INFORMATION TECHNOLOGY AND CULTURAL CHANGE: TOWARD A NEW LITERACY?

Benjamin M. Compaine

Program on Information Resources Policy

Harvard University

Center for Information Policy Research

Cambridge, Massachusetts

A publication of the Program on Information Resources Policy.

INFORMATION TECHNOLOGY AND CULTURAL CHANGE:
TOWARD A NEW LITERACY?
Benjamin M. Compaine
September 1984, P-84-5

The Program on Information Resources Policy is jointly sponsored by Harvard University and the Center for Information Policy Research.

Printing 5 4 3 2

June 1985

PROGRAM ON INFORMATION RESOURCES POLICY

Harvard University — **Center for Information Policy Research**

Affiliates

Action for Children's Television
American District Telegraph Co.
American Management Systems, Inc.
American Telephone & Telegraph Co.
Arthur D. Little, Inc.
Auerbach Publishers Inc.
Automated Marketing Systems
BellSouth Corporation
Bell Atlantic
Booz-Allen Hamilton
Canada Post
Cellular One
CBS Broadcast Group
Commission on European Communities (Belgium)
Communications Workers of America
Computer & Communications Industry Assoc.
COMSAT
Continental Cablevision, Inc.
Copley Newspapers
Cowles Media Co.
Dai-Ichi Kangyo Bank, Ltd. (Japan)
Databit Inc.
Dialog Information Services, Inc.
Digital Equipment Corp.
Direction Generale
des Telecommunications (France)
Doubleday, Inc.
Dow Jones & Co., Inc.
Dun & Bradstreet
Economics and Technology, Inc.
EIC Intelligence Inc.
LM Ericsson (Sweden)
Federal Reserve Bank of Boston
Gannett Co., Inc.
GTE Sprint Communications Corp.
Hitachi Research Institute (Japan)
Honeywell, Inc.
Hughes Aircraft Co.
E.F. Hutton and Co., Inc.
IBM Corp.
Information Gatekeepers, Inc.
International Data Corp.
International Resource Development, Inc.
Invoco AB Gunnar Bergvall (Sweden)
Knowledge Industry Publications, Inc.
Kokusai Denshin Denwa Co., Ltd. (Japan)
Lee Enterprises, Inc.
John and Mary R. Markle Foundation
MCI Telecommunications, Inc.
McKinsey & Co., Inc.
Mead Data Central
MITRE Corp.
Motorola, Inc.
National Association of Letter Carriers
National Telephone Cooperative Assoc.
The New York Times Co.
NEC Corp. (Japan)
Nippon Telegraph & Telephone Public
Corp. (Japan)
Northern Telecom Ltd. (Canada)
Northrop Corp.
NYNEX
The Overseas Telecommunications
Commission (Australia)
Pacific Telesis Group
Pitney Bowes, Inc.
Public Agenda Foundation
RCA Corporation
Reader's Digest Association, Inc.
Research Institute of Telecommunications
and Economics (Japan)
Royal Bank of Canada (Canada)
Salomon Brothers
Satellite Business Systems
Scaife Family Charitable Trusts
Seiden & de Cuevas, Inc.
Southern New England Telephone
State of Minnesota Funding
State of Nebraska Telecommunications
and Information Center
Telecom Futures, Inc.
Telecommunications Research
Action Center (TRAC)
Telecom Plus International, Inc.
Times Mirror Co.
Times Publishing Co.
TRW Inc.
United States Government:
Central Intelligence Agency
Department of Commerce:
National Oceanographic and
Atmospheric Administration
National Telecommunications and
Information Administration
Department of Health and Human Services
National Library of Medicine
Department of State
Office of Communications
Federal Communications Commission
Federal Emergency Management Agency
Internal Revenue Service
National Aeronautics and Space Admin.
National Security Agency
U.S. Army:
Office of the Assistant Chief of
Staff for Information Management
United States Information Agency
United States Postal Rate Commission
United States Postal Service
US West
United Telecommunications, Inc
The Washington Post Co.
Wolters Samsom Group (Holland)

ACKNOWLEDGMENTS

Special thanks are due to the following persons who reviewed and commented on previous drafts of this report. These persons and the Program's affiliates are not, however, responsible for or necessarily in agreement with the views expressed herein, nor should they be blamed for any errors of fact or interpretation.

Walter Baer
Kurt Borchardt
M. C. Clanchy
Susan Crooks
Martin Ernst
Howard Gardner
Anthony Green
Ronald T. LaConte
Joshua Lederberg
D. Verne Morland
Lloyd N. Morrisett
Susan Neuman
Robert Pattison
E. Laurence Povich
L. John Rankine
Gordon T. Ray
Andee Rubin
Jerome Rubin
David Shefrin
Jules Tewlow
Randall L. Tobias
Shoshana Zuboff

TABLE OF CONTENTS

	Page
Executive Summary	i
Preface	iii
Introduction	1
Traditional Literacy	3
Writing, Printing and Behavior	8
Other Consequences of Change to Written Literacy	11
Forces and Trends Suggesting a New Literacy	13
Stages of Development of a New Literacy	17
Popular Conceptions of the Meaning of the Widespread Use of Computers	28
Players and Stakes	32
Toward an Agenda for the New Literacy	35
Summary	50
Notes	52

FIGURES AND TABLE

Figure 1: The Road to the New Literacy?	18
Figure 2: Example of Spatial Skill	22
Table 1: Framework for Research on the New Literacy	37
Table 2: New Jobs/Skills in the Workplace as Measured by Want Ads, 1977 - 1984	40

EXECUTIVE SUMMARY

. The New Literacy is the bundle of information skills that may be required to function in society, skills that may evolve from the capabilities made possible by the increasingly widespread use of inexpensive compunications technology. It is not about the need or ability to program computers.

. Historically, as technologies have changed, the skills level needed to perform certain tasks often declined. Simultaneously, the need to master the skill becomes more important because it is expected that the ability to perform the task has become part of the bag of skills widely available in society.

. The trend in compunications use has been to lower the labor involved as well as the skill required for accessing and manipulating information. The question behind the New Literacy notion is what are the implications for how society decides what can be done with information that prevously was hardly thinkable or unthinkable?

. Among the players with stakes in understanding the dynamics of a New Literacy are those in the print media business, who are concerned about the rate of replacement, if any, of paper-based information products. Banks and other financial institutions, educators, large users of information services, and government policymakers are others with obvious direct stakes in when, if at all, the bundle of skills we are calling the New Literacy becomes real.

• The New Literacy would involve a fundamental innovation in conceptualizing and processing information. This would involve a shift in perceptions about information formats and uses as fundamental as the shift from oral to written records was as the basis for traditional literacy.

• To get from here to the New Literacy may include at least one intermediate stage. If the current state of literacy is Literacy I, a second stage, Literacy II, might be characterized as "old wine in new bottles," meaning that an electronic information infrastructure may be used to create and process information, but in ways that reflect an ingrained linear tradition. A third stage, the New Literacy, may lead to entirely new or expanded forms of imagination. The ability to think holistically and intuitively rather than sequentially and logically is one possibility.

• Among the questions and issues raised by the notion of a New Literacy are:

--What are the underpinnings of traditional literacy and what is their relationship to current linear process technology?

--What are the elements of newer information technologies that may shape future information processing?

--What are the nontechnological factors that facilitate or retard a society's acceptance of elements of a literacy?

• Among the areas of study for the New Literacy are: Literacy Skills; Organization and New Literacy; Institutions and the New Literacy; the Individual and New Literacy, including learning and cognition.

As soon as printed books superseded manuscript codicies, large numbers of identical illustrations began to be reproduced. The circle of technologists whose minds could be engaged by a particular problem or stimulated by a particular idea was thus indefinitely enlarged.

---Eugene Ferguson, Curator of Technology, Hagley Museum. From Science, August 26, 1977.

PREFACE

In 1983, the Program on Information Resources Policy published a document, originally written for the journal Daedalus, that described "The New Literacy." It referred to something other than the "computer literacy" that has become a popular topic in professional and, increasingly, in mass audience publications. The notion of the New Literacy is that, based on the historical precedents of oral and written literacy, it would be timely to think through what, if any, are the long-term economic, cultural, political and other implications of widespread use of computer-based processes for the creation, manipulation, storage and transmission of information (broadly defined). How might a New Literacy affect human behavior involved in problem solving or the balance between verbal and nonverbal behavior for such activities as productivity, learning, artistic creating, governing and human relations?

Stakes: Or Why Study the New Literacy?

The Daedalus article was greeted with enthusiasm from many sectors. Publishers could relate the New Literacy idea to their need to understand the future of their printed products and the timing of a potential market for electronically distributed content. Those in the "bit transport" business -- telecommunications organizations incorporating various technologies -- had similar questions about the demands on their networks for data communications. Educators were asking what they should be teaching in their classrooms--and how they should be teaching it. Noninformation companies told us about their

uncertainties concerning internal information flows and the proliferation of stand-alone microcomputers on the desks of many of their executives.

Two countervailing forces tempered this encouragement. First, we wanted to make sure we were not pulling ourselves into some superficial or trendy topic that would be in retrospect a blip rather than a long term trend, such as the prematurely heralded computer-aided instruction in the 1960s. Second, we had to be confident that this notion of New Literacy lent itself to research that would be useful to policymakers.

After more than a year of presenting our ideas in varied forums and internal discussions, we are satisfied that what we are calling a New Literacy (other labels are welcome) has both substance and significance. We believe there are enough early factors-- perhaps not yet trends--to warrant the start of work on describing and tracking the forces that may help establish if and when a substantial change is underway in the bundle of skills called literacy. We think that we have identified in this document areas of research that are economically and intellectually feasible.

Objectives of this Paper

This paper is an extension of the previous publication, The New Literacy, Or How I Stopped Worrying and Learned to Love Pac-Man*. It is intended to explore further what we mean by the New Literacy concept, why anyone does or should care about it, what questions, problems and/or issues it raises, and where research might be most productive at this stage of the project.

*Benjamin M. Compaine. Cambridge, Mass.: Program on Information Resources Policy, Harvard Univ., I-83-1, 1983.

The description herein is meant to be suggestive and reportorial rather than exhaustive and definitive. The literature on the nature of literacy alone could be reviewed in a document many times the length of this one and include references ranging at least from Albert Lord's views of Homeric poetry and Slavic literature to Marshall McLuhan's always controversial insights. The research of pyschologists on subjects such as reading and learning and more recently video games and computers, the digging of historians into developments of written and printed records, the work of sociologists and cultural anthropologists on societal impacts and changes encompass only some of the grist for the mill of the New Literacy.

