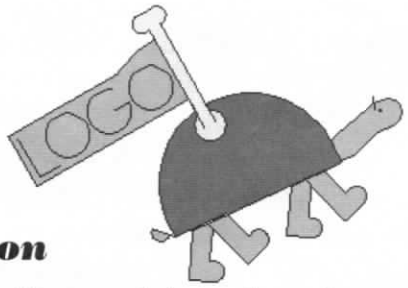
Logosium '97

John Hay School
Seattle, Washington
Sunday, June 29, 1997



Call for Participation

The fourth annual Logosium will be a day of Logo workshops, discussions, and presentations. Once again this year, Logosium will include sessions conducted by students sharing their projects with other students and with adults.

Sessions may be one-hour presentations or panel discussions, or three-hour hands-on workshops, on any topic of interest to the Logo community. If you wish to offer a session, send a one-page description to:

Marian Rosen & Michael Tempel
c/o Logo Foundation
250 West 85th Street
New York, NY 10024
Telephone: 212 579 8028 Fax: 212 579 8013
e-mail: mbrosen@icon.stl.net michaelt@media.mit.edu
The deadline for submissions is April 15, 1997.

Registration: Adults (including presenters): $55.00
Children under 18: $6.00

For NECC registration, including Logosium, and hotel information contact:
NECC '97
1244 Walnut Street
Eugene, OR 97403
Telephone: 800 280 6218 or 541 346 283 Fax: 541 346 2565
e-mail: necc@oregon.uoregon.edu
Web: http://www.neca.uoregon.edu

Logosium is a NECC '97 pre-conference activity sponsored by the Logo Foundation and ISTE's SIG Logo.

LOGO USERS GROUPS

Long Island Logo Users Group
Contact: Marilyn Tahl
516 333-4018 (evenings)
516 627-8110 (days)

Los Angeles Logo Users Group
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Country School
5243 Laurel Canyon Blvd.
North Hollywood, CA 91607
818 769-2473

Logo Anonymous
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