THE TEXTURE OF KNOWING IN THE INFORMATION AGE
INTERPRETING THE PERSONAL COMPUTER STORY AS A CHAPTER IN THE HISTORY OF ADULT EDUCATION

In 1992 it seemed that the David of the computer world, the so-called "personal computer" had succeeded in bringing the Goliath of the computer world, the mainframe, to its knees. Computers started off big, huge, and almost immediately began to get smaller. In 1982 it was the personal computer that prompted Time magazine to declare the computer the machine of the year. At that point the personal computer was only seven years old, compared to the almost forty years that the mainframe had been around. Hostility to mainframe culture was one prominent theme in the birth of the personal computer and the personal computer culture, as is suggested by the name "personal" computer. Since 1982 many have tended to portray personal computers and mainframes as locked in mortal combat for the soul of society, a war which seemed to be over in 1992. What actually happened, however, was not the death of the mainframe and the triumph of the pc, but rather the triumph of networks bringing together mainframes, personal computers and everything in between.

This is, of course, a highly distorted picture of computer history, a caricature. Nevertheless, like a good caricature, it exaggerates in the direction of the truth. The truth is that it is useful for many purposes to summarize the story of the computer in three stages, the mainframe, the pc, and the network stage.

In what follows I shall tell this story, the story of the personal computer, as a chapter in the history of adult learning and education. It is useful to approach this topic as a "story" for two reasons. First, it builds into our essay a standing reminder that computer technology is not standing still. Second, the three stages we have identified can be roughly identified with three important concepts, automation, creation, and networks, which will be important themes.[1]

Since the first computer was only invented during the Second World War, most adults over forty have learned what they know about computers as adults. And since the personal computer, which is what most of us are familiar with, has only been widely available in the last ten years, hands-on knowledge of computers has been for most adults over thirty a skill learned as an adult. Adults and children "are all starting at the same time."[2]

For many adults, learning about computers has been an

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[1]"A friend of mine, a man of science, finds my idea that the narrative can be a form of thought hilarious." The sentiment of this "man of science" is no doubt still widely shared, but recognition of the value of narrative for knowledge is far more widespread than it was even twenty years ago. The quote is from Elting E. Morison, in From Know-How to Nowhere: The Development of American Technology (New York: Basic Books. Inc., Publishers, 1974), p. ix. See for example Renato Rosaldo in Culture and Truth: The Remaking of Social Analysis, Boston: Beacon Press, 1989, chapter 6, on "Narrative Analysis."

[2]Pamela McCorduck, in The Universal Machine: Confessions of a Technological Optimist, quotes the director of a computer education project in Senegal: "With the computer, for the first time in the history of civilization, we are all starting at the same time" (p. 2). The exaggeration of this sentence is characteristic of an enormous amount of discourse about the computer. The same thing could be said about many other technological innovations, from the railroad, to the automobile, to the airplane, to cameras.

experience charged with fear or fascination or excitement or all three. For others it has come as a burdensome necessity. For many, learning about computers has created welcome opportunity to change, to leave a large corporation and launch an enterprise, to leave a boring job and start something fresh. For others the change has been imposed, threatening, unwelcome. For a great many, the computer has meant the loss of a job and even homelessness. For some the computer has become a consuming interest, an obsession, a thrill,[3] for others, such as Wendell Berry, what they have learned about the computer has led them to choose not to associate themselves with it.[4]

For some, "learning about computers" has taken the form of inventing or designing new computers. For one of the designers of three early personal computers, the learning-invention process expressed a political vision, to bring computer power to "the people."[5] For others such as Herbert A. Simon, the computer has been a means of exploring the cybernetic possibility of "substituting machines for any and all human functions in

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[3]See, for example, the experiences described in an article by Herb Brody, entitled "The Pleasure Machine," Technology Review, April, 1992.

[4]Wendell Berry is the most eloquent example. See his simple statement, "Why I Am Not Going to Buy a Computer," in What Are People For?, Wendell Berry. San Francisco: North Point Press. 1990.

[5]Michael Swaine & Paul Freiberger, "Lee Felsenstein: Populist Engineer," Infoworld, 5/45, 105-107.

organizations."[6] In large numbers of organizations, the availability of the personal computer made computer power accessible to middle managers and led to a kind of guerilla warfare within the organization by those at middle and lower levels against the central data management departments at the top.

The way in which computers have been experienced, learned, interpreted is not a matter of individual response alone. There are cultural, ethnic, gender and religious factors involved. "How can African man live in IBM without losing himself?" is a question asked by a Rastafarian, and cited in a study of Black life in corporate America.[7] A female writer is said to identify men with "power, computers, soulless technology, abstract science and efficiency."[8] In the 1991 Gulf War, Saddam Hussein saw the conflict in terms of "Islamic belief against technology."[9]

There is, in other words, not one story of the personal computer but many. In what follows, I will tell the story more

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[6]Herbert A. Simon, cited in Weizenbaum, Computer Power and Human Reason, 1976, p. 244,245.

[7]Davis, George and Watson, Glegg. (1982). Black Life in Corporate America: Swimming in the Mainstream. Garden City, New York: Anchor Press/Doubleday, p. 2.

[8] "Ms. Wolf identifies men with power, computers, soulless technology, abstract science and efficiency." Essay in The New York Times Book Review for April 4, 1993 on Christa Wolf, an East German Communist writer.

[9]Cited in The University of Chicago Magazine, April, 1993, "Is Fundamentalism Fundamentally Changing Society?" by Debra Ladestro. p. 19.

than once, each time seeking to approach a telling which will open up the most fruitful possibilities for human fulfillment, for democratic, equitable, spiritually nourishing life.

This essay is about interpretations, meanings, images, myths. It is about the human experiences and ways of internalizing the machine. The machine itself, as an artefact, is of interest as the "evocative object" of these experiences and interpretations.[10] Since, however, internalizations are what shape external structures and institutions and configurations this essay is about political, economic, social and cultural reality as well, including the computer itself, its uses, its configurations, its ends, as expressions of human choices and goals. It is, to put it another way, an essay about the mutual interplay of external artefact and internal spirit, internal spirit and external artefact, each creating, shaping, and changing the other.[11]

The significance of the personal computer for adult education goes beyond the learning experiences of a generation of

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[10]The phrase is taken from Sherry Turkle, <u>The Second Self</u>, written in 1983. Three years earlier she had expressed the idea of the "Computer as Rorschach." (Turkle, 1980). Even earlier, in 1964, Herbert A. Simon introduced a book on computers and automation with the same idea: "Computers are splendid ink blots." (Simon, 1964, p. ix).

[11]My understanding of adult education and learning is based on Peter Berger's sociology of knowledge (Berger, 1966). Adult education is best understood as on form of "externalization" alongside of the infinitely varied forms described by Berger. Likewise, adult learning is best understood as one form among many of "internalization."

adults becoming computer literate. It goes beyond simply dissemination of knowledge about computers. It also goes beyond the appropriation of the computer as an instructional technology. The full extent of the challenge posed by computers for adult education requires attention to the full range of interplay between the computer and knowledge.