There are many tantalizing tidbits that do not neatly fit into this paper, but may be incorporated into future pieces of our efforts. There is the passing observation by Barbara Tuchman in A Distant Mirror that monks lost their monopoly as copyists of manuscripts to professional scribes in France in the 14th century, and that the scribes were licensed by the University supposedly to ensure accurate texts, yet turned out to be "the agony of living authors who complained bitterly of the copyists' delays and errors." Many present-day authors will recognize that the technology of the printing press did not create the tension between them and publishers.

Then there is the note by Parkinson that the Exchequer in England maintained its books in medieval Latin through the mid-19th century--not because it had to, but because Latin concealed the budget's mysteries from scrutiny. Some would say that today government accounts are kept in Greek.

Of more contemporary vintage, my colleague John McLaughlin notes that computer-generated graphics and computer-controlled flight have

already had a profound effect for training pilots, allowing them to experience many more types of situations than they could ever be exposed to by flying--and without the danger of risking lives or equipment.

What follows, then, is a pass at introducing what we believe is a new concept. It is a request to readers to help us determine the scope of a New Literacy, to help determine the research questions and their priorities. This paper is not the end but the beginning of a study of a New Literacy.

INTRODUCTION

The New Literacy is the bundle of information skills that may be required to function in society, skills that may evolve from the capabilities made possible by the increasingly widespread use of inexpensive compunications (computer and communications) technology. It is a literacy that builds on, rather than replaces, contemporary notions of literacy. Literacy itself has never been a static concept. Over centuries, the bundle of skills we call a literacy has evolved with technology, as well as with the political, economic and social systems. The current notion of literacy has evolved from the technology of the quill pen, paper, movable type and the mechanically powered rotary press.

The New Literacy is <u>not</u> about the need or ability to program computers or even to work devices labeled "computer." But increasingly, information is being digitally stored in some electronic medium and being delivered to users by telecommunications or via devices that can make the information readable, viewable, or audible. The continuation of these trends, enabled by technology, impeded or aided by government regulation, accepted or resisted by our culture, is likely to create the need for a new bundle of skills and processes that will define the New Literacy. Should the notion that a New Literacy is emerging prove accurate, it will not happen overnight. More likely, it will be an evolution that involves a transition period in which the tools of the

New Literacy are used with the substance of the traditional literacy.

The foundation of a New Literacy is the social and cultural change that is likely to come about from the increased use of digital electronic processes. At this stage, it is little more than a notion; testing its validity may take years or decades. However, there is basis in history for it and there is circumstantial evidence in the present that the consequences of a possible change in the fundamentals of literacy need to be taken seriously.

Still, it is almost impossible to predict the nature of any change. For example, historian Elizabeth Eisenstein, in considering the impact of printing on Western civilization, noted that while it is relatively easy to describe the development of printing in the 15th century, "It is another thing to decide how access to a greater abundance or variety of written records affected ways of learning, thinking, and perceiving among literate elites."[1] The key issues in the notion of a New Literacy are in seeking some understanding of the influence of modern information technologies on learning, behavior and perception, not only by literate elites but principally by the general public.

The long-term implications could be substantial. Along with the technological alterations in how we are able to construct, store, and use information are likely to evolve parallel changes in how we approach the situations for which we seek out information.

As a hypothetical example, imagine society prior to the development of a cheap, reliable straight edge and the ball point pen. Although the concept of a straight line may have been well known, the skill to draw a straight line free-hand would have been restricted to a relatively few skilled craftsmen. They would have been futher encumbered by the

technology of the stylus and waxed tablets or reeds and papyrus as their media. Therefore, any sort of geometric problem whose solution required use of straight lines for solving, such as for structural designs, would have been difficult. By contrast, the widespread application of the straight edge would have broadened the base of those technically able to draw lines. The improvement in drawing implements, to quill pens, fountain pens and ball point pens, further reduced the difficulty in drawing lines and made their application feasible for more people.

The result is that as several technologies changed, the skill level needed to perform a task declines, but the need to master the skill becomes more important because it is expected that the ability to perform the task is part of the bag of skills widely available. Moreover, and at least as important, we could assume that the widespread ability to draw accurate straight lines meant that tasks that may have been previously unthinkable--such as complex architectural renderings--became quite thinkable and doable and for a larger group of people than before.

Translated into New Literacy terms, compunications makes possible the previously hardly thinkable or unthinkable. Thus, the ability to randomly access information from a vast data base and manipulate it (whether as market research or a crossword puzzle) is not new. We can always go to a library and randomly access its stacks. But it has been highly labor intensive and has required considerable skill on the part of the searcher. The trend in computer and communications use has been to lower the labor involved as well as the skill required. (Compare, for example, the use of the complex search routines for the bibliographic data bases such as Dialog and the much simpler ones for Nexis/Lexis).

The question behind the New Literacy notion, then, is whether the pervasive use of compunications will reduce the skill levels needed for certain types of problem solving and general information-seeking behavior in society and at the same time make it necessary for this new level of skill to become an integral part of what it means to be "literate."* And, if this comes about, what are the implications for how we decide what can be done with information that previously was unthinkable--or at least too expensive to do?

TRADITIONAL LITERACY

History provides a wealth of precedents for the changes we are experiencing today. Each generation seems to think its problems or opportunities are unique. History sometimes shows us quite the opposite. The development of low-cost computer power and its attendant implications for educational, industrial, social and political structures all have antecedents. For example, the introduction of photography in the 19th century collided with the popular wisdom about the role of art and painting. Then, the questions were about the new technology of the photographic process and how it might affect human

* Personal experience with combined spreadsheet/graphics programs on personal computers (Lotus 1-2-3 being the best known but not the only one) suggests there is already some of this new information-manipulating behavior at work. Use of full text data bases, such as Nexis, suggests another way in which compunications enables researchers to seek answers to questions that were often unfeasible to ask before. These may be seen some day as the modern equivalent of the straight edge.

views on the reality of war or on creativity. Today, similar types of questions are being raised about the effect electronic publishing is having on print and on the impact of television and video games on children.

The development of current notions of literacy is closely tied to the technologies of the printing press and the steam engine. An understanding of the previous evolution in technology and literacy is context for today's changes.

What is Literacy?

Literacy frequently describes a range of skills. It is used to mean the ability to read and write in one's vernacular. Being "literate" may mean being familiar with the great works of literature and philosophy of a culture. Sometimes it is also applied to basic skills, such as the ability to fill out a bank check properly or to understand simple written instructions. We also see literacy modified by very specific skills. A person who can identify the works of composers might be referred to as being musically literate. The ability to understand calculus may qualify one as being mathematically literate. And today, the ability to write programs in computer languages that make the computers perform tasks is being called computer literacy. Indeed, the mastery of almost any skill can be called a literacy: mechanically literate, visually literate, and so on. The term literacy itself comes from the Latin litteratus, or marked with letters. In medieval usage, to be literate meant to be learned in Latin, not simply the ability to read and write in the vernacular.[2]

This variety of uses of the term "literacy" both reinforces and muddies the concept as used in this paper. It reinforces because, as it is used here, literacy is not a simple commodity, but a dynamic bundle of skills that may encompass visual, auditory, mechanical and other abilities, with the mix varying over time and among cultures. The variety muddies the waters because it is hopeless to try to describe literacy if the term is extended to include proficiency in any particular skill.

Thus, this paper is not about a narrow meaning such as computer literacy, or the ability to program a computer or work a computer for its own intrinsic worth. As a starting point, this paper accepts a point of view that literacy in modern Western society is "a complex cultural phenomenon involving relations between attitudes towards language and mechanical skills."[3] The attitudes involve a consciousness of the uses and problems of language, this awareness being the foundation of literacy. But the pragmatic aspect of a literacy is the means by which this consciousness is expressed. Twentieth-century American culture holds that the skills of being able to read and write are at the foundation of literacy.

This has not always been the case, however. Before the written record came into widespread use in 11th-century England, the oral tradition predominated. To be literate meant the ability to compose and recite orally--in Latin, of course. Into the 12th century, to make a record of something meant to bear oral witness, not to produce a document for others to read. Even where written records existed, "the spoken word was the legally valid record."[4]

Moreover, because of the difficulty of writing with a quill on parchment or with a stylus on wax, writing was considered a special skill that "was not automatically coupled with the ability to read."[5] The most common way of committing words to writing in 12th-century England was by dictating to a scribe, who was an auxillary to literates and not necessarily himself able to compose. Indeed, the scribe may have sometimes had to read back the composed work to the "literate" who had dictated the poem or memorandum. Thus, composing and dictating were typically paired, rather than reading and writing.

Today, reading and writing are the basic skills of literacy. In 19th-century England, the goal of bringing reading and writing skills to the common man was not an end in itself. According to the literati, it was not merely the ability to read but the reading of the "right" material that separated the truly literate from the great unwashed. The printed word was supposed to bring spiritual enrichment and intellectural enlightenment to the English nation. Novel reading was held in particularly low esteem by some elements of the literati, with much the same disdain held today for commercial television, video games and even the multitude of self-help and how-to books in some sectors of society. In 1879, an English librarian told a meeting that "schoolboys or students who took to novel reading to any great extent never made much progress in after life."[6] The irony of this should not be lost on those who are convinced that television and even newer electronic media are eroding literacy. What they really mean is that they menace the <u>traditional</u> concept of literacy.

WRITING, PRINTING AND BEHAVIOR

History provides the strongest argument at this time that if a new literacy emerges from the expanding use of compunications it will have a profound--if unpredictable--impact on society. The precedent goes back not just to the development of the printing press but to the development of phonetic alphabets as the basis for writing. The fundamental impact of written compared to oral literacy cultures on thought processes has been grist for philosophers, sociologists, anthropologists, psychologists, historians, and linguists for thousands of years. Socrates told the story of the reaction of Thamus, King of Egypt, to whom the god Theuth brought the art of writing: . . .[T]his invention [writing]," said Thamus, "will produce forgetfulness in the souls of those who have learned it. They will not need to exercise their memories, being able to rely on what is written, calling things to mind no longer from within themselves . . ., but under the stimulus of external marks...."[7]

Thus, the notion that writing fosters behavior or even thought processes different from a verbal literacy is an old one. In more recent times, the writings of Goody, Innis, McLuhan and Ong, among others, address the relationship between thought processes and the technology of expression.[8] In general, this group of writers proposes that the development of alphabets consisting of a small number of symbols made possible "a stage of logical thinking that is not possible in cultures with only an oral tradition."[9]

The merging of written and oral culture happened over time, with elements of the old oral tradition being incorporated into the growing

use of written texts in Western culture. For centuries after written texts appeared, they remained largely subsidiary to their oral presentation. Manuscripts before printing were bulky volumes. They were often meant to be read aloud to others. Authors such as Chaucer and Boccacio wrote their stories in the form of stories being recited orally, and probably most people who were exposed to their writings heard them read aloud.

