Thinkertoys In Informationland

By Jerome T. Durlak
Institute of Environmental Research
and York University

During the past two centuries, men gained knowledge and power, which vastly increased their ability to predict and control, and they used these powers to make a world increasingly unpredictable and uncontrollable.

Geoffreu Vickers
Values Systems and Social Processes

Many of today's children will be spending more than half their life in the unknown world of the 21st century. To cope effectively with the unknown, individuals must have a well-developed ability to think. Without it, adults will be destined, eventually, to become crippled by their own obsolete thought patterns as well as knowledge that is no longer relevant. They will be confused and overwhelmed by a vastly changed future society in which they will no longer know how to participate. To prepare an individual for a useful, fulfilling life in the 21st century there must be extensive systematic instruction in the skills required for original and independent thinking, creating, and problem-solving. This essay examines the potential of a new "thinkertoy"[1] - the microcomputer.

Information Multiplies Fast

Currently, education emphasizes mastery of the known. It does little to prepare an individual to cope effectively with the unknown.[2] Dr. Robert Hilliard, an educational broadcasting specialist for the U.S. Federal Communications Commission, has said: "At the rate at which knowledge is growing, by the time the child born today graduates from college, the amount of knowledge in the world will be four times as great. By the time that same child is fifty years old it will be thirty-two times as great, and 97 percent of everything known in the world will have been learned since the time he was born."[3] While we may quibble with his statistics and use of the word "knowledge", it is likely we would all agree that the tide of information is ra-

pidly increasing and it is exceedingly difficult to swim against the undercurrents.

Part of the reason for this phenomenal growth of information is the convergence among computers, mass media and telecommunications. The powerful fusion of a computer, a television set, fibre optics and switching mechanisms should potentially amplify our capacities to deal with our social and physical environment. However, this technology also can extend our senses to a point that the interactive character of these tools may actually reshape not only the information content, but also the way we perceive - in ways that our conventional wisdom and traditional institutional means may not be able to foresee, comprehend or effectively control.

Microprocessors: General Purpose Tools. Many people are not aware that one of the reasons for the convergence of these information tools is due to the development of a microprocessor which is a general purpose tool. A Japanese manufacturer of small calculators asked for a custom "processing" chip that would be smart enough to perform arithmetic and other functions and still fit inside a hand-held case. It also had to be cheap enough to result in a total price sufficiently low to create a mass market for the complete unit. Intel Corporation accepted the task and delivered the tiny powerful, silicon-based semiconductor chip in 1971.[4]

Microprocessor Is Computer's Logical Brain

A microprocessor is not a computer. It is central processing unit, a computers' logical brain. Three more sections are needed to complete a computer: a memory containing basic instructions, such as how to multiply and divide (the program); a memory to store new instructions and results; and an input/output unit.[5] A first even with the large-scale integration of tens of thousands of individual electronic devices: transistors, diodes, resistors and capacitors on a chip, each section required its own electronic chip or series of chips. Now all four can be packed routinely into a minute piece of silicon. It is these general purpose machines that help to run a television set, the telephone switching system, the teletext machine, the video game as well as your oven, car and refrigerator.

As a result the computer that cost a million dollars a few years ago and took up an entire room now fits on a table top and costs several thousand dollars. In 1975 there were approximately 150,000 operating computers in the world. By the end of 1977 ten times that many were

being produced every month and were being operated by ordinary workers and citizens instead of the former "super-elite" - the big system specialists.[6] The self-contained computer that sits on my desk costs twelve hundred dollars in Canada ($800 US) and has been used by over seventy "children" ranging in age from four to seventy-five.[7]

The Social Context. The mass media as we know them today, radio, television and movies only allow us to be passive receivers of information. The only control we exercise is turning the machine on or off and switching stations or channels. Pay television is really more of the same. It may widen our choice, but our own control is minimal. Interactive cable certainly should widen or fragment our choice (depending on your point of view) even further, and may allow us to become active participants in surveys, etc., but one will never be completely confident that the information presented, the forms of the questions, or the instantly calculated results are not rigged.[8] So as television presents us with an illusion of reality or maybe determines reality for us, interactive cable will probably be used to enhance the illusion of active participation. We must ask ourselves if these new services will provide useful information, will be accessible to everyone, will hinder or facilitate face to face communication and most importantly, do we really need it anyway? "Information is power, or at least the right information, at the right time, in the right place can mean power. More egalitarian distribution of information can mean more egalitarian distribution of power."[9]