If we are in an information age, in a knowledge society, in a learning society, then the educational professional sits squarely astride the defining resource of that age and society and bears a responsibility to bring critical judgment to bear on what is otherwise a thundering banality.

I approach adult education as a discipline that must place itself within the historical context of the information age and the knowledge society and is responsible for bringing to bear upon this defining feature of the age all of the depth and illumination possible to what is otherwise a potentially superficial sensibility.

THE COMPUTER AND KNOWLEDGE

The computer is linked to "knowledge" in four distinct ways: knowledge about computers, the artificial intelligence enterprise (AI), knowledge production, and research.

Knowledge about computers has been the subject of much attention by educators under the banner of computer literacy. One purpose of this essay is to place the social and cultural processes of knowing about computers within a larger social-epistemological context. For this reason, it is important to bring into the picture other ways in which computers and knowing processes intersect.

The computer is the "smart" machine, whatever that is taken to mean. As such it is a symbol of a massive change in the economic role of knowledge that is affecting all of society summed up in the phrase "knowledge production." This phrase can be taken in two distinct ways, depending on whether knowledge is the thing produced or a resource used in production. In the latter sense it refers to the systematic application of knowledge to the production of goods and services. In other words, it refers to "production" in the economic sense and therefore to "knowledge" as an economic resource. The phrase could also refer to research, that is, the production of knowledge, but I will use it in the economic sense. In any case the computer is linked to both processes, the economic production of goods and services, on the one hand, and research on the other.

The question I want to pose concerns the ways in which the computer's links to knowledge, its role as object of knowing, its role as "knower," its role in making knowledge productive of other goods and services, and its role in the formal processes of constructing knowledge, i.e. research, is affecting the way we think about knowledge and knowing and, therefore, the way we think about education and learning. To put it another way, I want to ask if and how the computer is affecting epistemology.

If we look more closely at these four links between computers and knowledge, it is clear in two of the four cases that the computer might be affecting the ways in we think about knowledge. The first case, knowledge about computers, which I interpret broadly to refer to everything from expert knowledge to computer folklore to interpretations of the computer is, I believe, highly relevant to current epistemological discourse. The second case, which involves those capabilities of the computer which resemble thinking, has already given rise to a large literature exploring its impact on our concepts of knowledge and knowing processes, centered on the artificial intelligence projects. Likewise, through its role in research, the computer is clearly playing a role in the production of knowledge and it seems appropriate to ask about its potential impact in this role not merely on the accumulation of more and different knowledge but also on how we think about knowledge. In the case of economic production, however, to suggest that the computer is affecting epistemology through its role in production may seem far-fetched. It is certainly the case that while a lot of attention is being paid to the impact of knowledge on production, less attention is being paid to the impact of "knowledge production" on knowledge. I want to explore not only how knowledge is shaping production but how the role of the computer in producing goods and services is shaping knowledge. Focusing on the computer will help make this discussion concrete.

The importance of knowledge production for epistemology lies in its impact on the image of science. Science is "establishment" epistemology. It is <u>the</u> legitimate way of knowing and, in turn, plays a legitimating role.

In what follows I want to show how the role of knowledge in economic production, exemplified by the computer, is both re-enforcing the dominant epistemology of science, and undermining it. It is re-enforcing it through its successes, real and perceived. It is tending to undermine it in two ways, first through its failures, its destructive consequences and its differential impact on the population, for example. Second, it is tending to undermine the authority of science as establishment epistemology by exposing the contradiction between science as detached, neutral inquiry and science as intentionally and differentially applied.

THE MAINFRAME WORLD

From the beginning, computers have been used for knowledge production in both senses of the phrase, production of knowledge (research) and production by knowledge (business). The power of the computer to speed up complex scientific calculations made it useful for research. Its ability to store large quantities of data and to perform operations on the stored data efficiently and reliably made it useful for automating routine tabulation, record keeping and information tracking operations in business and government.

The first programmable electronic computer, the ENIAC, was designed during the Second World War to calculate firing tables needed to aim artillery. Scientists knew how to perform the calculations, but the time it took to carry them out significantly delayed production of new weapons. What the electronic computer contributed to the production process was sheer speed. The computer was designed to apply knowledge to production. Ironically, by the time it was built, the war was over, so that the first problem it was used to solve dealt with the hydrogen bomb. Thereafter it was used both for research and military production purposes including ballistic tables, weather prediction, atomic energy calculations, cosmic ray studies, and random-number studies.

The government was the first customer of computer services. The U.S. Bureau of the Census, in 1951, purchased a computer to tabulate the 1950 census. This was the first computer system used for "data processing" purposes, that is, for uses other than scientific, military, or engineering.

In analyzing the impact of computers on knowledge production it is important to distinguish between actual implementation and prediction. Actual implementation in the first years was not as dramatic as prediction. Computers were initially used in business to carry out very mundane tasks such as automating routine office operations, including payroll and accounting. Computers did not bring about the information explosion; on the contrary, managing the information explosion was one of the reasons for introducing computers. In fact, far from being revolutionary, for the most part they fit in perfectly to a trend that had begun much earlier to bring "scientific management" to organizations.

The fifties and sixties, when computers were introduced into business, saw the triumph of the giant corporation, led by the automobile companies. The typical corporation was organized along military lines. It was bureaucratic, hierarchical, structured for control through chains of command, standard operating procedures, job classifications. It was based on the premise that change could be controlled incrementally.

Like the government and the businesses which could initially afford computers, the computers themselves were large machines, "mainframe" systems, which dominated the public image of what a computer was up until about 1975, up until, that is, the invention and proliferation of the personal computer starting in the late seventies and early eighties.

Computers were viewed as the perfect tool for perfecting control in such an environment. Control was the key concept. Control was defined in terms such as "cybernetics" and automation. The computer was the supreme product of "cybernetics," defined as the study of control systems based on communication.[12] Control was understood in terms of stable systems, stable structures that could be automated.

What was the impact of the computer on knowledge, on how knowledge was viewed? To answer this question it is important to consider the <u>kind</u> of knowledge and intelligence that has dominated the invention, use, and interpretation of the computer.

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[12]Cybernetics is "the study of control and communication in machines and living beings" according to Norbert Wiener, who coined the modern use of the term. This definition is quoted from <u>God & Golem, Inc</u>., Cambridge, Mass.: The M.I.T. Press, 1964, p. vii.

Computers sprang from belief in the power of what has been variously described as rules-based, procedural, or "algorithmic" intelligence or knowledge.[13] The computer culture has for the most part focused attention on formal, systematic, procedural knowledge. Computer science today is defined as "the systematic study of algorithms and data structures."[14] An "algorithm" can be defined as "a procedure or recipe that can be given to a person or machine for doing a job."[15] This definition comes from a computer science textbook entitled Great Ideas in Computer Science which identifies the idea of the "algorithm" as "the first and most important" of the ideas that make up the field.

The marriage of the computer, embodying rules-based, systematic knowledge, with "scientific management," or Taylorism, produced the mainframe computer culture, epitomized by IBM.[16] The

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[13]"[C]omputing machines can do anything which can be described in detail with a finite set of instructions." This statement is from the author of information theory, Claude E. Shannon (Perspectives on the Computer Revolution, p. 285.

