LOGO WORKING PAPER # 9

April 20, 1973

Cognitive Development In People and Other Machines

In recent weeks various misunderstandings have been evidenced concerning the philosophy and goals of the LOGO Project. Consequently, I have prepared the following statement which I trust will clear up any confusion about this matter.

Admiral Turtle

The LOGO Project has as its explicit goal the creation of a total alternative to elementary education as it is currently conceived. Our work with intelligent machines has led us to investigate those cognitive structures basic to all known information processing systems, be they people or computers. Based on these considerations we have found ways to greatly foster and accelerate cognitive growth and we are currently implementing these techniques at an elementary school within the greater Boston area.

We believe along with Piaget, Montessori, Dewey and all other reasonable educational scholars that children learn by thinking about doing. (See, e.g., Piaget and Inhelder: The Child's Concept of Concept.) It is clear that a sufficiently bright person can master any skill in a short period of time, say, three weeks, by thinking in the proper way about what he is doing. The fact that most people are not able to do this proves only that the right ways of thinking are not widely known and that most people aren't very bright, anyway.

Our task, then is to amplify the correct ways of thinking, which are:

1) Look for a recursive model.

2) Break a problem into subproblems.

3) Look for simple and extreme cases.

4) Discover and investigate the bugs.

The ability to think recursively is perhaps the basic distinguishing feature of higher cognitive development. In fact, the correct applicaton of this principle to cognitive studies leads directly to our basic premise, viz., that one teaches children by teaching them to learn, and one teaches them to learn by teaching them to learn to learn. Recursive thinking is evident in most good human, and in all good machine, thought; and permeates such disciplines as cosmology, psychology, mathematics and music. (See, e.g., Bamberger: Waldstein und Wiederkehr--Recursive Figuration in Beethoven's Op. 53.)

Breaking problems into subproblems (the "divide and conquer" strategy) is so well-known and appreciated that nothing more need be said, only that the task of computer programming provides the most elegant examples of and opportunities to employ this technique.

Isolating a problem via the investigation of simple and elegant cases is one of the best ways to

gain an intuitive understanding of complicated processes. For example, the "turtle geometry" developed as part of the project has had profound success in introducing children to mathematical and physical thinking. (See di Sessa and Abelson: Tensors, Turtles, and Tots--A Preoperational Vista of Geometrodynamics.)

Finally, when one learns to depersonalize and thus avoid the negative emotional effects of "bugs" (we frown upon the highly charged word, "mistake") one is able to take a more balanced and objective approach to ones own learning. Moreover, the isolation of a bug can often lead to useful insights. For example, the uncritical application of the recursion principle to teacher training leads to the conclusion that one should teach teachers to teach. The investigation of the resulting bug (which is responsible for the deplorable state of this country's teacher training) leads to the realization that there is no significant body of skills associated with teaching, only the necessity to be reasonably sensitive to and tolerant of a particular child's intellectual needs. Once free of this misconception we are able to focus on the child's

cognitive schemata per se.

Having found the principles of correct thinking, it is only necessary to communicate them to the child by obtaining appropriate hooks into its data structure. This simple realization is precisely overcoming the aforementioned bug. Most other education programs have become bogged down in the inessential aspects of human cognitive growth, traceable ultimately to the fact that one is dealing with an information processor made of meat rather than semi-conductors. In order to concentrate more fully on the non-trivial part of the student and avoid the confusion arising from interactions with the protein shell, we have decided to construct a model called Comprehensive Heuristic Image of Logical Development (CHILD). By instructing CHILD we should readily discover the most efficient methods of interacting with any individual's data base. (See Goldstein: Little Brother -- An Intelligent Student for the LOGO Monitor.) Incidently, this project has the spinoff benefit of providing approriate goals for the genetic modeling which is now becoming possible.

In conclusion, we are confident that our

approach will lead us to simple and clean techniques for assuring that any child will grow to be a mature, well-functioning, intelligent and happy adult, i.e., a good problem solver.