Players Can Create Own Programs

While it is possible to be a passive receiver by strictly using canned game programs on a self-contained microcomputer, it is possible for users to actively program the machine and create their own programs. Many people are afraid of programming, but languages are becoming more powerful and general as well as easier to use and learn. Another sign that some people are tired of being passive receivers of television is the hundreds of thousands of Canadians who in the past two years have bought more and more sophisticated video games. In an interview Nolan Bushnell (who invented Pong, and founded Atari which is now one of the largest video game manufacturers) was asked what kind of people are buying the more expensive top of the line, video computer systems. His reply:

We're finding out that it's turning out to be everybody. We at first thought of it ourselves as a carriage trade item, but it turned out to be a family toy or a family

investment. Now instead of popping $500-$600 for a pool table, they're seeing video games as something the whole family can do together.[10]

In a recent book that John McHale wrote before his untimely death, it says that we are beginning to see the emergence of different information communities which have overlapping generational groupings and are not static but moving in time. The first information community is made up of people who are still oriented towards traditional information means and media-print, books, etc. The age of this group ranges mainly from 35 and up. The second is made up of those relying increasingly on visual and audio channels bypassing print and avoiding the newer computer based information technology. This group extends across all ages, income groups and education levels. Finally, the third information community is made up of those literate in, and control of the new information technology. These are mainly better educated, higher income people between the ages of 18 to 45. He suggests the sizes of these three community groups are changing as more people move into group 3 via the educational process. Another important caveat is that "the younger members of group 2, though oriented to visual and audio channels, also embraces rapidly growing interests and skills in the new information technologies."[11]

Builds Two Computers

It is easy to find proof of this. If you live in a city that is large enough to have a home computer store, go visit it during school hours. You will see it filled with young boys playing hooky from schools. There is a variation in smaller towns. Last year when I went to Data 78 - a computer show in Toronto - I met a young teenager from Paris, Ontario who was busy programming a computer for one of the well-known computer manufacturers. He had learned to program computers from extension courses and had already built two of his own computers from scratch. The computer salesman, who also had a Ph.D. in Physics, told me that the boy was one of the best programmers he had ever seen. This is not the first time I have been told this by computer salesmen. It is becoming common knowledge in the trade that many computer manufacturers in the US are actively seeking young programmers not yet in their teens.

Before we examine children's use of computers as thinkertoys, let us briefly explore how the "television" generation might have paved the way for the presently emerging "electronic" generation.

There are a plethora of books and studies written on children and television, but the book that I find most useful in the present context is Tony Schwartz's book The Responsive Chord.[12]

Tony Schwartz suggests that print learning required a great deal of effort by the child for relatively little knowledge to be acquired with less effort. Television also provides the same information to adults and children - children are no longer sheltered from knowledge. So younger children begin to understand the scientific gadgets and words better than their elders.

As a result the generation gap has disappeared. It is the absence of such an information gap that causes much of the friction we are experiencing. The two groups, adults and children, are encountering each other more directly than ever before. These encounters are often painful because each group finds a different meaning in the event, based on the different sensory patterns each applies to experience.[13]

Today's Child Is Scanner

Schwartz argues that children's media involvement also restructures their patterns of reacting, feeling, and thinking. Today's child is a scanner who "perceives sensory information a millesecond at a time, and he experiences life as a continuous stream of fleeting, millesecond events."[14] In this way of life, involvement has greater value for young people than conceptual knowledge of the world.

From an adult looking at children from the old sensory perspective, this appears to be a very fragmentary point of view that has no connections to the past and no firm goals for the future. However, to a child involved in this scanning process his experience of life, as viewed through his patterns of auditory and visual perception, is in harmony with his patterns of thinking. Because children are experiencing a very high information perception rate they are able to see patterns of interaction very easily and actively seek these patterns out.

In writing papers, students swiftly change the subject, shift the scene, drop a line of argument in order to pick it up later and not lose the logic of development. They were not trained, as we, to carefully proceed from one statement to another after a careful definition and elucidation of the points they are trying to make in an argument. "Educators stress analytic, deductive reasoning, which conforms to the way they think, while students scan huge

amounts of information in search of patterns."[15]

Schwartz argues that media children enter school united to other students in a common experience of the world as a result of their common use of media. They can fill in, or respond to, or resonate with a vast amount of information that they share with others. The educator's job in these circumstances is to sharpen a student's skill so that they can efficiently process the vast amount of information that they experience in life.

Finally, Schwartz suggests that television can become a valuable reading readiness tool.[16] Only recently have reading materials been designed to utilize a child's media experiences.[17]

Learn To Read Fast

My experiences in working with children on microcomputers is that they learn to read rapidly because they want to read what is on the screen of the computer. I have also kept track of several children who have access to microcomputers in the home and all their parents agree that kids go outside and play as much as they ever did. What children do is play with the computer during the time that they would ordinarily spend watching television.