[14]Norman E. Gibbs and Allen B. Tucker, "A Model Curriculum for a Liberal Arts Degree in Computer Science," Communications of the ACM, March 1986, 29/3, p. 204.

[15]Great Ideas in Computer Science: A Gentle Introduction, Alan W. Biermann, Cambridge, Mass.: The MIT Press, 1990. p. xi.

[16]The interpretation of "Taylorism" is contested. According to Neil Postman, Frederick W. Taylor's book, The Principles of Scientific Management, published in 1911, "contains the first explicit and formal outline of the assumptions of the thought-world of Technopoly" (Postman, 1992, p. 51). These beliefs included the assumption that "the primary, if not the only, goal of human labor and thought is efficiency." According to Peter Drucker, the "most important step toward the 'knowledge economy' was pioneered by Taylor, who "did not start out (as most people believe who have never read him) with ideas of efficiency or economy" (Drucker,

ideal of rules-based knowledge is to be formal, systematic, rational, logical, context-free, explicit.

Thus the computer brought rules-based knowledge, procedural knowledge to bear on production in a way that was unmatched for flexibility, programmability, and versatility. Yet initially, as noted, the computer's actual functions in business and government made it simply one more in a long line of business machines that had been invented and introduced into the scientifically-managed corporation in the first half of the twentieth century to routinize and/or speed up operations.[17]

In stark contrast to the prosaic reality of most computer installations was the accompanying interpretation. Public attention was directed to the future, to what computers would be able to do five, ten, or twenty years down the road. Writing in 1960, Herbert Simon made the prediction that "[w]ithin the very near future - much less than twenty-five years - we shall have the technical capability of substituting machines for any and all

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1968, p. 271). Drucker's "knowledge society" is Postman's "technopoly."

[17]James R. Beniger, in The Control Revolution: Technological and Economic Origins of the Information Society (Cambridge, Mass: Harvard University Press, 1986), concludes, for example, that the "Information Society . . . is not so much the result of any recent social change as of increases begun more than a century ago in the speed of material processing. Microprocessor and computer technologies, contrary to currently fashionable opinion, are not new forces only recently unleashed upon an unprepared society, but merely the latest installment in the continuing development of the Control Revolution" (p. vii).

human functions in organizations."[18] In the same essay Simon refers explicitly to physicians, corporate vice presidents, college teachers as jobs which will be capable of being automated completely (p. 417).

Simon's prediction is a function of his belief in the universal applicability of algorithmic or rules-based knowledge to all intelligence. Put another way, his prediction is a function of his belief that rules-based intelligence is exhaustive of the "mind." This is supported by another prediction, that "in the world of 1985 we shall have psychological theories that are as successful as the theories we have in chemistry and biology today. We shall have a pretty good understanding of how the human mind works" (p. 422).

It is important to note that Simon was not a journalist. He was considered a leading authority in management and is regarded as a pioneer in artificial intelligence, not to mention several other fields of expertise. Predictions like this from pioneers in the field and other experts can be multiplied. What is important about such interpretations for purposes of this essay is the way they colored the impact of computers on how we think about knowledge and knowing. The major effect was to reinforce the privileged position of "science" as the only legitimate way of knowledge.

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[18] "The Shape of Automation," in: Perspectives on the Computer Revolution, ed. by Zenon W. Pylyshyn. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970, p. 409.

Thus the epistemological impact of the computer initially was no more revolutionary than its sociological impact. In both domains the computer functioned in part at least to reinforce long-standing trends. The societal impact on the whole was to re-enforce the existing relations of power, privilege, wealth, status.

Turning to education, adult education in particular, one question concerns the way in which knowledge, skills, competency, understanding of the new technology was disseminated. However, to start here would be to miss the most interesting link between the computer story and adult education, which is to be found in the very origins of the machine, the research, the inventions, the theorizing, the imagination, the speculation, the disciplined experimentation, which occurred. This is one of the important stories of "adult learning" in the twentieth century. One form of adult learning is research, the production of knowledge, and invention.

Once computers began to be used commercially, the need for trained operators, programmers, support technicians, systems designers grew rapidly. The schools and universities could not fill this need. Computer science as an academic discipline was just beginning to establish itself as late as 1964 and its focus was on the scientific uses of computers and research, not on the commercial market. Thus organizations had to hire and train their own computer staff. Initially recruiting from mathematical and engineering students, organizations rapidly found demand outstripping supply. Also it was found that there was a high correlation between programming and language skills so that many adults switched careers to enter the computer field. On the job training was the predominant method of education.

The role of adult education as an organized enterprise in this first phase of computer history was negligible. Likewise, adult education's appropriation of computer technology as a tool in its own programs was not feasible during this period. This is not to say, however, that the computer did not impact adult education. The impact of the computer on structural unemployment in the sixties and seventies is debated. As we have seen, during this period computers were creating jobs. At the same, they were displacing workers, though the extent of such displacement is not clear.

Furthermore, I would speculate that the trends towards what Michael Collins has called the "cult of technique" characterizing far too much of adult education today, were re-enforced by the discourse accompanying the deployment of computer technology. The characteristics of this "discourse" call for further attention. Hyperbole was the order of the day, both on the part of those who championed the new technologies as well as those who opposed them, both on the part of the outsiders and onlookers, the media, and the insiders, the scientists. The result has been a new stage in the construction of the myth of technological progress.

One example will be cited. In 1981 a Japanese computer pioneer, Yoneji Masuda, published <u>The Information Society as</u>

Post-Industrial Society which concluded by spelling out his "vision of computopia," which will be characterized by freedom of decision, equality of opportunity, the flourishing of diverse voluntary communities, freedom from overruling power. Masuda's argument is that the computer, an "ultimate science," confronts mankind with the choice of such a utopia or "destruction of the spiritual life of mankind." Masuda goes even further. "The final goal of Computopia," he suggests, "is the rebirth of theological synergism of man and the supreme being, or if one prefers it, the ultimate life force" (p. 154).

Along the way, it should be noted, Masuda points out that one of the "tremendously superior characteristics" of the computer is "the complete objectification of information" (p. 50). While Masuda's assertions are extreme, he represents one important impact of the computer, the re-enforcement of "scientism," the belief in the supremacy and exclusive legitimacy of science as way of knowing.

At the same time the role of the computer in applying knowledge to economic production, making this productivity of knowledge so visible, so pervasive, so dramatic, threatens the image of science as objective, detached inquiry. Science is clearly implicated in the structures of society.

FROM MAINFRAME TO THE PERSONAL COMPUTER

The personal computer is the most conspicuous symbol of the changes brought about in computer technology by size reduction. Between 1946, when the first electronic computer was actually put into use, and 1975, the conventional date for the appearance of the first microcomputers, the most dramatic technological innovations were those which reduced the size of the components. In weight, the computer went from thirty tons to a few pounds. The reductions in size brought reductions in cost which led to the staggering growth in all aspects of the computer industry and the penetration of computers into all aspects of society.