Printing had a different impact from writing. Greater legibility of print lead to more silent reading and a changed relationship between the reader and author. This lead in turn to styles of writing other than those mimicking the oral style.[10] Among other changes in attitude or behavior that have been attributed to print are:

> --a sense of private ownership of words;
> --a resentment of plagiarism;
> --a rise of the notion of creativity and originality;
> --a sense that the words of an author were in definitive or "final" form, compared to manuscripts, with their marginal comments and hence in something of a dialogue with the outside world.[11]

Walter Ong suggests that the telephone, radio, audio records, and television have brought us to a period of "secondary orality."[12] Although bearing some resemblance to the old orality, today's orality is different because the audience today is most often invisible and inaudible to the speaker. Moreover, he sees secondary orality as being more deliberate and self-conscious--more like writing and print--because it is based permanently on the use of writing and printing.

Symbols, such as letters, words, and numbers, are used to convey information. Education to a large extent is the process of teaching children to master the manipulation of the symbols used in a given culture. Writing appeared as a complete system in Greece by the 7th

century, B.C., although its final standardization was not reached until the 4th century.[13] It made possible a permanently recorded version of history and thereby created the basis for critical historical inquiry. It also made easier the teaching of logic and specialized learning. The relationship between writing and symbol manipulation skills is central to the notion of the New Literacy, because the power of digital information processes today has the potential to restructure the way in which we use writing.

Writing, particularly analytic writing, increased the explicitness of language compared to the oral tradition. David Olson argues that analytic writing minimizes the number of possible interpretations of a statement. The oral tradition appeals more to shared experiences, interpretations, and intuition; and it is interpersonal and rhetorical. Written texts, on the other hand, appeal to rules of logic for implications and are formal, not intuitive.[14]

Such hypotheses find some empirical support in studies of cultures that use non-phonetic written forms, such as Chinese ideograms, and in surviving oral cultures. In one comparison of written and oral literacy groups, Patricia Greenfield found that the oral cultures rely more on context for communication because communication is more often face to face and shared by smaller groups. Writing, however, uses linguistic context independent of immediate reference. She concluded that context-dependent forms of communication and thought were more primitive than context-free ones.[15]

There is an abundance of indicators -- only a smattering of which is presented here -- that suggests that writing, and by derivation, printing, has helped develop a logical, sequential, sense of

relationships in modern literate societies. Ideas of cause and effect are in the form of things in sequence, a relationship which some anthropologists, linguists and others believe is alien to predominantly oral cultures. Even Chinese writing invests each ideogram with total intuition that leaves little role to the visual sequence of what follows and precedes it. David Hume argued in the 18th century that there is no causality indicated in any sequence, yet in Western literate society we adhere to the notion that certain things must follow from others.

Such suggestions about the relationships of oral literate and written literate cultures to approaches to thinking or behavior must not be taken as absolute. Homeric poetry, for example, though a creation of an oral society, consists of rigid hexameters, while the prose of William Burroughs or the painting of early 20th century Cubists are anything but sequential or logical. Rather, there appears to be evidence that societies tend toward predominance of certain effects associated with the existence or absence of a written alphabet and the widespread use or lack of printing. The traditional literacy, with its roots in the oral mode, is today associated with writing and print.

OTHER CONSEQUENCES OF CHANGE TO WRITTEN LITERACY

The gradual shift to a literacy that emphasized reading and writing skills brought political, social, economic, and cultural changes, few, if any, of which could have been foreseen by contemporaries of the printing press. Print did not burst upon Europe in the 15th century and suddenly change what had been a predominantly oral culture. Indeed, the oral tradition did not and has not died. Robert Pattison reminds us:

"When men learn to write they do not forget how to speak. Even with writing, much information--probably most information necessary for fundamental human activity-- continues to be passed along solely by speech and held in the mind without written record."[16]

The gradual emergence of written texts and then printing in medieval England, and with them the rise of reading and writing skills, did of course have their consequences. They included new kinds of social structures, such as bureaucracy and business, that were encouraged by reading and writing skills. Nonetheless, and perhaps contrary to some modern myths, literacy has not led to uniform outcomes across cultures. Widespread literacy cannot be automatically associated with any particular form of government or economy. Literacy has not always widened the perspectives of those who attain its skills.

In both the economic and political arenas, widespread basic literacy is not a reliable indicator of structure. Rome in the first century A.D. had a large literate population but was a military autocracy. Iceland has had nearly universal basic literacy since the 18th century and is a pacific democracy with an economy based on fishing and agriculture. Sweden and Scotland each achieved mass literacy prior to the 19th century yet remained far poorer than less literate neighbors.[17] On the other hand, in Saudi Arabia, where only 40 percent of the population can read and write, thanks to oil the per capita gross national product is 60 percent higher than in Great Britain. The Soviet Union takes great pride in figures of almost 100 percent literacy. Whether they are accurate is secondary; more important is the lesson that literacy and authoritarian regimes are not antithetical. This would seem to cast doubt on the belief that a literate people will

always demand personal freedoms. Or put cynically, "There is no guarantee that because people can read and write, they can also think."[18]

There is evidence that suggests that a literacy is closely intertwined with the culture in which it is introduced. The outcome is thus specific to each culture. The Shah of Iran learned this lesson the hard way. Although he was successful in expanding reading and writing skills among his people, he either did not recognize or was unable to overcome their traditional religious and cultural values. Thus, the Iranians were simply unable to have access to more information of national or global events on which to project their traditional Islamic values.

FORCES AND TRENDS SHAPING NEW LITERACY

Print was not so much a break with the past as it was a technological force that contributed to an already well-established trend exemplified in England in the 11th century: growing use of written records instead of records stored in human memory. Similarly, the current premise is that the effects of recent electronic technological developments in computers and communications are a continuation of a long and well-documented historical process. Video games, personal computers, the increasing cost of paper and physical delivery, widespread use of automatic teller machines, electronic mail, growth in electronic data base publishing, and others are not isolated nor mutually exclusive developments. They are pieces of a dynamic process in much the same tradition as were, for example, the development of the

steam-driven rotary press, the spread of the railroads, innovation in manufacturing of cheap paper, and improvement in optics for eyeglasses. These latter forces led to profound changes in the nature and breadth of written literacy, from the elite to the masses. Now, other forces are coming together with a potential for a new set of effects.

Computers have been purchased by the millions for homes and schools, with prices of useable systems now under $600 and continuing to drop. Video games, which peaked with sales of about $8 billion in 1982, are merging with home computers that can play the games as well as perform simple word processing, educational programs, household programs, and write-it-yourself programs.

In offices, the success of the IBM personal computer and other computer systems in the $1000-plus category is largely due to the functions these machines have succesfully performed, in particular the spreadsheet calculations, word processing, data base management and information retrieval for small and medium businesses that previously could not afford computerized operations. Well over 2 million personal computers in the $1000-plus category were shipped in 1983 alone. Large businesses are using the personal computers to place direct computer power at the hands of more people. Travelers Insurance Co., as one example, had 2000 PCs in its offices by 1983 and had formal arrangements for 10,000 more by 1986.[19] Aetna Casualty and Life figured it had one video display terminal for each six employees in 1982 but expected to have one terminal per two workers by 1985. Manpower, Inc., a temporary help firm, has experienced such a surge in requests for temporary office workers for word processing and personal computer operators that it is traininng 700,000 of its workers to use these tools. And it is equiping all 1050 of its own offices with personal computers.[20]

According to figures compiled by Xerox, there are perhaps 15 million adults working with VDTs as part of their daily routines.[21] They include secretaries using word processors, order takers for catalog retailers, reservation clerks at airlines, car rental agencies, and travel agencies, stockbrokers checking securities prices, newspaper reporters and editors creating tomorrow's edition, and lawyers researching court decisions. These are not necessarily the people being thought of when "computer" literacy is discussed.

It is difficult to estimate the pace at which cultural change will take place. But the notion that there is something special about "the book" or about print is culturally derived. As noted in the first portion of this paper, the written word was not always held in high esteem. That is, we have become used to and comfortable with print. We have developed conventions for its use. "Print" or "video" are essentially examples of formats in which some content or substance can be displayed or otherwise manipulated by users. Words can come as speech or as writing. And that writing can be gouges carved in rock, toe marks in the sand, ink on paper, or glowing phosphors on a screen.

These are among a multitude of ways in which we can express information substance. Substance may be data, knowledge, news, intelligence, or any number of other colloquial and specialized denotations and connotations that can be lumped under the general rubric of "information."

Process is the application of instruments, such as typewriters, computers, printing presses, the human brain, telephone wire, or delivery trucks in the creation, manipulation, storage and transmission/distribution of substance in some intermediate or final

format. For example, a traditional newspaper, an ink-on-newsprint format, relies on processes including entering thoughts of a reporter into a computer by manipulating a keyboard of a video display terminal with storage in the computer, and the eventual creation of a printing plate and distribution to consumers via trucks. Part of that process may be different should the same article be distributed to some consumers via a telephone link to a video display terminal. In that case, some of the process is the same (the entering and storing of information), the formats are different for the end user (text on screen vs. ink on paper), but the substance may remain constant.

The message of the New Literacy notion is that changing processes and formats may have a long-term effect on how users deal with substance. A generation of children is being exposed to video games and computers at home and school. Unlike print or even radio and television, these devices change the relationship between users and the process by which they interact with information.

Unlike users of a printed book or conventional motion picture, users of digitally based substance find they can manipulate the image on the screen, change it and often store it, without necessarily leaving the footprints of penciled marginal notes or splices that have been the basis for modifying substance provided in traditional formats. The thousands of engineers and draftsmen who are using computer-aided-design terminals are in the forefront of what could be a fundamental change.

Behind this vanguard may be a generation that is starting to discover that a computer is more than a number cruncher or text manipulator. Anyone who has had access to a computer such as Apple's Macintosh, with a graphics program, quickly discovers that one no longer

need be an artist to "draw." What the straight edge was to straight lines, so MacPaint may be to modern graphics. With virtually no more skill than is necessary to connect two points with a ruler today, a user of these types of programs, combined with an appropriate printer, can create diagrams and pictures, for use in correspondence, for business, for engineering study, for charts, or for pure art.