Microcomputers as Thinkertoys. Russell Ackoff, in Redesigning the Future suggests: "The young do not want to be put into competition with machines; they want to know how to use and control machines."[18] Children have recently began to consider a calculator as a friend and the microcomputer seems to fit in the same category: it somehow has to be understandable because it is so small. Children usually begin to use a microcomputer for playing games and these games do teach some interesting notions. For example a sophisticated Star Trek game can make a computer appear very smart, but if the computer cannot process a command that's misspelled, children immediately realize that there are serious limitations on the nature of the machine's intelligence. Very young children can learn to program a computer using a simple yet powerful language callet PILOT. In the process of "teaching" a computer to carry on a conversation, children very quickly realize that it is the programmer who imparts the wisdom or lack of it.

Games can motivate the learning of basic skills and sophisticated concepts. These games can simultaneously incorporate fantasy, systematic feedback and competition as well as foster teamwork, cooperation, and cross-age helping.[19] It is also not necessary to maintain or manage

a student's progress, because parents or teachers can look at printouts of actual games a child has been playing to get an idea of the child's level of achievement. Games can also be used with young children and handicapped children to improve hand and eye coordination and motor skills. The problems that adults face is that they must be comfortable with the idea that they will often know much less about a given aspect of computing than his or her children do. It is neither necessary nor desirable nor possible to limit children's areas of exploration to those of adults.

There are also many small electronic games (which contain microprocessors) that put drill and mastery of basic skills into a fun perspective. For example, The Little Professor ($15) or Dataman ($25) can take children through exercises in addition, subtraction, multiplication and division at several levels of difficulty. Speak and Spell ($59) is a talking learning aid for building spelling, pronunciation, and reading skills through microcomputer electronics. It also has plug-in modules ($15) that increase its vocabulary.

Tool Has Creativity

The microcomputer can also be used as a tool for creative activity rather than a presenter of questions and answers. Children can compose music, create colored drawings, write stories or run robots.

Any child who likes music can have vast new horizons opened by having access to a computer with a music generator. That is, children are no longer prevented by the lack of dexterity from exploration of composition and other musical instruments. "The computer becomes an obedient orchestra and will play any piece the child can describe."[20]

Another device that is being used effectively to introduce computers to young children is Seymour Papert's robot turtle.

A turtle is a computer-driven supertoy. It can move forward or backward and can rotate around its center. A pen is attached to its center, and when the pen is down, the turtle draws a line wherever it goes.[21]

Using a programming language called LOGO, children learn to control the motions of the turtle, thus expanding their knowledge of what Papert calls turtle geometry. Papert feels that the experience of a program-controlled device can be used to "give children, to quite an unprecedented

degree, a sense of power of ideas in general, of science in particular and especially of mathematics."[22] As Turtle geometry can give a child a grasp on movement in space, access to a microcomputer and a music generator can help a child think about relations in time and in "tonal space".[23]

The rates of progress in microelectronics suggest that in about a decade many people will possess a notebook-size computer with the capacity of a large computer of today. Hopefully, this computer will be a tool for creative activity rather than a presenter of questions and answers. This concept has been taken the farthest by Alan Kay and Adele Goldberg at the Xerox Palo Alto Research Center. The Xerox group has shown that junior-high school children can compose music, create animated cartoons, and write stories, given a powerful programming language such as their SMALL TALK language, and a computer oriented to color animations, music, and text.[24]

Adult Shy Of Computers

Adults and Computers. Adults have a rather strange idea of what a computer is, based on their experience of incorrect bills, seemingly unchangeable data bases and very slow responses to inquiries. The Lawrence Hall of Science in Berkeley has extensive computer drop-in courses for children and adults, but they often find that adults are much more afraid of the machine than children.[25] In a recent conversation with David and Annie Fox who run the Marin Computer Centre in California,[26] a non profit organization, where anyone can walk in and learn about computers in a safe, non intimidating environment I was told that their first "customers" were children. After a period of time parents grew curious about where their children were spending they spare time and they too got hooked. However, it was the children who took the first initiative.

Learning from Children. Margaret Meade believed that we are in a situation in which we must begin learning from our children. "Adults assume that there is still general agreement about the good, the true, and the beautiful. Also, that the built-in ways of perceiving, thinking, feeling, and acting are essentially constant."[27] She feels that such beliefs are completely incompatible with the findings of anthropology which has documented the fact that innovations in technology and in the form of institutions inevitably bring about alterations in cultural character.