With the personal computer came the possibility of a new and very different relationship to the computer for everyone, not just the small elite. When the personal computer appeared, the most conspicuous feature of computer systems in the business world was the fact that "users," that is, those for whom the data was being processed, were <u>not</u> in control. On the contrary, the system was under the control of specialists: programmers, operators, systems analysts, and the computer department's managers. A widely used computer science textbook from 1980 refers to the users of the computer system as "perhaps [sic!] the most important people connected with the computer center"[19]

The physical location of the mainframe computer and its peripheral devices gave visible expression to the separation between user and system. They were housed in air-conditioned rooms that were off-limits except to authorized personnel.

The specialists controlled access to the system, programmed

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[19] Gary B. Shelly & Thomas J. Cashman, <u>Introduction to Computers and Data Processing</u>. Fullerton, CA.: Anaheim Publishing Company, 1980, p. 1.19.

it, kept it running. They understood the programming languages required to communicate with the system. With some exceptions all information fed into the system had to go through the hands of the input operator or programmer. All information reported out, again with rare exceptions, went through the hands of the experts.

The language used to describe the technical relationship between the computer, locked up behind closed doors, and the terminals that were outside, in the office, on an input operator's desk, is revealing. It is described as a "master-slave" relationship. A "slave" device, such as a terminal, could not communicate without permission from the master, the central computer. Terminals were "dumb," without any processing intelligence. The relationship was hierarchical, a relationship between "primaries" and "secondaries."[20] Control was centralized. "Peripherals" were utterly dependent upon the central computer and its controlling system software.

The operators tended to be remote from the users of the data, working behind the locked doors and glass windows of the computer room. The programmers also worked in isolation from the users of the data, talking to one another and to the machines themselves. The systems analyst was the link between the system and the user. The analyst was responsible to investigate the

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[20] To be precise, terminals themselves were not secondaries, but were attached to intermediate devices known as cluster controllers that were the actual "secondaries."

needs of the users and design programs that would meet those needs.[21]

What was the state of organizational knowledge about computers prior to the advent of personal computers? Who knew what?

Clearly the knowledge was distributed hierarchically. Controlling expertise was in the hands of a separate department, the Management Information Systems (MIS) department, which might depend upon the vendor on a regular basis for additional expertise.

A high percentage of the MIS programmers, operators, systems analysts and other computer professionals at the time acquired their expertise as adult learners. Very few of them received their computer knowledge in colleges or universities. Most were trained by the companies that hired them, starting out as operators or entry-level programmers or trainees and rising in the ranks to become systems analysts, systems designers, managers.

Deciding what data needed to be collected, how it should be organized for retrieval, and therefore what data could be reported to whom was a process that could take months, even years, because once the decisions were made and the system was implemented it could not be modified readily. This long design and implementation lead time resulted in a certain rigidity in

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[21]Shelly & Cashman, 1.19

such information systems. It also created a strong inducement to centralize and standardize corporate functions to take full advantage of the investment of resources in such projects.

Beyond the walls of the department user knowledge of the computer systems was of a very different kind. Data terminal operators had specialized skills required to look up information and display it. Other staff and even customers might have to learn how to fill out computer data entry forms. Managers had to learn to sift through voluminous computer reports looking for relevant information. The rigidity resulting from the long design and implementation time meant that users had very little control over the information once the system was in place.

The personal computer dramatically changed this. It made possible for the layperson a qualitatively different relationship to the computer. The personal computer is "personal" in the sense that it can only be used by one individual at a time. It is mine. While in use it is under the complete control of that user. That was the revolutionary difference. The large computers were precisely <u>not</u> under the control of the user. They were under the control of someone else, a separate division or department, the computer experts. This was a political, not a technical, difference. The technical boundaries in size and power between personal computers and minicomputers and even mainframes have become blurred with time, but the political difference, the difference in who has control of the machine, has remained in sharp focus.

What the inventors of some of the first personal computers had in mind was precisely a machine that, in contrast to the large systems of the time, would be user controlled. Lee Felsenstein, the inventor of one of the first microcomputers, was committed to the idea that the power of computers should not be restricted to a computer "priesthood." His early designs were influenced by Ivan Illich's idea of "convivial technology," that is, technology that people can teach themselves and others easily.[22]

Byte magazine, in an article in 1983, pointed out: "Many microcomputer owners take comfort in the thought that their entire system sits on a desk in front of them . . . the joy is in the sense of having complete control of the resource"[23]

Personal computers, computers that are used by only person at a time, entered the nation's consciousness in 1982 to such an extent that Time Magazine elected the personal computer "Machine of the Year." The pc had begun making inroads in organizations a few years earlier. By 1982 the flow of computers into organizations was taking on the proportions of a flood.

This definition of the pc in terms of control has been obscured by attempts to define it in technical terms such as size or processing speed or performance. However, all such technical definitions have tended to be short-lived as new developments

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[22] Michael Swaine & Paul Freiberger, "Lee Felsenstein: Populist Engineer," Infoworld, 5/45, 105-107.

[23] (Byte, 1983, p. 402).

have enabled manufacturers to pack more and more technical power into smaller and smaller boxes.

Putting personal control of a computer into the hands of thousands of individuals opened the gates to a flood of innovation, invention and creativity. It also brought into sharp focus what the individual, the user, the programmer, the home computer owner, brings to the computer. With the personal computer it becomes impossible to overlook the interpretive role of society, culture, the person, the way in which society, the individual brings beliefs, feelings, ideas, plans, attitudes to the machine. The machine brings something to society based on its intrinsic characteristics as a rules-based machine, for example. But society brings something to the machine. The resulting interaction or relationship is interactive, two-way.

Using the word "relationship" about computers and humans suggests anthropomorphism. It may seem to beg the question of the "animate" nature of the machine, a contested issue. Yet there is nothing inappropriate about speaking of a person's "relationship" to their automobile, their house, their stamp collection, sailboat, favorite old sweater, or book, or to a lake, a tree, a flower, the Grand Canyon, etc.

Very early after the appearance of the personal computer, Sherry Turkle, a psychologist and sociologist at M.I.T. wrote The Second Self: Computers and the Human Spirit, a classic investigation into emerging computer cultures. In her chapter on the personal computer Turkle focuses on the role of the computer as a catalyst of culture formation. But the role of society, that is, what society in the form of the individual and the culture brings to the computer is also richly illustrated.

She notes how the promotional literature emphasized the instrumental, but users spoke about the noninstrumental in describing "what they did with their computers" (168). The background of the individuals she profiles is pertinent. As adults they "bring new pressures and greater complexity to their relationships with their machines" (p. 170). In the case of an individual she calls "Barry" his background explains what he does with the computer and how it affects him. One relevant aspect is Barry's comment about the unpredictability of what he will be doing with it in six months (169). Even more pertinent is that many of the computer programmers brought to the pc a dissatisfaction with the "fragmentation of knowledge" at work, and found a sense of power from having "full knowledge of the system" (p. 170,171), what Turkle describes as the intellectual transparency of the home system (189), the total understanding available.