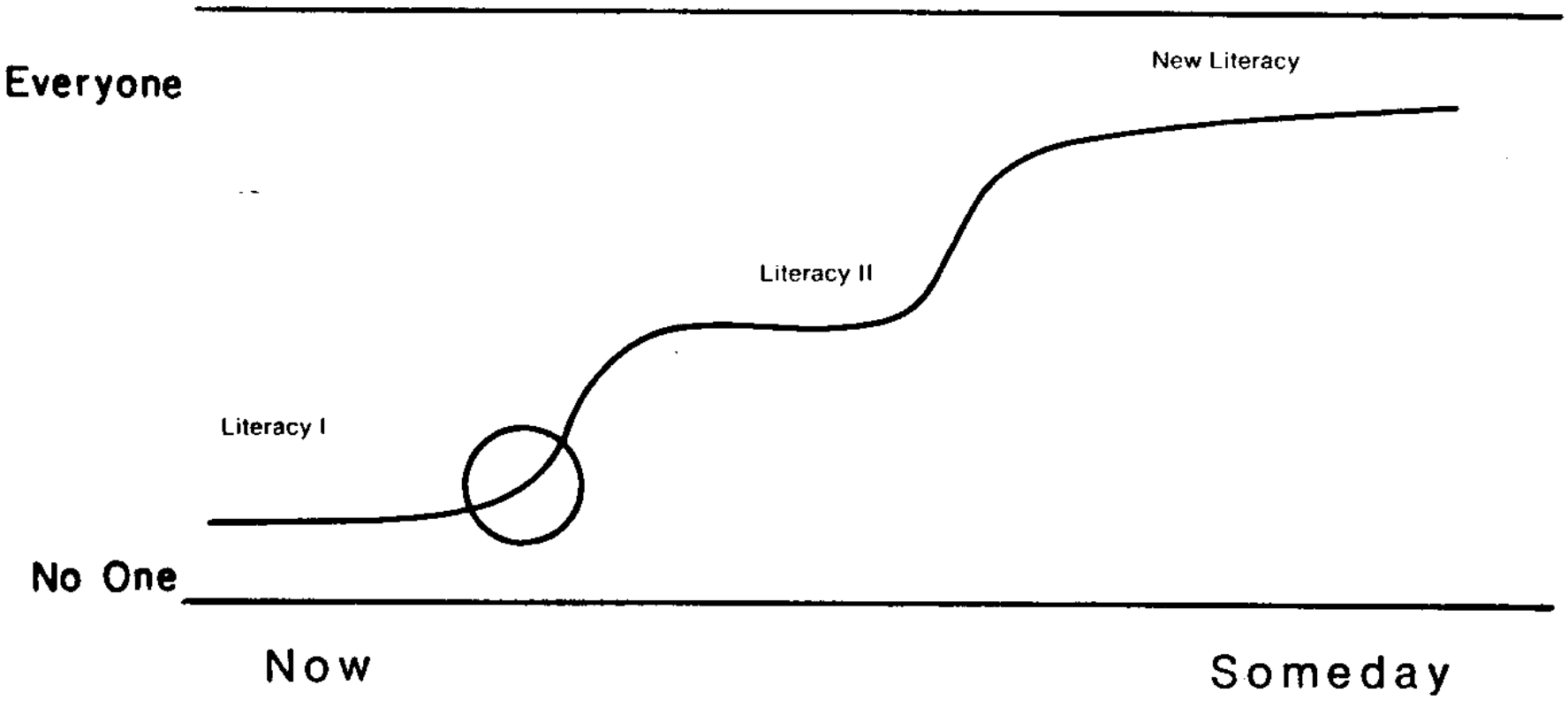
If the New Literacy notion is correct, then over time those literate in newer (but increasingly more commonplace) compunications processes such as these are likely to internalize fresh approaches to using substance, in much the same way that increasing familiarity and comfort with written records changed how information was used when it was stored predominantly in memory and conveyed primarily orally. As the straight edge opened up the world to common use of straight lines, so may the widespread use of computers open up opportunties for lowering and expanding the skills associated with its powers for manipulating information.

STAGES OF DEVELOPMENT OF A NEW LITERACY

There is reason to expect a New Literacy to develop in at least two stages, as illustrated in Figure 1. If the current literacy can be dubbed Literacy I, the first stage of change is Literacy II. This stage might be characterized as "old wine in new bottles." That is, we may be using newer processes and formats for substantive manipulation, retrieval and storage, but thinking about the substance in traditional ways. This is analagous to the early days of television, when the first programs were often televised versions of radio shows (i.e., Fred Allen)

FIGURE 1

THE ROAD TO A NEW LITERACY ?



or films shown in 20-minute segments (the length of time to show 400 feet of 16 mm film with introduction and commercials). Only after some years did the video medium yield programs that took advantage of its strengths, such as the sight gags of Milton Berle and Ernie Kovacs. The 30-minute segment also became predominant.

Parallel to the experiences of early television, today much information retrieval from computer data bases is handled as the automated equivalent of paper-based media. Videotex services present numbered "pages" of content. The concept of a logical sequence from first to last page remains. In the office, word processors are rapidly replacing typewriters, but they are still operated by secretaries who keyboard previously typed, handwritten, or dictated material. Spreadsheet programs replace pencil and calculator used for otherwise similar applications. In the schools, much of the use being made of personal computers is for drills and exercises that are little changed from the older printed versions. Such applications often do serve useful functions and may result in greater productivity or more timely information for decision making. They also create opportunities for experience with electronic information processes. But essentially the change is in using new products to perform conventional tasks using a recognizable work flow.

We may be at the threshold of a rapid take-off in Literacy II, the pre-New Literacy era. The merging of video games and home computers; the accelerating use of personal computers in the home, workplace, and school; the expanded use of intelligent devices as part of appliances and the ordinary telecommunications system, are among the indicators that the technology is finding its way into many aspects of life in the general population as opposed to being only for those in the computer priesthood.

Stage Three: The New Literacy

The New Literacy, however, is the stage in which there would be fundamental innovation in conceptualizing and processing information. This would involve a shift in perceptions about information formats and uses as fundamental as the shift from memory to written records was as the basis for traditional literacy.

Is a learned essay the most effective way to make a point in an era of a multiplicity of audio and visual formats? Or as one researcher has asked,

> How efficient is language of text in serially connected strings or sentences and paragraphs as a medium for communicating complex concepts and relationships? How can such a perfectly linear medium deal with multi-tiered parallelisms and connections of today's reality? With more words, longer sentences, fatter books?[22]

Paradoxically, New Literacy may see a return to the need for the older skills of oral composition. In the evolution to Literacy II, managers and authors have discovered the increased efficiency of dictating messages and compositions onto audio tape for keyboarding into a word processor. Even with the rough edges of dictated composition, the ability to read the transcribed sentences and make penciled corrections and then changes at the word processor is more productive than alternate means of getting thought into polished print. Although dictation has long been used, its combination with inexpensive and highly portable audio cassettes and word processing makes this technique viable for more people at lower labor costs than former methods of stenography and frequent retyping of imperfectly dictated thoughts.

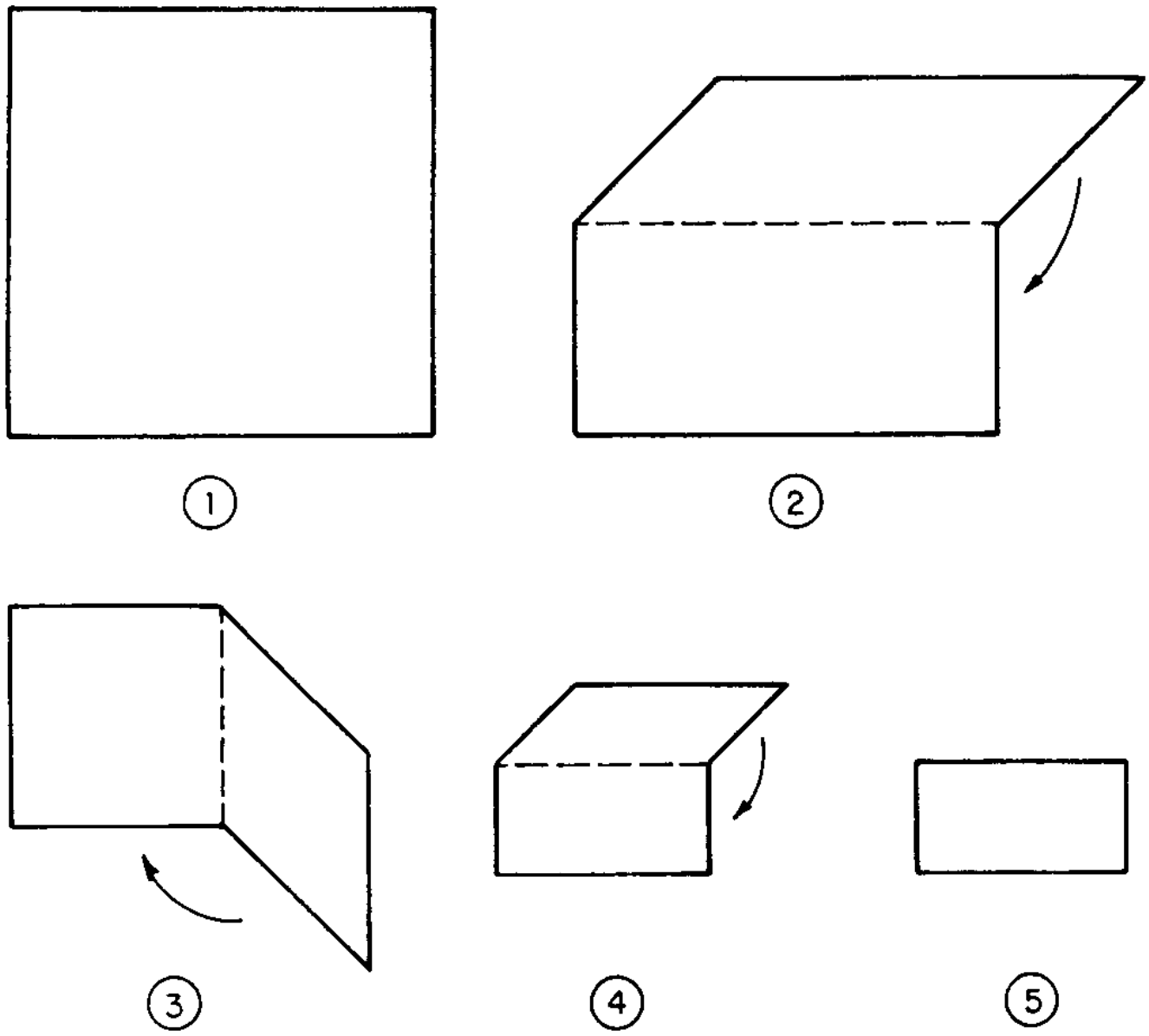
The New Literacy application of such oral composition may arrive with reasonably reliable voice recognition capability of computers. This would permit bypassing the keyboarding of messages almost completely. Thus, skills of oral composition and even dictation (only now to a machine) may once again become essential components of literacy, as they were prior to the development of the printing press.[23]

One researcher, psychologist Howard Gardner, has recently introduced a reformulated theory of multiple intelligences in Frames of Mind. He argues that linguistic intelligence, the one most commonly measured by intelligence tests, is only one of six intelligences, the others being musical, logical-mathematical, spatial, bodily-kinesthetic, and personal. His theory is consistent with research that has provided evidence that different parts of the brain control different abilities or in Gardner's term, intelligences. For instance, to the extent that reading is a visual experience, it might be considered a form of spatial intelligence. Yet, linguistic skills have been shown to remain intact even when visual-spatial portions of the brain have suffered massive injury.[24]

Spatial intelligences, says Gardner, "are the capacities to perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and to be able to re-create aspects of one's visual experience...."[25] A spatial problem may be described in purely linguistic form. Figure 2 is a visual-spatial statement of a problem. It may also be described in linguistic form as follows: Take a square of paper, fold it in half, then fold it in half twice again. How many blocks would be created on the sheet after the final fold?