To quote her:

As I see it, the development of...cultures will depend on

the existence of a continuing dialogue in which the young, free to act on their own initiative, can lead their elders in the direction of the unknown. Then the older generation will have access to the new experimental knowledge, without which no meaningful plans can be made. It is only with the direct participation of the young, who have that knowledge, that we can build a viable future.[28]

A Possible Future Scenario. Let me end this paper with a possible future scenario: A condensation of a short story written several years ago by Henry Kuttner entitled Mimsy Were The Borogroves.[29]

Testing His Time Machine

The story takes place in some distant future where Unthahorsten was testing his time machine. The device needed a control, a three-dimensional solid which would react to the conditions of another age. In a nearby storage bin he came up with an armful of discarded toys of his son Snowen which he put into the time machine as it disappeared back in time. The toys were found in the twentieth century by Scott who was playing hooky from the local primary school. One of the toys was a square transparent crystal block, small enough to cup in his palm. The crystal was a sort of magnifying glass which enlarged the things inside the block. The things inside the block were miniature people who were deftly building a house. Scott wished the house would catch fire and it did. He also wished the people could put out the fire and the people with a great deal of odd apparatus extinguished the blaze. It was fun. The little people really did what Scott told them, inside of his head. If he made a mistake they waited till he'd found the right way. They even posed new problems for him. The cube taught Scott, with alarming rapidity - and taught him entertainingly.

Emma and his younger sister (about three years old) found another toy which to an adult would look like an abacus. It was a foot square composed of thin, rigid interlocking wires. On the wires colored beads were strung that could slide back and forth, from one support to another, even at the point of juncture. The angles formed by the wires had a ridiculous lack (to an adult) of Euclidean logic. She started sliding the beads and she managed to make one of the beads disappear. After a while the motions of the beads didn't seem so strange. Even when the beads vanished. She began to learn new directions, etc.

When their parents asked where the toys came from the kids bluffed by saying it came from an uncle who had just

left town for a few weeks. The parents unfortunately didn't get rid of the toys instantly because they did not realize their significance. With the instinct of children - Emma and Scott played with the toys in private and the more intricate experiments were never performed under the eye of an adult. Emma learned more from the toys than Scott. He could communicate his thoughts but Emma could not except in cryptic fragments that she drew on papers.

After a while their parents began to get worried because their children were acting strangely. They got more worried when they found out that their children hadn't got the toys from their uncle and couldn't find similar toys anywhere in the city. They then consulted with a well known child psychologist. The toys fascinated the psychologist and during the conversation he pulled out Hughes' High Wind in Jamaica and read from a passage:

Babies of course are not human - they are animals, and have a very ancient and ramified culture, as cats have, and fishes, and even snakes; the same kind as these, but much more complicated and vivid since babies are, after all, one of the most developed species of the lower vertebrates. In short, babies have minds which work in terms and categories of their own, which cannot be translated into the terms and categories of the humand mind.

Use Minds Differently

He explained to the parents that while children and adults have the same senses, they use their minds in a different way. Just as a mixmaster can whip up batter and potaotes so can it squeeze oranges. "We don't know how much about the potentialities of the mind, but we do know that the mind becomes conditioned as we mature." It learns certain familiar theorems and all thought thereafter is based on patterns that we take for granted. "Our minds are conditioned to Euclid but since a young child doesn't know Euclid a different sort of geometry from ours would not impress a child as being illogical. Children believe what they see". The psychologist insisted that the parents get rid of the toys. They did and after a while the children seemed "normal" once again. They enjoyed swimming, hiking, movies, games, etc. However, they did hold unintelligible conversations and studied meaningless scrawls written by Emma. One day Scott's mother asked him if he could read the scrawls. Scott said that he could not read it exactly, but could tell what it means. The children's work continued until one day Scott yelled exultantly to Emma - "This is it - Come on." Both kids ran upstairs and began to make some noise upstairs. The father raced up the stairs and opened

the door to Scott's room and watched the children vanish "like a movement in a distorting mirror". All that was left was a piece of paper with a stanza of verse from Through the Looking Glass:

> "Twas brillig, and the slithy troves
> Did gyre ad gimble in the wabe:
> All mimsy were the borogroves,
> And the mome raths outgrabe."

The notes Emma had made on the page had translated Carroll's words into symbols both she and Scott could understand. The children had fulfilled the condition of the time span condition. They had gone forward to meet their destiny.