This contrast between work and home computer, between the fragmentation at work and the "completely knowable world" at home, the lack of control at work and control at home occurs often. One home computer owner talks about "coming to see all of your kinds of thinking," (187), experiencing what I would call epistemological richness. Another aspect of the home computing experience cited by some owners was certainty, contrasted with ambiguity at work (187). Still another aspect cited was acquiring a sense of what it is like to work within a formal system, a soft access to a world of hard rules.

What is most apparent from Turkle's evidence is the variety, diversity, and contrasting interpretations brought to the computer by different users. While for some the computer offered a desired transparency, for others its appeal lay in its mystery!

There is here a delicious irony here. For some keeping the computer mysterious maintains the belief in it as alive (194), as having a soul and hence as like us. For others, the computer is transparent, and hence not like us. The role of the knower becomes clear. Different individuals see different possibilities based on differences in what they bring to the computer, in this case different epistemological values, expectations, concerns, beliefs.

The personal computer explosion amplified and widened the circle of discussion of machine intelligence and in the process introduced new dynamics. In addition to highly technical arguments about the nature of machine and human intelligence there was now an emotional, personal, passionately engaged quality.

Some brought to the pc explicit political ambitions which resulted in "recasting" the computer as a symbol of decentralization, community, and personal autonomy (p. 172), a symbol of hope for a new populism. They used the computer as an object to think with, to think about who one is, who one would like to be, to think about society, politics and education (173). What is important about this is that it represents an active role on the part of the user, the interpreter, the society in approaching the computer. They used the computer as a "building block for a culture" (173). They used "images of computational transparency" to suggest political worlds. They deposited into it longings for a better, simpler, and more coherent life.

Her discussion of another early personal computer owner, "Wayne" who taught himself to program, places this "adult learning project" into a context of participation in a subculture, of his feelings as the holder of esoteric knowledge, of his wants (he wants to know exactly how things work), of his frustrations (at gaps in his ability to follow the system through), of the tie-in with his long-standing political frustrations, of what he "saw" in the computer, of what he hoped for, of its role as a compensation for dissatisfactions in the world of politics and the world of work (175).

In the case of Howard, she talks about a fantasy which he brings to the computer and the corresponding thrill he experiences, about his searching for ways to make a local fix or hack, his "fevered love of programming," which she contrasts with what Carl likes, what Carl chooses. They approach the computer with different aesthetics. Their choice of programming language is another manifestation of the active role they take. She correlates these choices with differences in style, taste, and culture. The pertinence of this to my thesis lies in the value placed on the differences, which is positive. The differences are valued as positive, as demonstrations of a richness in the world of computer programmers and personal computer cultures and subcultures, not a messiness to overcome.

A particularly interesting example of an interpretation brought to the computer, in this case by the biggest vendor of them all, IBM, is their promotion for the pc as "an icon of antitechnological innocence," an "antitechnology technology" (p. 184). This is so blatant an interpretation it falls into the category of "spin," or hype. In this same context Turkle uses the term "projection" to refer to the promises which manufacturers "project" onto the computer, the way they "present" the computer in terms of status, and the resulting expectations which are created.

In accounting for the desire for transparent, direct understanding of the computer exhibited by many programmers, Turkle points to individual personality but then adds that it reflects other things as well. Continuing, she says,

> For many pioneers of the personal computer culture, this style of relating to the computer was 'overdetermined' in the sense that a host of other, more general forces also came together and were expressed through it (181).

Other factors she cites include (1) an intellectual dimension (a technical interest), (2) a more psychological dimension related to the computer's holding power namely, the way in which the pc lends itself to identification with the machine as a part of oneself, (3) the contrast with the other computer at work,

The picture she paints of their relationship to the computer is not one-dimensional. Rather it is overdetermined. Furthermore, although she uses the term to describe the desires which these early users brought to the computer, I would add that the relationship to the computer is overdetermined in the additional sense that the relationship was not merely one-way but reciprocal and that the forces accounting for the computer's influence back on the user are overdetermined.

She has demonstrated what the first pc users brought to the computer, the desires, hopes, likes, loves, fantasies, personalities, aesthetics, work situations, frustrations, political dissatisfactions, epistemological frustrations and desires. She has brought into the picture the choices they made, the different kinds of uses they put the computer to, the ends they brought to it and the way in which their choices and uses and ends were related to their personalities, their cultures, their work situations.

The computer is a "general purpose" machine. This description has both a precise technical meaning and a more general lay meaning. In the latter sense it means that the purpose of the computer is not defined in the way any other machine is. No one has trouble knowing to what use they would put a refrigerator or a car, or a hammer, or a fan. The same is not true of the computer. Its purpose is not clear because it can be used for so many different purposes. The enormous variety of uses to which the computer has been put is one of the features which gives it such rich symbolic power since the power of a symbol lies in its multivalence.

The explosive growth of the personal computer industry has been accompanied by an enormous learning effort on the part of adults. The first generation of personal computer owners were do-it-yourself hobbyists. The built their own computers from kits, created and joined computer clubs, began publishing new computer magazines. Self-directed learning projects such as this have continued to account for a great deal of computer education. At the same time personal computers have invaded organizations and fueled a massive training effort. In part the training has been an official response to a sudden need for more and more computer literate managers, secretaries, CEOs, shop-floor managers, professionals. In part, however, the training and learning occurred at the initiative of individuals at all levels without official organizational sponsorship or support.

What is clear from our epistemological analysis of the creative, active, interpretive role brought to the computer by learners, users, owners, observers is that the learning process is not determined by the characteristics of the object to be learned alone. It is an interactive process. Furthermore, it is equally clear that what the individual brings to the process of learning and using the computer is in turn affected by the total historical, social, political position of the individual, so that the learning process cannot be understood and interpreted in strictly individualistic or psychological terms. It requires a grounded approach, a contextual approach.

This leads us to ask questions such as who had access to the personal computer cultures? Who did not have access? For what reasons? Were there race, class, gender, geographical, cultural, ethnic groups who participated more than others or did not participate? For what reasons? How did this compare with the earlier mainframe cultures? These questions have epistemological significance, that is, they bear on the kind of knowing involved and therefore on the kind of learning.

Finally, we return to the political question, the impact of the personal computer stage on the official epistemology of science. On the one hand, it is obvious that the personal computer is modelled after the powerful rules-based mainframe and minicomputers that preceded them. On the other hand, the rich diversity and creativity brought to the computer by the individuals who have put them to use has re-introduced the "human" factor, that is the subjective, personal, factor which is <u>not</u> under control. Side by side with the centralized, standardized, cybernetic hierarchical organizations there has emerged the rich chaos of individual, personal creation and variation. Side by side with the rich diversity has come competition and incompatibilities which have acted as barriers to cooperation, creativity, sharing of information.

This leads us to the third chapter on our story, the network.

NETWORKS

The personal computer is under the complete control of the owner. This total access is one source of its power. At the same time, many personal computer owners have quickly discovered that they want to be able to exchange information with other computer users, share data, share resources such as printers. The result is that side by side with the growth of personal computers there has been a concurrent growth in computer networks.