FIGURE 2

Spatial-Visual Presentation of a Problem



HOW MANY BLOCKS EXIST AFTER THE FINAL FOLD?

Different people will find the visual presentation more or less difficult than the linguistic description. It may be hypothesized that which one is easier for most people is largely dependent on the values a culture places on the development of these skills. Gardner points out, for example, that while traditional cultures place major emphasis on oral language, our culture places relatively greater emphasis on the written word.

Information is largely gained by reading and expressed in writing. He continues:

> While oral and written forms of language doubtless draw on some of the same capacities, specific additional skills are needed to express oneself appropriately in writing. The individual must learn to supply that context that in spoken communication is evident from nonlinguistic sources [such as gestures].... As an individual becomes more skilled in one means of expression, it may well become more difficult for him or her to excel in the other.... [emphasis added]

If this somewhat controversial observation is valid, the New Literacy may involve a lessening of conventional print-dominated behavior, accompanied by the development of intellectual and creative processes tied to the random access and "floating in space" nature of electronically stored information.

Publishers of children's books in Great Britain, for example, are concerned about the 38 percent decline in retail sales between 1972 and 1981. They are placing much of the blame on television and video games. (They have apparently ignored the declining birth rate.) In their panic, they have cited Bettelheim and Pribram who believe that books and reading are fundamental to the development of imaginative faculties.[27] Such beliefs, however, would seem to be precisely the trap of the

cultural blinders imposed by the current concept of literacy. Print literacy may point minds toward a particular direction of creativity and imagination, but it may block out other forms.. The interactive, manipulative, "real time" processes fostered by computers (including video formats in conjunction with devices such as the video disk player) may therefore lead to entirely new or expanded forms of imagination for a greater proportion of society. While this may be unsettling to traditionalists, in itself it is likely (if it indeed comes about) to be neither good nor bad--just different.

The types of seemingly random failures that sometimes plague automatic control systems, such as those that troubled the Oakland-San Francisco BART subway system, have been attributed to a weakness in holistic analysis. Eugene S. Ferguson, a historian and Curator of Technology at the Hagley Museum, reasons that such malfunctions are a product of the rationalistic numerical analysis that dominates over nonverbal thought. "Because perceptive processes are not assumed to entail hard thinking," says Ferguson, "it has been customary to consider nonverbal thought among the more primitive stages in the development of cognitive processes and inferior to verbal or mathematical thought."[28]

In fact, reasons Ferguson, just the opposite may be the case. He believes that the ability to think holistically and intuitively rather than sequentially and logically may be the skills more appropriate to the tasks facing us in the coming decades. A less extreme -- and more supportable -- view would be that an increased proficiency at holistic/intuitive reasoning could be a helpful <u>supplement</u> to our traditional skills in logic.

Although we might think of intuitive behavior as opposite from logical behavior, the two concepts are not necessarily opposites. Kids working their way through screen after screen of a video game, avoiding apparently randomly appearing hazards while shooting moving targets, may seem to be intuitive. Yet perhaps there is some underlying logic these kids have internalized -- and couldn't articulate if asked -- that accounts for their seemingly intuitive moves. At the least, the argument could be made that some value system is behind the apparent intuition.

Sherry Turkle, a psychologist at the Massachusetts Institute of Technology, has studied and observed children and adults in various stages of their familiarity with computers, including video games. Among a particular subculture of computer users -- hackers (computer fanatics whose lives revolve around programming computers) -- she has reported that many describe their experience in terms of a "mind meld" concept popularized by the Mr. Spock character in the television series "Star Trek." What this extreme group of users describe is a situation where they feel their own minds become one with the computer (or with a person across space communicating in real time via electronic mail).[29]

Turkle has also identified stages computer users pass through that may apply to a more general population. First, she has observed a metaphysical stage. Users ask philosophical questions relating to artificial intelligence, such as "Can a machine really be made to think?" A second stage is that of mastery--winning over the computer. Hackers are obsessed with mastery. Other users finding themselves spending hours trying to get a "bug" out of a program or learning the functions and nuances of an applications program. The final stage is

identity, wherein the benefit of the computer is internalized. It does more than perform a specific function but it "helps determine self." In the long term, speculates Turkle, the computer may result in a "new model of the mind," a somewhat controversial notion explored by linguist Noam Chomsky, among others.

In analyzing the fascination of so many children (and adults) with computer-driven video games, Thomas Malone studied the components of the games. His conclusion is that they fulfill identifiable intrinsic needs, including the challenge of achieving a well-defined goal and stimulation of curiosity. Malone suggests that these intrinsic satisfactions can be built into educational applications of computer instruction.[30]

His work, as well as that of Turkle, suggest why interactive digital processes may have a more profound long term effect than television has had. Television, as it is generally used, is a far more passive medium -- its severest critics would call the bulk of its programming mind deadening. Our intent here is not to become involved that debate. However, while at first brush we might see considerable similarity between the potential of television in 1950 and that of compunications today, the parallel is quite superficial.

The three-dimensional, interactive nature of today's video games only begins to suggest the dimensions of the possibilities of changing processes. Creators of computer-controlled randomly accessible video disks are just starting to explore the non-linear dimensions of that process. Consider a video "map" of the German city of Dusseldorf on a video disk created by Interactive Television, Inc., a Rossyln, Virgina firm. Using a keyboard, a user can type in the name of any street or

landmark. It appears on the screen in full video. Manipulating a "joystick" allows the user to proceed down the street, looking straight ahead, as if driving a car. However, the user can request a view left, right, or rear. At any point, the user can switch to an aerial view of the street or an intersection. Another command allows zooming in or out to see details or surroundings. Or the user can change to a street map of either the immediate vicinity or, for context, of the entire city. A marker indicates the location of the user. On a second monitor, a computer-generated drawing constantly indicates where users are in relation to the sector of the street where they started and nearby cross streets.

This application therefore combines full motion video, a printed map (on video), and a computer image. It allows users to alternate instantly between being amidst everyday reality (i.e., one's routine ground level view of the street) and levitating above it at will (the aerial shot). It mixes detail and context. It has neither an obvious beginning nor end. And it is controlled in infinite variations by individual users. In time it may turn out to be as primitive in technique and application as was D.W. Griffith's "Birth of a Nation" in the early days of motion pictures compared to George Lucas' high-tech "Star Wars." But it suggests the potential break with the basic literacy skills that have shaped much intellectual behavior for nearly 1000 years.

This digital map emphasizes the benefits that could accrue from combining holistic with sequential/logic skills. The written and spoken word and much of the technology of these has been useful for presenting discrete pieces of information. Man has had to pull these pieces

together into some general principles. The skill needed to see a whole from the pieces varies widely in society. One consequence has been a tendency for us to lump things into discrete--and often polar--categories. We have good and bad, black and white, live or dead, high or low, and so on. The range of alternatives of the video map--and this is just a handy example--suggests the opportunity for organizing elements into a continuum of alternatives instead of the either/or we thought we were boxed into.[31] One strength of the computer is the ability to organize, to find commonalities, to switch from detail to overview. Instead of having to rely on a relatively small number of people who have the skills for high level synthesis, compunications technology may make synthesis available to a much larger number. This potential change has implications for modifying decision making.

POPULAR CONCEPTIONS OF THE MEANING OF WIDESPREAD USE OF COMPUTERS

The mass media today are filled with articles about what is often characterized as computer literacy. Some of these representations are more thoughtful or accurate than others. But such articles do symbolize the rise in the popular consciousness of compunications in daily life. The following sampling is meant to suggest the range of understanding and perhaps the direction of at least the short term public agenda in this area.

Many of the subjects in these articles express the headlong dash of schools -- or the need for the schools to get involved with -- teaching students about the computer. Typical are articles such as "Educators See a New 'Must' for College Course: Computer Literacy"[32] and "At High-Tech High, Everyone Gets C's--in Computing."[33]

The pressure to put microcomputers in the classroom seems filled with the urgency of the Oklahoma Land Rush of the last century. A national survey from Johns Hopkins University indicates that in January 1983, 53 percent of all elementary and high schools in the United States already had at least one microcomputer used for instruction. In the last six months of 1982 nearly half of secondary schools that did not own a microcomputer bought at least one, so that 85 percent of high schools had at least one computer by 1983. Two-fifths of the high schools had five or more microcomputers. Even in the poorest school districts, 41 percent of schools had microcomputers.[34]

At the college level, the scramble is as great. At Manhattan's New School, computer course registration accounted for almost 10 percent of the 25,000 enrollment in the Fall 1983 semester. A new course on "Computer Literacy" attracted two times the 1100 places that were available.[35] Colleges and universities including Drexel, Carnegie-Mellon and Clarkson are requiring new students to purchase personal computers as standard equipment, along with textbooks and other routine supplies.

Summer seems to be no time to relax, either. One educator notes that computer camps "come into existence almost daily."[36] More than 100 of the traditional camps accredited by the American Camping Association offered computer instruction by 1983 and at least a similar number of camps have been established that specialize in computer instruction.

Contentiousness can be found in the variety of viewpoints of the role of computers in the workplace and in the home. One study, funded by the National Science Foundation, speculates that by the end of this century electronic information technology will have transformed American

home, business, manufacturing, school and political life.[37] Computer-based technology is being attributed with the beneficial ability to lead society to a new era of higher productivity and of improvements in the quality of work. But at the same time, there are warnings about implications for invasion of personal privacy by business and/or governments and so-called information gaps between information haves and have-nots.