FOOTNOTES

1. *I have been told that Theodore Nelson who wrote Computer Lib in 1974 was the first person to use thinkertoy. However, I have Scandinavian friends who used the word thinkertoy over ten years ago in reference to LEGO BLOCKS.*
2. *George Gerbner, "Teacher Image in Mass Culture: Symbolic Functions of the Hidden Conclusion," in David Olson, ed., Media and Symbols (Chicago: National Society for the Study of Education, 1974).*
3. *Quoted in Alvin Toffler, Future Shock (New York: Random House, 1974), p.141*
4. *Charles J. Sippl, Micro-Computer Handbook (New York: Petrocelli/Charter, 1977) p. xiv.*
5. *Jim Schefter, "Microelectronics," Popular Science, January, 1978, p. 53*
6. *Charles Sipple, op.cit., p. x.*
7. *My concern in this article is the small computer systems that are prepackaged as stand-alone units. These table top computers have a self-contained power supply, the capability for memory expansion, an interface for a TV set or a keyboard-display console as well as software capabilities that approach in sophistication those found in much larger conventional systems. In addition, these systems can be interfaced to such peripheral devices as "floppydisk" memories, tape cassettes, paper tapes and line printers. With these enhancements a small computer system could serve as a full development system.*
8. *See John Brunner, The Shockwave Rider (New York: Ballantine Books, 1975).*
9. *Jean Charles Michel Guite, Requium for Rabbit Ears: Cable Television in Canada (Stanford, Institute for Communication Research, 1977), p. 57*
10. *David Ahl, "Video Games Three Perspectives", Creative Computing, Vol. 4, 1977, p. 32*
11. *John McHale, The Changing Information Environment (London: Paul Elek, 1976), pp. 33-35*
12. *Tony Schwartz, The Responsive Chord (Garden City: Anchor Books, 1974) pp. 108-118*
13. *Ibid., pp. 109-110*
14. *Ibid., p. 111*
15. *Ibid., p. 113*
16. *Ibid., p. 116*

17. For example, Rosemary Potter, New Season the Positive Use of Commercial Television with Children (Columbus: Charles E. Merrill Publishing Company, 1976) and James Murrow and Murray Guid., Media and Kids (Rochelle Park: Hayden Book Company, Inc., 1976)
18. Russell L. Ackoff, Redesigning the Future (New York: John Wiley and Sons, 1974), p. 74
19. An excellent discussion of these ideas is by Bernard Baret, "Computers and Early Learning," Creative Computing, Vol. 4, No. 5, 1978, pp. 90-95 and Karl Zinn, "A Place for Personal Computing in Schools and Colleges, Interface Age, Vol. 3, 9, 1978, pp. 70-75
20. Seymour Papert, Uses of Technology to Enhance Education (Cambridge, Massachusetts Institute of Technology Artificial Intelligence Laboratory, 1973), Memo No. 298, p. 16
21. Ibid., p. 103 - a turtle can be bought at a store for approximately $300, but it can also be made with Meccano sets or spare parts for $50 or less - depends on your ingenuity.
22. Ibid., p. 8
23. Ibid., p. 16
24. See Alan C. Kay, "Microelectronics and the Personal Computer," Scientific American, Vol. 237, No. 3, 1977, pp. 231-244
25. See Robert Kahn, "Computer Education at Lawrence Hall," Creative Computing, Vol. 9, No. 1, 1978, pp. 94-95
26. See Annie Fox, "Marin Computer Center", People's Computing, Vol. 7, No. 3, 1978, pp. 7-11
27. Margaret Meade, Culture and Commitment (New York: Doubleday and Company, 1974), pp. 47, 48
28. Ibid., p. 73
29. Henry Kuttner, The Best of Henry Kuttner, edited by Frederick Pohl (New York Bantam Books, 1975), pp. 1-35.

Editorial Notes, cont. from p.2

In this issue, Jerome Durlak tells a little about telecommunication-computers in the lightweight revolution which may prove to be based on the shifting sands of silicon - the chips - in which case it could turn out to be a sort of quick sand engulfing human relations...or possibly a technological talisman. A happy aspect, however, is the thinking games that people play.

At present, fascination with machination prevails but many are questioning where we will be led by the imbalance or into what morass by the technology that stresses as prime values, speed, efficiency, the technical over the moral, the secular over the spiritual, fixation on the present over the past. It is a continual critical dilemma that Harold Innis described in the 1950's as an historic truism where a bias of "space values" over "time values" leads to monopoly and the instability of a society. Arnold Rockman who personally attended the euphor over "communication" at the turn of the 60's and has since seen it evaporate, projects the salvaging of cultural and community aspects in urban and rural contexts. Alan Baker essays alienation as a dysfunction of communication and Chris Martin hears the "dominant sound" of owner hegemony in satellites. Marshall McLuhan intones, "the medium is the message".

-Earle Beattie, Editor