A computer network consists of two or more computers that are linked together. The link may be a cable or it may be a signal, radio or laser beam, for example. Computer networks come in all shapes, sizes, configurations. There are thousands of networks which consist of two or three computers in an office that share a printer. The largest computer network in the world is the Internet, a network of networks which encompasses millions of computers around the world.

The nineties are witnessing explosive growth in the number, size, and capabilities of networks. Public awareness of computer networks is growing as a result of corporate and political promotion. Even more significant is the speed-up in the convergence of computer, telephone, and television networks, and the international consequences of this convergence, economic, political, national, cultural.

There are many interacting causes of the networking boom, technological, economic, political, cultural, social. Technological innovations continue to bring down the prices of everything to do with computers, including networking devices. Sharing hardware and software among many users obviously makes economic sense. On the international scene data networks, so-called "information superhighways" are being promoted as an essential national infrastructure to remain competitive. Social causes include the need to share information, to collaborate on projects, to coordinate planning and decision-making within and between organizations. Knowledge and information has both a social, communal, collective side as well as a personal and individual side.

While the need to share information and knowledge was a contributing cause to the growth of computer networks, it is also true that the growth of computer networks has in turn contributed to an increasing awareness of the shared character of knowledge and knowing.

One of the best-written studies of the impact of computers on organizational knowledge brings this out in dramatic fashion. Shoshana Zuboff, in The Age of the Smart Machine, shows how organizations which introduced computers to automate procedures found the computers supplying them with unexpected new information about their operations. She calls this the informating power of the computer. The new information provides new perspectives on the organization, including new insight into the complex interdependencies of different parts of the organization. It also offers opportunities to control and plan operations based on this new understanding of complexities that were simply unavailable without the constant monitoring made possible by the computer.

One outcome is that while automation has eliminated human involvement in certain operations, it has increased the need for human intervention at other levels and increased the level of understanding needed for interpreting the information made available and making decisions. This has led to the current obsession with the "learning" organization within management and organizational literature. It has also led to a questioning of the hierarchical structure of the organization. A "learning" organization requires a flatter structure, modelled along collegial lines.

At the same time, Zuboff's study also documents the role played by political power and control structures within organizations in the appropriation of the computer.

Parallel to these developments within organizational and management literature is a new attention to the collective, social character of knowledge within philosophy, one consequence of the momentous impact of Thomas Kuhn's 1962 study of the structure of scientific revolutions. Even those critical of Kuhn have been profoundly influenced by him. Stephen Toulmin, for example, begins his study of human understanding in the wake of Kuhn's work with an investigation of the collective use and evolution of concepts.[24]

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[24]Stephen Toulmin, Human Understanding. Princeton, New Jersey: Princeton University Press. 1972.

Especially significant, I believe, is Lorraine Code's argument that knowing other people is a kind of knowledge that has equally strong claims to paradigmatic status as knowledge of objects.[25] Knowledge of other people as a model of knowing is especially relevant to adult education because, in the first place, it requires constant learning and hence gives legitimate meaning to the concept of lifelong learning. Second, as Code points out, if knowledge of other people were taken as exemplary it would be more readily apparent that knowledge is "qualitatively variable" (Code, 1993, p. 34). It is "open to interpretation at various levels; it admits of degree in ways that knowing that a book is red does not." It is acquired interactively and relationally. It is multidimensional, multiperspectival. It is ongoing, communicative, and interpretive, never fixed, or complete.

Code's argument for the paradigmatic status of knowledge of other people occurs in the context of a larger argument for "taking subjectivity into account." Knowing other people involves the subjectivity of knower and known and hence is not ultimately under the control of knower. The "interiority" of mental processes and experiential constructs and their unavailability to observation set limits on what the knower can

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[25]Lorraine Code, What Can She Know? Feminist Theory and the Construction of Knowledge. Ithaca: Cornell University Press, 1991, especially pages 36-41. See also her article, "Taking Subjectivity into Account," in Feminist Epistemologies, eds., Linda Alcoff and Elizabeth Potter. New York: Routledge, 1993.

access, limits set by the person who is "object." Hence, claims to know a person "are open to negotiation between knower and 'known,' where the 'subject' and 'object' positions are always, in principle, interchangeable" (Code, 1993,p. 38).

The kind of knowledge that has driven the development of computer networks and the kind of knowledge involved in knowing other persons share certain characteristics. Both involve ongoing communication processes. Both involve interactive processes. For example, scheduling classes in a training company requires ongoing communication and coordination between management, marketing, and training staff. Management staff need to decide whether to open a particular class session, cancel it, what classroom to use, what equipment needs to available. Marketing staff need to know when a particular class is scheduled and whether there are available seats in a given session. The trainer obviously needs to know when and where classes are scheduled in advance to be prepared. Training schedules are typically volatile in today's business environment, subject to change sometimes up to the last minute.

This is a simple example of thousands of planning, decision-making, project-management processes that occur routinely in every organization. Such processes involve shared knowledge. They involve knowledge as an ongoing, collective activity. They call attention to knowledge as an interactive, open-ended, dynamic experience rather than knowledge as a finished product that can be packaged and placed on a library shelf.

It should also be noted that "networks" are a central feature of a revived approach to the AI enterprise.

SUMMARY OF FINDINGS REGARDING THE COMPUTER AND KNOWLEDGE

It is time to summarize what has been shown at each stage of the computer story about the interplay between computers and knowledge. First, the mainframe stage was stamped with the beliefs about knowledge from which computers sprang, the belief in the power of rules-based knowledge. This kind of knowledge is completely explicit. It breaks knowledge down into units which can be characterized by procedures and then organizes the units into a completely controlled, hierarchical overall structure. The parallels between such machine intelligence and the organizational and management models of the time were transparent. Politically, this chapter in the computer story had the important epistemological effect of re-enforcing the privileged position of science as the only legitimate way of knowledge.

The personal computer chapter makes clear that the computer cannot be understood without including in the picture what the user brings to the computer. The creative, active, interpretive role brought to the computer by learners, users, owners, observers, promoters, vendors, etc. means that the epistemological and other characteristics of "the computer" are not defined by the "intrinsic nature" of the machine alone. This stage is dominated by the beliefs about knowledge that users

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The personal computer chapter makes clear that "the computer" is the result of an interactive process between the user and the machine. It is equally clear that what the individual brings to the process of learning and using the computer is in turn affected by the total cultural, historical, social, political position of the individual, so that the learning process cannot be understood and interpreted in strictly individualistic or psychological terms. It requires a socially grounded approach.

Finally, the network chapter brings into view the requirements of knowing as an interactive, ongoing, intrinsically social process. Networks reflect the needs imposed by collective knowing processes.

In all three moments there is something brought to the machine and something which the machine brings to the culture. What the machine brings in the mainframe stage is its algorithmic power. What is brought in the mainframe stage is the belief in rules-based knowledge. What the computer brings in the pc stage is individual, personal control. What is brought in the pc stage are the projections, needs, desires, fantasies of the user. What the machine brings in the network stage is the interactivity. What is brought to the machine in the network stage are requirements of knowing as an intrinsically shared experience.