A Congressional task force is assessing whether or not the information industry will be the "new engine of real economic growth" in coming decades.[38] Yet rather than growth, some authorities worry about economic disarray and radical changes in the workforce. "Technological displacement is occurring everywhere, from the design shop to the supermarket checkout counter," observes an official of the AFL-CIO.[39]

In response to either perceived opportunities or perceived threats to compunications-based technology, many public policymakers are looking to "high-tech" to bolster older manufacturing-based economies. Typical is Pennsylvania, which is allocating millions of dollars to buy computers for its public schools (more than $5 million in 1982-83), with substantial amounts being spent to train teachers to use this equipment in the classroom.[40]

Challenging Assumptions

These articles suggest that the link between the use of computers in schools and higher education and their long term role and impact in society and the economy appears to be based on the assumption that job opportunities in the industrialized world increasingly will be in professional and technical areas that require considerable education and training in computer-related skills. A corollary assumption is that

high technology will require upgraded skills because workers will be using computers and other technical equipment.

There are responsible studies that indicate that these are misleading assumptions. According to one analysis, the "expansion of the lowest skilled jobs...will vastly outstrip the growth of high-technology jobs."[41] Moreover, high technology industries and their products are "far more likely to reduce the skills requirements of jobs in the U.S. economy than to upgrade them."[42] Indeed, more than 20 years ago, Harvard Business School professor James Bright studied how automation affected job skill requirements in several traditional manufacturing industries. Contrary to the common assumption of a need for increased skills, Bright found that after a short period of a need for increased skills, such requirements sharply declined as the degree of automation increased. He observed: "Many so-called key skill jobs, currently requiring long experience and training, will be reduced to easily learned, machine-tending jobs."[43]

Even at the professional level of management, there is today debate on the question of the need or even desirability of computers. One management consultant argues that "top managers must learn to cultivate ignorance. The higher you go, the less you should know about what is actually going on. Managers must rely on others to know."[44] Ray Moritz, a vice president of Computervision, a CAD/CAM manufacturer, claims that "even after 20 years in the computer business he wouldn't touch one of those things."[45]

This attitude has found at least some support, judging from the letters column of The Wall Street Journal. But it has also brought responses such as the newsletter editor who wrote: "Realize that

personal use of computers brings a new literacy to executives and managers by enabling them to exercise imagination and creativity."[46]

It is in this context that the notion of a New Literacy is worthy of study. Traditional literacy was not necessary for a worker to move from the farm to a factory although it became a requirement to move into supervisory and managerial positions. Perhaps the New Literacy may not be a requirement for a service or information-based economy. Still, the traditional literacy has been instrumental in creating an educated population, with attendant benefits for the personal quality of life and for growth of scientific and humanistic culture. What of a New Literacy?

PLAYERS AND STAKES

The notion of a New Literacy has implications that could permeate all aspects of society and institutions. Some constituencies are affected directly. Print media businesses are asking about the future of their ink-on-paper products. Should they take comfort in the current resistance of the mass consumer to switch to electronically delivered information services, or will the next generation of potential newspaper/magazine/book buyers be more responsive to electronic retrieval and manipulation? Banks and other financial institutions have already found a sizable segment of customers (initially their younger ones) ready to use automatic teller machines. Now, in Great Britain, a relatively small savings bank has made the strategic decision to channel capital funds into providing customers with video terminals for electronic home banking, instead of building branch offices.[47] Will similar decisions start to be made on a similar scale elsewhere in the industrialized world?

Educators are among the most concerned about immediate implications, in particular on issues of curriculum design and materials budgets. Questions are being raised about what schools and higher education should be teaching. Business institutions ranging from smokestack industries to high-tech research organizations are trying to predict their need for certain skills. They are looking for answers to concerns about productivity and product or service quality. Government policymakers are involved with direct questions, such as priorities for expenditures for education and job retraining, and indirect issues, as seen in international trade concerns and the desirability of an agenda for a national industrial policy.

The breadth of the indirect effects of a potential New Literacy may be seen in recent evidence that a few bright, generally law-abiding middle class teenagers are using their new computers and skills to invade private computer facilities via telephone connections. The popular film "War Games," released in the summer of 1983, told the story of a teenager who first gained access to his school's computer and changed records in it and then almost started a nuclear war by tapping into a military computer using his home computer and the public telephone network. Life mimicked art in 1983 when the FBI uncovered several groups and individual teenagers who had gained access to hospital, defense, and other private computer systems, for the most part apparently for the challenge rather than for sinister ends. The incidence of this new type of crime, much of it coming from adolescents who would never consider traditional burglary, is as much an indicator of a socio-cultural change as are the more frequently cited positive indicators.

The stakes involved in the New Literacy are immense, although not all quantifiable. If the education community is slow to understand and respond to changes, the loss will not be in terms of jobs for teachers or in sales of textbooks, but in long-term effects on society and, in the case of a given state or locality, the ability of its industry to compete with others who were more responsive. The failure of a newspaper publishing company to recognize the coming of a New Literacy may result in an erosion of its traditional business and perhaps loss of market opportunity for new business. Nevertheless, neither type of change is likely to happen overnight. Change that is technologically inspired is difficult enough to track in real time. Change that is culturally derived, which is at the base of the New Literacy, tends to be incremental as well. For many years, there may be little hard evidence of fundamental shifts resulting from the skills incorporated into literacy. Then, the confluence of several needed technological developments and the maturing of cultural trends may result in relatively rapid effects.

For example, one frequently expressed technology-based reason given for why electronic display will not become a popular alternative to print is the relative crudeness of the resolution of video displays compared to printed text. Extended periods of reading text from a screen has been blamed for headaches and eye stress. Full screen video displays also have not been portable and are thus considered at a disadvantage compared to print. Similarly, a typical culturally based apology for print is provided by a group that is funded by the book industry:

> . . . (I)n the public consciousness books lend permanence, respectability, and credibility to a venture. The popular image of the book--which some people had expected to be demolished by competition from the electronic and non-print media--remains unchallenged as a symbol of knowledge.[48]

However, recent experience with electronics in general and with semiconductor technology in particular suggests that portable, high-resolution flat screens are in the offing. Low resolution flat screen displays came on the market in substantial numbers in 1984, capable of showing as much text as a CRT monitor. Several manufacturers are already marketing portable television sets using liquid crystal flat screens. It is reasonable to assume that within the foreseeable future the argument of portability and resolution will cease to be an issue. Similarly, work is proceeding with downloading text (that is, sending text via telephone, cable, or even broadcast to an electronic storage medium such as a floppy disk or erasable read only memory) or simply selling in retail stores complete works of print encoded in semiconductor modules. When, and at what cost, these developments will be ready for the mass market is less crucial for this discussion than is the point that technology is likely to provide the necessary infrastructure for a New Literacy.

TOWARD AN AGENDA FOR STUDYING THE NEW LITERACY

The agenda for research of the New Literacy clearly goes beyond such narrow questions of whether all children need access to a microcomputer and need to learn computer programming. Rather, the objective of this line of study is to understand better the forces that will determine

when, or if, the model of Figure 1 will be played out and with what likely consequences. Thus, among the potential questions and issues --issues on which debate may not yet exist but on which the stakes may be high and the outcome therefore important-- that may need to be addressed are:

-- What are the underpinnings of traditional literacy and what is their relationship to current forces that may impinge on literacy?

-- What are the elements of newer information technologies that may shape future information processing?

-- What is the correlation, if any, between available technology and the substance--or content--that is gathered, created, stored and transmitted to seekers and users of information?

-- What are the nontechnological factors that facilitate society's acceptance of elements of a literacy?

-- What bundle of skills may make up a New literacy and how, if at all, will they complement/supplement the traditional bundle of literacy skills?

These and similar general questions and issues will form the basis for investigating areas of New Literacy as they may apply to institutions, organizations, and the individual. As such, it may affect policy in areas of education, labor, the workplace, law and government.

Table 1 is suggestive of the areas in which the evolution of new tools and processes made possible by computers and computer-aided devices may have some effects that can start to be tracked today. The listings are not exhaustive, nor are they mutually exclusive. For example, in looking at institutions, one would also be concerned with organization. Or the study of skills overlaps with cognition and

learning for individuals as well as with schools and universities as institutions. Table 1 does present the start of a framework for exploring areas that would be affected by a change that grew from the curve presented in Figure 2, from traditional to new literacy.

TABLE 1

FRAMEWORK FOR RESEARCH ON THE NEW LITERACY

Skills	Organization	Institutions	Individual
Read	Hierarchies	Governments	Cognition & Learning
Write	Centralize/ Decentralize	Corporations	Relationships
Infer	Power	Schools/Universities	Home
Synthesize	Authority	Workforce	
Analyze	Accountability	Organized Labor	
Recall	Responsibility	Professions	
Speak			

Literacy Skills

The ability to read and write is generally considered the entry point of literacy in most modern cultures. Reading, however, does not have to be from a printed page--it can be from light projected through film or glowing phosphors on a screen in the shape of words. Writing less often means a fine cursive hand than the ability to compose sentences to express ideas, independent of the technology (quill pen on parchment, keyboard to a VDT).

We also assign degrees of literacy in relation to other skills that are considered either helpful or essential to function at some higher order of society, among them: the ability to speak well, to recall facts, to infer meaning, to analyze facts, to synthesize ideas.

Changing the array of tools available is not likely to affect the tools themselves, but may have an impact on the necessity to become more adept at one or more of these skills and the dégree of ease or difficulty of doing so. As with the earlier example of the straight edge and the skill in drawing straight lines, there is anecdotal evidence that computers and certain applications programs may enhance the ability for more people to gain certain skills. Spreadsheet programs combined with an integrated graphics capability is one example. Relational data base programs for personal use may be another. The tortuous exercise that many students have to go through of creating an outline may be expedited by programs that can create outlines from entered thoughts (whether the program can aid in the development of the thoughts themselves is still subject to debate). There is some evidence, from limited trials, that word processing programs have helped some school children become better writers--and readers.[49]

As an agenda item, research might include historical studies of forces that affected literacy skills in previous eras, such as writing, printing, and mechanization. This could be tied to an analysis of causes and effects (e.g., to what extent did cheaper printing techniques in the 19th century help push mass reading skills or did the need of industry pull mass literacy into society?) which policymakers today might find helpful in their need for crystal-ball gazing.

As another agenda item, developments in skills can be tracked as part of the socialization and education process--at home and in the schools, or as part of the work training process. One attempt at doing the latter is summarized in Table 2.

Are there any reliable measures that will enable some quantification of trends toward Literacy II and eventually the New Literacy? In one limited but ongoing unpublished study of the Program, the want ads in The New York Times have been analyzed annually for the same day since 1977. It has tracked jobs for word processor operators and for secretaries required to have familiarity with word processing, for travel agents who must be familiar with online reservation systems, and for accountants with skills in using automated systems. Table 2 shows some of the results through 1984. Other indicies for which baseline and subsequent data might be useful include microcomputer sales to various user groups (e.g., home, school, workplace), sales of software, library expenditures on equipment and software, number of titles and sales volume of educational computer software, sales of interactive videodisk machines and programs, volume of use of on-line information services in both residences and the workplace, sales of modems, and volume of traffic over telephone local-area digital-transport networks.

These and other measures might help to indicate the degree to which the infrastructure and operating components which would seem to be necessary for the evolution of the New Literacy are being put in place.

Productivity. The common wisdom holds that a well-educated (therefore presumably literate) workforce, is a more productive one. What skills are associated with productivity in the growing service/information sector of the economy? Are they associated with a particular literacy? And can productivity be measured in qualitative terms as well as quantitative, e.g., a piece of market analysis that is more accurate because of the ability to access and manipulate more data?

TABLE 2

NEW JOBS/SKILLS IN THE WORKPLACE
AS MEASURED BY WANT ADS*

A. Overall Demand for Compunications Experience

	Total # Want Ads	# Requesting Experience	% Experience
1977	1234	72	5.8
1978	1531	103	6.9
1979	1402	122	8.7
1980	1476	127	8.6
1981	1449	133	9.1
1982	1160	120	10.3
1983	1094	155	14.2
1984	1529	257	16.8

B. New Jobs vs. New Skills

	# New Jobs	%	# Mentioning New Skills	%
1977	42	3.4	30	2.4
1978	67	4.3	39	2.5
1979	60	4.2	62	4.4
1980	66	4.0	67	4.5
1981	65	4.4	68	4.6
1982	50	4.3	70	6.0
1983	62	5.7	93	8.5
1984	60	3.9	197	12.9

C. Automation in Selected Occupations

	% Travel Agents	% Bookkeepers	% Secretary/Typist
1977	0	12	0
1978	0	13	2
1979	11	14	3
1980	22	18	3
1981	50	15	8
1982	71	24	15
1983	79	31	16
1984	93	36	26

* From The New York Times, fourth Thursday in June for each year. Counted were jobs or skills that mentioned compunications skills. Examples of new jobs include: Vydec, Wang, CRT, mag card, NCR, keypunch or computer operators; data entry clerks; word processors, systems analysts; programmers; telex operators, data processors. Examples of new skills include: "Experience with" or "Knowledge of" EDP, ADP, computerized systems, payrolls, etc.; "ability to use" word processing, mag card, SABRE, APOLLO (air reservations systems), Compugraphics, NCR, and IBM machines.

Organization and New Literacy

If knowledge has anything to do with power, then the ability of more people to have more information (maybe knowledge, maybe not) may over time affect the relationships within and among organizations. Traditional concepts, such as current limits to managerial span of control, evolve new meaning. The ongoing debates over centralization vs. decentralization may be affected. And the traditional hierarchical relationship in most organizations may come under new forms or pressure.

Implications for organizational structure. At a design facility of a large Detroit manufacturer, seven draftsmen have replaced their "boards" with computer-aided-design (CAD) terminals. Although the objective of the change was to improve their productivity (it has--many jobs are done in half the time), some of the results were unexpected. The draftsmens' jobs had been to take a design from a product designer and make the drawings from which a product engineer could make molds to create the part. But using the CAD process, the draftsman is able to create a three-dimensional design that can drive the machines that cut the mold directly. The draftsmen are thus encroaching on the turf of the engineers. At the other end, their capacity for creating a three dimensional image and for changing its shape or other characteristics by a few instructions to the computer has made them into designers as well. This organization is now having to deal with the complications that arise when the boundaries among jobs blur as the result of technology.

Studies of information-intensive industries. There are already several types of jobs and industries that are well along in a change to compunications-based structures. The securities trading business, for example, has always been an information-intensive one. Nathan Mayer Rothschild used his sophisticated news service to get word of the outcome of the Battle of Waterloo back to London hours before his rivals, providing him with a profitable trading advantage. Today, the trading rooms at investment and brokerage houses consist of more video display terminals and telephones than traders.

In the airline business, compunications has dramatically altered reservations handling, presumably giving airlines much greater control over load factors and scheduling. Pilots, who have long had to monitor dozens of instruments and make numerous calculations and judgments under pressure, are flying increasingly in cockpits where most of the monitoring is done by computers. As one report described the new planes: "...130 microprocessors...control everything from flight paths to cabin temperatures." Six video displays in the Boeing 757 replace many gauges and dials. "Two of the screens have replaced the flight engineer. Pilots, whom Boeing designers call "flight managers," are needed for less flying and "much more monitoring of sophisticated flight information."[50] This is already being translated into new designs for jets airplanes, taking advantage of the computer's superior ability to simultaneously control more surfaces than could a human pilot.

In engineering and drafting facilities, T-squares and even calculators are giving way to computer-aided design. Light pens are replacing ink pens, as designs can be drawn for representation on a video display screen and manipulated to reflect modifications, to

simulate forces and stress on the element being designed, even to reveal a third dimension of a two dimensional drawing. In such cases, draftsmen are learning to use the system as more than an automated two-dimensional processor. They have started to think in three dimensions and as a result to add design and engineering features to their jobs.

Jobs such as securities trading, flying, scheduling, designing and drafting may turn out to be unique exceptions to long term trends--or may indeed be in the forefront of changes that will permeate other jobs and industries. Either way, they are ripe for case studies, to better understand how these jobs differ from the pre-compunications era; what different demands they place on the people performing them; how, if at all, the technology has affected the skill mix and the skill levels of job holders; whether the newer way of performing the jobs has led to different ways of formulating solutions to problems or of creating opportunities that had not been considered previously.

Institutions and the New Literacy

There are implications in the New Literacy for government, business, schools and universities, professions, and the workforce. These include the relationship between these institutions and their constituent groups and the role of the institutions themselves. As an example of the former, what may be the consequences for the workforce as many routine jobs are taken over by intelligent devices, such as the scanners at supermarkets check-out counters and robots in many phases of an increasing number of manufacturing jobs? What are the implications for organized labor and their employers? For the schools and universities that educate and train managers, lawyers, draftsmen, welders, and mechanics?

As for the role of institutions themselves, the challenge may be nowhere clearer than in the role of the education establishment, including schools and universities, public policymakers at boards of education, legislatures and Congress, publishers, and teachers' organizations, among others.

In the near term, a salient question may be how to take advantage of the interests and cognitive skills that young children may be coming to school with as the result of experiences with computers in the home or learned in the first years of school. If the school children are at the threshold of New Literacy, while their teachers and the creators of learning materials stay planted in Literacy I, educational opportunities may be missed.

Indeed, the major crunch may be in this transition period. The issue will likely involve what should be taught. Electronic calculators are cheap, highly portable and ubiquitous. Point-of-sale terminals, having replaced the cash drawer in stores, perform all calculations for clerks, including how much to charge for one bar of soap when its price is 3/$.85 and how much change to return to the customer. Word processing programs, quickly replacing typewriters, are incorporating dictionaries that check spelling and even aids that detect grammatical flaws. Thus, just as printing and typing undermined the need to teach fine cursive writing, perhaps the time will come when spending extensive classroom hours on memorizing multiplication tables, spelling lists and the fine points of grammar will be as unnecessary as it has become ineffective, with the time devoted to other subjects.

If the technology permits breaking out of the print/film/audio sequential processes, how can it be--if indeed it should be--exploited

to incorporate the new spatial, non-linear possibilities? In the longer term, this problem may disappear, as the snake gradually sheds its Linear Literacy skin. Eventually, today's 10 year-olds will become adults and assume their place in the curriculum-setting process. It will likely be at this point that we will have a more certain fix on whether there is the start of a change from the print model to an internalized use of digital/electronic processes.

In the meantime, will computers, video disks or other pieces of hardware be incorporated into curricula with more fundamental impact than the film strip projectors purchased in the 1960s and now often gathering dust in a closet? Could the move toward New Literacy reduce the amount of time spent teaching spelling, grammar, and basic arithmetic skills in favor of time on history, language, or composition (this latter may be oral or graphic, as well as written), aided by programs that make use of spread sheet, data base, or word processing capabilities of intelligent devices?

The Workplace. Will fundamental changes be reflected in the workforce? Will these involve merely automating jobs to get higher productivity? Are there real implications for affecting those managerial tasks considered "brain" jobs? In the 1950s and 1960s, there were widespread predictions that automation--the replacement of manual labor by machines--would eliminate large numbers of jobs and extensively change the workforce. These predictions were largely correct, but without the massive structural unemployment that such a scenario implied. Instead, new technologies have established new industries to replace those that have declined and created new types of jobs that more than made up the slack.

Among the institutions that are already having to rethink some practices as the result of technological change is the legal system. One area that is likely to be of ongoing concern is the nature and protection of intellectual property.

The notion of copyright has been closely allied with the development of the printing press. Initially, the control of printing under the British Crown and subsequently the high cost of presses themselves made protection of creative works relatively easy to control and monitor. The printing press made written words widely available, but they were still centrally produced. Film and recorded audio disks have followed similar patterns.

Today, technology has had two consequences that underlie control over intellectual property. First came electrostatic copying, which made duplication of the printed word cheap and highly decentralized. Audio and then video cassettes have made copying of sound and pictures readily available. Thus, not only production but distribution of created works has become democratized. Even more recently, software for microcomputers has become subject to regular unauthorized copying.

Closer to the concept of the New Literacy, however, is the second possible consequence. That is the determination of what really is the intellectual property that should be protected. If a computer manipulates data or other information entered into it, is the output copyrightable--and by whom? Should it belong to the creator of the algorithm of the object or source program the computer used? To whoever owns the computer? To whoever owned the original data? Thus, the questions of what is the original creative work and what is a derivative work, often contentious and litigated points under normal circumstances, are likely to enter a new and less understood dimension.

Documentation and contracts. In 11th-century England, the word of witnesses was given far greater weight in legal and commercial transactions than were written records.

> Witnesses were alive and credible because they could defend their statements; writing was dead marks on a dead surface, unable to clarify itself if it proved to be unclear or to defend itself against objections.[51]

That was one result of a society rooted in oral literacy. Not until the 13th century was the shift to written records complete. In the intervening years, conventions developed that helped make the written form more verifiable: dating documents, having witnesses sign them (so they could be used if the witness disappeared or died), and creating indentures (a jagged tear across a piece of parchment, each half of which had the agreement written in it, so that only the authentic versions would fit together) the use of seals and red tape, (this latter running continuously from page to page of documents to insure no page has been removed), are other examples of verifying devices that helped promote acceptance of written records.

Today, we may be faced with a similar transition period. Videotapes are being used along with photographs for evidence. But to what extent are records on computer tapes legally binding? Would a will stored on a floppy disk carry the same weight in probate as a paper document? Can methods be devised to detect "erasures" or alterations of digitally stored records? How can digitally stored records be authenticated? What are the legal issues that may affect rules of evidence or contracts?