Beliefs as a basis for creation and invention. Defines the machine. Projections as a basis for use. Requirements of knowing. The latter two have to do with what is brought to the machine, whereas the first has to do with the bringing into being of the machine in the first place though there is here obviously something brought to the machine.

THE LIMITS OF TECHNOLOGICAL THINKING

What sort of epistemology is needed to do justice to the computer story? What theory of knowledge will support an adequate interpretation of the interplay between the computer and knowledge? What sort of epistemology will take into account all of its aspects, will reveal more than just the utilitarian, will disclose what is brought to the computer by its users and cultures, will uncover its symbolic, political, economic roles? How adequate is the epistemology (or epistemologies) of the adult education enterprise for interpreting the computer appropriately?

What is needed is an epistemology that does not content itself with abstraction and instrumentalism. Minimally, based on what we have seen, an adequate epistemology must recognize the potential of rules-based knowledge. Second, it must take into account all that individuals as active, creative, feeling, thinking positioned agents bring to the computer. Third, it must do justice to the social, communal, interactive character of knowledge. Fourth, it should shed light on the use of the phrases "knowledge work" and "knowledge production." Do the epistemologies employed in adult education theory, policy and practice do justice to these criteria?

We can pose the question in a more pointed way by asking whether a rules-based epistemology can do justice to the history of the computer we have outlined? In other words, can computational technology as a way of thinking be used to interpret computer technology as event, as history? Can "technicist" thinking, which, according to some critics,[26] dominates adult education, do justice to the technical processes which are the source of such thinking? Mechthild Hart has coined the phrase "encircled thinking" to refer to an approach which "sees the solution to the problems caused by the introduction of new technology within the very same technology, and only there."[27]

The criteria we have identified for an epistemology that

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[26]Collins, Adult education as vocation, for example.

[27]Meththild U. Hart, Working and Educating for Life: Feminist and International Perspectives on Adult Education. London. Routledge, 1992, p. 134.

will do justice to the computer story can be summed up in a single criterion, Does it do justice to the multiple contexts of the story, the technical, the personal-subjective, the network-communicative, the work-productive contexts? Does it enlarge and enrich the context of understanding? Is it context-rich?

Algorithmic thinking follows scientific epistemology in seeking contextless universals as the ideal form of knowledge. It is, therefore, a form of thinking which in its very intent moves in a counter direction to an epistemology which will nourish a context-rich interpretation of the computer. The issue of context is key in the critique of artificial intelligence efforts based on "rationalistic" thinking made by Terry Winograd, an insider in the field. In Understanding Computers and Cognition, co-authored with Fernando Flores, he points out that the "ideal" assumed by such approaches "is to completely 'decontextualize' the text."[28] Winograd and Flores call for an approach to computers which recognizes the fact that language and cognition function within a "web of commitments" (p.119). One section of their discussion of an alternative to the rationalistic approach analyzes "organizations as networks of commitments" (p. 150ff.). Winograd and Flores draw on Heidegger's concepts of "thrownness" and "being-in-the-world" to recover the inescapability of context. The key term "intelligence" in the phrase "artificial

[28] Understanding Computers and Cognition: A New Foundation for Design. Terry Winograd and Fernando Flores. New York: Addison-Wesley Publishing Company, Inc., 1986, p. 28.

intelligence," is defined in terms of context: "the essence of our intelligence is in our thrownness" (p. 99). Context can never be fully articulated. "[T]here is always more that is not articulated, falling back into the fathomless background of obviousness" (p. 149).

We come back to the question of the adequacy of adult education epistemology. The first issue is determining what epistemologies characterize adult education. Michael Collins, whom we have cited earlier, does not explicitly deal with epistemology, but he does characterize adult education as being dominated by an "ideology" of technical thinking (Collins, 1991). Mechthild Hart has dealt more explicitly with epistemology in her richly dimensioned call to rethink education (Hart, 1992). According to Hart, the epistemology of adult education is taken uncritically from mainstream ways of thinking about knowledge and knowing. Therefore, if we accept her analysis, the characteristics of adult education epistemology can be determined from her analysis of the dominant epistemology epitomized by science and "knowledge work."

A primary feature of the dominant epistemology as characterized by Hart is separation, or better, separations, splits, blocks, blinders, compartmentalization, for example, between thinking and doing. "The scientist, like the knowledge worker, assumes a specific position within the social division that separates and brings into a hierarchical relationship thinking and doing" (Hart, 1992, p. 138). In other words, it abstracts thinking from context.

A second feature of mainstream ways of thinking about knowledge and knowing is its devaluation of subjectivity which produces a very impoverished view of the person and of individuality. "Subjectivity is left behind, or discarded precisely because it does not lend itself to scientific investigation and control. From the perspective of the 'scientific manager', it is a surplus that is quite useless" (p. 131).

A third feature is "the destruction of intersubjectivity" (p. 148) without which there is no concept of shared, communal knowledge and knowing.

In other words, judged by the criteria identified above, mainstream epistemology that is, the epistemology which informs adult education is not adequate to the task of offering a satisfactory interpretation of computer history and culture. By contrast, if we turn to the alternative approach to knowledge and knowing delineated by Hart and measure it against the same criteria we find an epistemology that is context-rich, that enlarges and expands vision, that validates subjectivity as well as intersubjectivity, that advances our understanding of "the overwhelming importance of self-knowledge in an essay on commodity and subsistence production within an international context. Hart's analysis of "knowledge work" and "knowledge production" must be considered a major contribution to a critical and constructive understanding of the computer story.

In the first place, her entire essay is a substantive call for "the courage to know," that is, the courage to "alter's one location, the point from where one looks at reality" and thereby to make visible what is otherwise invisible to any one individual or group, to cross the boundaries which isolate those at the top or at the center, from the creative, constructive, positive wisdom and knowledge of those at the bottom or at the margins. In other words, all of the force of her epistemology is directed towards crossing the boundaries which characterize the "geography of seeing" of mainstream epistemology (p. 202).

For example, she approaches "knowledge work" by viewing it from the perspective of "subsistence work." Subsistence work involves labour necessary to life, such as the work of bearing and raising children, personal services directly relating to other people's physical and mental well-being, work performed by peasants and tribal people. From the point of view of the dominant culture, knowledge work is the ideal type of work. Subsistence work is considered demeaning and unprofitable. However, if one starts from the view that sustenance and life is the ultimate purpose of human work then a viewpoint which devalues subsistence work as uselsss and unproductive must be questioned.

As an alternative to "industrial-patriarchal" ways of thinking which split work and life, body and mind, knowledge and self Hart constructs the concept of "subsistence knowing," based on "the epistemology of mothering" (p. 183). Such an epistemology approaches the problem of particularity and generality not in abstract terms but in terms of the concrete experience of raising a child. It is characterized by a "fundamental respect for empirical reality" in contrast to the distance from empirical reality which she finds in technologized work (187). It is further characterized by limits on the nature and importance of the knowledge of the authority, the mother in this case. "Because she is in contact with the continuously changing nature of her child, and, consequently of her task, the mother's knowledge and never be finished or be absolute, but must remain tentative and provisional" (p. 188). Knowledge and the act of knowing "are intricately woven into the relational matrix of mother, child, and society." It has multiple sources, "combines in manifold ways," is "alive, contracts and expands," is constantly created and recreated, endures ambiguity and provisionality. "its primary gesture is therefore acknowledgement and respect for the endless complexities of reality" (p. 190).