The Individual and New Literacy

Individuals are, of course, the central focus of the New Literacy. The development, and indeed the existence at all, of a literacy depends ultimately on how individuals are affected by the forces around them, whether technological, political, social, economic, or otherwise. In roles as students, teachers, workers, parents, etc., people are the atomic units of any sociocultural change.

There is much speculation of how changing information technology will affect people in their homes and in their social relationships. One area that may be most helpful to explore further is that of how people learn and remember. As the tracking of the skills of a New Literacy needs to look at abilities such as inference or analysis, then it would be helpful to gain greater insight into relatively poorly understood areas such as learning and cognition.

Learning and cognition. After years of study, researchers still do not have a firm grasp of how we learn or remember. What does the literature say about how learning takes place, especially as it relates to the types of formats used: reading, watching, listening? How does active involvement of students in learning (as in role playing) differ from passive involvement (as in listening to a lecture)? What are the implications for the design of teaching materials incorporating the interactivity of computers, videodisks, etc.?

Effects of computer-mediated work. To an extent never before possible, computers can control the speed, accuracy, and measurement of work, particularly office work. For example, it is possible for a computer to count the keystrokes of a sectretary or data input clerk, creating a degree of control that previously was restricted to factory

work. Also, more layers of management can have access--if they choose to--to more information in a more timely fashion than ever before. The chief executive officer could check on daily sales directly, rather than wait for a report from a subordinate. In both these cases, the nature of jobs and reporting relationships might be shifted as the result of widespread use of computer systems. How do workers react when such systems are introduced? Are there long term effects on organizational structure? If so, what are they?

Education and the workforce. Historically, mechanization and automation have lowered rather than raised the skills needed for many jobs. Where point-of-sale terminals and optical scanner readers reduce the need of clerks to read prices and calculate change, when programs that automatically check grammar and spelling can be used by a word processor, what will be the skills on which education should concentrate? According to U.S. Bureau of the Census projections, high-tech jobs will account for only 5 percent of employment growth during the 1980s, far behind the demand for secretaries, janitors, sales and office clerks, and waiters and waitresses. What are the implications for educators?

SUMMARY

Literacy is a learned skill unlike real or non-verbal communicative processes. Western literacy is largely the product of the oral world in which it appeared. Although the direct causes and effects associated with literacy are controversial and unresolved, the ascendency of written over oral literacy in our society has had a profound impact on its development. The written record has enabled us to define concepts with greater precision, to maintain archives and refer back to them for facts and definitions, and to weigh more deliberately the local and persuasive elements of issues. "The capacity to employ various symbolized notations," writes Howard Gardner, "enables one to supplement one's memory, organize one's future activities, and communicate at one time with an indefinite number of individuals...."[52]

Our interest in studying the potential confluence of forces which may be driving toward a fundamental change in the notion of literacy should not be confused with a prediction that it will indeed happen. Perhaps there is something inherent in print that will resist being upset by alternative means of information acquisition and processing. But either way the stakes are high, and the threats posed and opportunities presented are there facing players and stakeholders. Policy and strategy are going to be based on assumptions about the future held by those who make the decisions. By pursuing research on the subject of New Literacy, we hope to help policymakers sharpen these assumptions.

There is a body of evidence that supports the assertion that there are multiple components to a literacy and that these components have

changed with technology and vary among cultures. Although we have much to learn about such areas as the functioning of cognitive skills, the weight of historical precedent would seem to come down in favor of being prepared for today's literate societies' acquiring an expanded set of skills, tools, and processes for literacy. The consequences of this will have to remain just speculation.

NOTES

1 Elizabeth L. Eisenstein, The Printing Press as An Agent of Change (Cambridge, England and New York: Cambridge University Press, 1979) p. 8.

2 M. T. Clanchy, "Looking Backward from the Invention of Printing," Literacy in Historical Perspective (Washington D.C.: The Library of Congress, 1983), p. 16. (Hereafter cited as Literacy).

3 Robert Pattison, On Literacy. (New York: Oxford University Press, 1982), p. 118.

4 M. T. Clanchy, From Memory to Written Record: England, 1066-1307 (Cambridge, Mass.: Harvard University Press, 1979), p. 56.

5 Ibid., p. 88.

6 Richard D. Altick, The English Common Reader: A Social History of the Mass Reading Public 1800-1900 (Chicago: University of Chicago Press, 1974), p. 233.

7 W. C. Helmbold and W. G. Rabinowitz, trans., Plato's Phaedrus (New York: The Liberal Arts Press, 1956), p. 68.

8 See for example: Jack Goody, The Domestication of the Savage Mind (Cambridge, England: Cambridge University Press, 1977); Harold A. Innis, The Bias of Communication (Toronto: University of Toronto Press, 1951); Marshall Mcluhan, The Gutenberg Galaxy: The Making of Topographic Man (Toronto: University of Toronto Press, 1962); Walter J. Ong, S.J., Interfaces of the Word: Studies in the Evolution of Consciousness and Culture (Ithaca, N.Y.: Cornell University Press, 1977).

9 Daniel P. Resnick, "Spreading the Word: An Introduction," Literacy, p. 3.

10 Walter J. Ong, Orality and Literacy: The Technologies of the Word (New York: Metheuan, 1982), p. 122.

11 Ibid., pp. 130-133.

12 Ibid., pp. 136-137.

13 Eric A. Havelock, The Literate Revolution in Greece and its Cultural Consequences (Princeton, N.J.: Princeton University Press, 1982), p. 320.

14 David R. Olson, "From Utterance to Text: The Bias of Language in Speech and Writing," Harvard Education Review 48 (1978), pp. 341-377.

15 Patricia Greenfield, "Oral and Written Language: The Consequences for Cognitive Development in Africa, The United States, and England," Speech and Language 15 (1972), pp. 169-178.

16 Pattison, On Literacy. p. 96.

17 Harvey J. Graff, Literacy and Social Development in the West: A Reader. (New York: Cambridge University Press, 1981), p. 253.

18 Pattison, On Literacy, pp. 149-150.

19 "Personal Computers: And the Winner is IBM," Business Week, October 3, 1983, pp. 76-83.

20 "Agency to Train 700,000 Microcomputer, Word Processing Operators, "Computerworld, July 30, 1984. p. 10.

21 Personal Conversation with Paul Strassmen, Vice President, Xerox, May 10, 1984.

22 Matthew Kuhn (Bell-Northen Research, Ottawa, Canada), "Will Electronic Information Technology Change Our Current View of Literacy in Communication?" Speech at Queen's College, Kingston, Ontario, February 9, 1983.

23 See Joshua Lederberg, "Digital Communications and the Conduct of Science: The New Literacy," Proceedings of the IEEE Vol. 66, No. 11, November 1978, pp. 1316-1317.

24 Howard Gardner, Frames of Mind (New York: Basic Books, Inc. Publishers, 1983), p. 98. Not all researchers support Gardner's theory and his being cited here should not be viewed as our endorsement of all his work. The notion of New Literacy and its possible implications were developed prior to the publication of Gardner's book. Still, he does bring considerable research and interpretation to bear on his theory and, if it does stand up under closer scrutiny, it would help explain why changing literacies can be affected by and have a broad effect on learning, thinking, and so on.

25 Ibid., p. 173.

26 Ibid., p. 95.

27 Bryan Appleyard, "The Struggle for Traditional Literacy," The Times (London), March 14, 1983.

28 Eugene Ferguson, "The Mind's Eye: Nonverbal Thought in Technology," Science 97 (August 26, 1977), pp. 834-836.

29 Sherry Turkle, Seminar, Program on Information Resources Policy, Harvard University, December 14, 1983. See also "The Subjective Computer: A Study in the Psychology of Personal Computation," Social Studies of Science (Beverly Hills, California: Sage) 12 (1982) pp. 173-205, and The Second Self: Computers and the Human Spirit (New York: Simon & Schuster, 1984).

30 Thomas W. Malone, "What Makes Computer Games Fun?" Byte, December 1981, pp. 258-277. The research was conducted for his Ph.D. dissertation in psychology at Stanford University.

31 See John Nasbett, Megatrends (New York: Warren Books, 1982), Chapter 10.

32 Gene I. Maeroff, "New 'Must' In College Courses," The New York Times, April 5, 1983, p. C-1.

33 Jane Carroll, "At High-Tech High Everyone Gets C's--as in 'Computing'," Boston Globe, April 12, 1983, p. 39.

34 "School Uses of Microcomputers," Center for Social Organization of Schools, The Johns Hopkins University, No. 1, April 1983.

35 "Call for Computer Classes Swamping Colleges," The New York Times, June 6, 1983, p. A1.

36 Ruth Bayard Smith, "Computer Camps Flourishing," Boston Globe, August 8, 1983, p. 39.

37 J. Tydeman, et al, Teletext and Videotex in the United States. (New York, McGraw-Hill, 1982) pp. 272-273.

38 John Bowles, "The Economy in Transition," Public Policy, Inc., Somers, Conn., 1982.

39 "Worry Grows Over Upheaval as Technology Reshapes Jobs," The New York Times, July 12, 1982, p. A-1.

40 "Pennsylvania Plans Computer Training to Bolster Economy," The New York Times, September 23, 1983, p. A-1.

41 Henry Levin and Russell Rumberger, "The Low Skill Future of High Tech," Technology Review, Aug./Sept. 1983, pp. 18-21.

42 Ibid.

43 James Bright, "Does Automation Raise Skill Requirements?" Harvard Business Review, August 1981, pp. 42-55.

44 Jack Falvey, "Real Managers Don't Use Computer Terminals," The Wall Street Journal, February 7, 1983, p. 22.

45 Ibid.

46 Robert H. Long, "Computer Adds Up to a Useful Tool," Letter to the Editor, The Wall Street Journal, August 30, 1983, p. 29.

47 Richard Hooper, Chief Executive, Information Services, British Telecom, personal conversation, Oct. 18, 1983.

48 John P. Dessauer, "Trends Update," Book Industry Study Group, New York, August 1983. p. 2. Quote attributed to John Huenefeld.

49 Andee Rubin and Bertman Bruce, "Quill: Reading and Writing with a Microcomputer," Reading Education Report (Cambridge, Mass: Bolt, Beranek and Newman, Inc, Sept 1983). See also Lawrence Feinberg, "Pupils Learn 2 R's with IBM," Washington Post, May 26, 1984, p.B1.

50 "Can We Keep the Skies Safe," Newsweek, January 30, 1984, p. 30.

51 W. J. Ong, review of M. T. Clanchy, From Memory to Written Record, in Manuscripta 23 (1979), p. 179.

52 Gardner, p. 359.