It is important to emphasize that this approach to knowing is developed within the context of an unblinking analysis of international work and labour conditions. She draws heavily on the work of a group of West German sociologists who have coined the term "housewifization" of labour to refer to "a systematic utilization of the sexual division of labour to cheapen both male and female labour" (p. 20). For my purposes, what is important about this approach is the methodology which lies behind it, which Hart characterizes as "the deliberate attempt to see trends and phenomena in their relation to each other, i.e. to see the structural and historical links between First and Third World, paid and unpaid work, market and non-market production, men and women, Black and White" (ibid). I would note in passing that an even more rigorously systematic formulation of this approach is to be found in the concept of "overdetermination" as developed by two economists, Stephen Resnick and Richard Wolff, in Knowledge and Class: A Marxian Critique of Political Economy.[29]

Hart is one of a growing number of thinkers and writers who are proving by their work the rich potential for constructing fresh, powerful, textured, healing ways of seeing, thinking, knowing, and learning to be found in the experience of women and others who occupy minority and marginal position in society. Such an approach is an example of what we have described earlier as context-rich. The perspective which her standpoint in subsistence work offers on the limitations of a world circumscribed by the technological myth is critical. On the other hand, viewed from the perspective of the three-part computer story I have outlined above Hart's interpretation of the computer appears to be monolithic and not sufficiently differentiated.

She opens her discussion of the growing "cult of computer worship" by calling attention to the interplay between context and machine, that is, between the social conditions surrounding the computer's appropriation and "the specific rationality

[29]Chicago: The University of Chicago Press, 1987.

inherent in the computer and the kind of human intelligence it represents and magnifies." To describe this inherent rationality she draws on Zuboff's first-rate study of automation cited earlier which brilliantly documents the contrast between the personal, sensuous nature of the craftsman's knowledge and the abstract, conceptual knowledge involved in computerized "knowledge work"(Zuboff, 1988) and the themes of control and power which, she says, are "inherently related to the potential of the smart machine itself" (p. 126).

There is no question that these themes of power and control, and abstract, conceptual rationality are tied to "the specific rationality inherent in the computer," especially as manifest in what we have described above as the mainframe stage or configuration. However, as we have also seen, the expression of power and control that is "inherent" in the computer is not tied to the hierarchical, top-down, one-way model. In the personal computer the same themes come to expression in the subjective, imaginative "antitechnology technology" of individuals and small groups and counter cultures(Turkle, 1984, p. 184). Furthermore, she has not done justice to Zuboff's account of the way in which the "informating" power of the computer posed a threat to the sharply hierarchical lines of authority of traditional management. Related to this is Hart's one-sided stress on the "recentralization of management," p. 152) which seems to run counter to the current trend towards "flattening out" of hierarchical structures.

I am not trying to argue here that "the computer" is a neutral tool. On the contrary it is, to borrow a phrase from Hart, "soaked with assumptions" (p. 8). There is a "technological myth." There is a kind of "encircled" thinking characterized by the notion of a knowledge explosion "where knowledge begets knowledge all by itself" (p. 159). Furthermore, adult education's approach to education and training in the workplace needs to heed Hart's call to account "for its inability or unwillingness to provide more critical and creative responses to current crises surrounding the issues of work and employment" (p. 200). Her critical analysis of the concept of "knowledge work" should be the starting point for a critical analysis of the epistemological aspects of work (Cf. Hart, p. 170).

Nevertheless, the computer must not be rejected by those who rejected the cult of the computer. Indeed, it seems to me that those who are working to construct a culture of caring have not taken seriously enough the power of the computer as a tool that could be used to this end. The fact that the computer is not a neutral tool simply means that the task of appropriating it for alternative ends has both a technical and a cultural, political dimension, not that it should be abandoned altogether because of the nature of its inherent rationality. It is this social, cultural, political, contextual dimension which appears to be missing in the response of adult education to computer technology and which Hart has supplied.

TOWARDS AN ADULT EPISTEMOLOGY

An adequate or "adult" response to the computer story must address itself to the whole web of contexts of the battle over the ends, the potential, the possibilities, the futures which the computer might make possible. What Hart says about freedom and necessity in relation to "work" I would appropriate to refer to the computer: "The burning core of the question of [the computer]... lies in the dividing line itself, and not on one or other side of the gap. Both sides together are only fragments of a 'fractured whole.'"[30] In other words, one cannot do justice to the computer story without doing justice at the same time to the human spirit. As I have written elsewhere, it is the "borderland," the "heavily charged boundary between inner and outer, private and public, individual and social domains" which is the place of battle.[31] One cannot do justice to technology without doing justice to the technological myth, and myth takes us into the realm of the spirit.

This means that only an epistemology that reconnects knowledge and knowing with the whole person of the knower, including the spirit, can support such a task. Langdon Gilkey, in a profound essay on the "religious dimensions in science" reaches back to the ground of science to uncover its roots in the spirit, in passion, in commitment, in "care."

Let us begin with the most fundamental basis of

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[30]Hart, p. 108, alluding to Adorno, 1974.

[31]"The Black Hole: Epistemology and the Liberal Roots of Adult Education," unpublished paper, 1992, p. 29.

> scientific inquiry as a human enterprise, that urge, drive, or passion in man which it presupposes and so which makes it possible as a human act. This is the sense of wonder of which Aristotle spoke, the unremitting eros to know, the unrestricted passion of the rational consciousness to explain, to understand, and to judge validly - that lies back of all science as a human activity. This is, as Tillich insisted, an ultimate concern, an ultimate commitment. This concern in the scientist as he conducts his inquiry is the most fundamental of the prerequisite for knowledge. Without method, as the history of cognition shows, no knowledge is possible, but without passion no method is possible. For method demands care, ... [32]

Gilkey is not taking for granted that science is the only legitimate or highest form of knowing. On the contrary this passage occurs within the context of a defense of other forms of knowing and an explication of the "uses of myth in a scientific culture."

To do justice to the computer story - means to complicate it, to concretize it, to overcome the blinding, abstracting, limiting, reductionist, conventional taken-for-granted perspectives that sanitize and declaw it. To do justice to it means learning how to see it, learning how to interpret it.

Why is this so important? Because it is the first step towards policy and practice that will be more than just reactive, submissive, passive, instrumental, utilitarian. It is the first step towards emancipation from the powers that would simply use adult education for their own purposes. It is the first step towards an independent judgement and voice.

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[32]Langdon Gilkey, Religion and the Scientific Future: Reflections on Myth, Science, and Theology. Macon, Ga.: Mercer University Press, 1970, p. 48.

To do justice to the computer story means overcoming the claustrophobic oppression that constricts us. What constricts us is our constricting epistemology, the pair of glasses over our eyes, the semi-opaque balloon that surrounds us and through which we see "the world." An "adult" appropriation of the computer is only possible on the basis of an adult epistemology.