FACTORS IN THE IMPLEMENTATION OF COMPUTERS IN EDUCATION

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FACTORS IN THE IMPLEMENTATION

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PREFACE

The purpose of the thesis is to make educators and the public aware of the hazardous factors that are involved with the implementation of computers into our schools. A historical resume of the development of computer is a factor vital to the understanding of the rapidity in which this transforming technology is progressing and becoming a essential part of our students lives. Three additional factors other than historical, are the physiological, psychological, and sociological.

I wish to express my sincere gratitude to Dr. Ted Mills for his patience and advice, and I am especially grateful to Dr. Kenneth Wiggins for acceptance into the Air and Space Workshop as my first graduate hours. I also wish to thank Dr. Russell Dobson for his efforts.

A special thanks are due my mother, my husband, Leville, and children, Michael, Robert, Randal, and Debra for their moral support and encouragement.

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CHAPTER I

INTRODUCTION

Classroom students are going to be using computers and it is necessary to look at the historical development of these machines and to become familiar with the hazardous factors that might be encountered as they are implemented into our schools. This thesis examines some of the physiological, psychological and sociological factors that are becoming apparent within the implementation of this new technology.

Children using computers or videos are entering an electronic world developed for adults, and they will encounter the same hazards. The majority of the information that has been presented in the following thesis has come from material that was prepared for adult use, however, it is also being applied to children as they use computers in the classrooms.

The needed literature was difficult to find and it became necessary to resort to the DIALOG Information Retrieval Service which included database searches in the areas of NEWSEARCH, PSYCHOLOGICAL INFORMATION, ERIC, TRADE AND INDUSTRY INDEX, AND THE EDUCATIONAL INDEX. The resulting information provided the material for the documentation of the hazards of the cathode ray tube radiation emissions and the remaining physical problems;however, the areas concerning the psychological and sociological factors are new and basically unexplored fields.

I feel that the information is speculative and opinionated. As factors concerning hazards are made available to the public, the information becomes redundant as the facts are reevaluated and republished.

The technology of the industry is constantly changing and therefore the information also changes or becomes outdated. It becomes necessary to use only the very recent information with recent meaning that which has been published within the past year and perhaps the past two years at the very most.

Educators are finding that implementing the new computers into the classroom is difficult. After only five or six years of classroom use, the administrators are still trying to decide the best way to fit them into their school's schedules. If computer literacy is added to a schedule, it will have to replace something in an already over-crowded curriculum. It has been estimated the some 96,000 microcomputers were used solely for educational purposes in 1982, this figure was expected to triple by 1985, (Goddy, 1984). Once this joy ride begins, there will be no stopping. The country as a whole is getting on the band wagon without asking where it is going.

CHAPTER II

HISTORY OF COMPUTERS

Early man found it necessary to solve problems and make decisions for survival and continued existence of his kind. There was a need for this intelligent and innovative being to develop and use the concept of numbers. The phenomenon of microcomputers is barely ten years old, and yet the purpose of computers--to store data and provide answers is as old as the history of man.

From Fingers and Toes to Zero

The act of counting on the fingers and toes led to the more complex acts of using pebbles and making knots with ropes. Today's computers are used to store facts, process the information and provide answers. Ancient people exhibited a similar means of problem solving with their formations of the mysterious megaliths at Stonehinge. These great rings of rock could well have been used a primitive computers to track the movements of the sun (Stoler, 1983). The sextent made long voyages possible and the establishment of industry and commerce flourished of necessity.

The use of the zero and the nine digits of the Arabic system were important steps that led to present day calculating. Two distinct advantages of the Arabic numbers over the Roman numerals were the concepts of number columns known as positional notation,

and the place-holder zero (Flory, 1982).

The First Digital Calculators

Our first true digital calculator was the abacus which was credited to the long line of the inventions made by the Chinese. However, evidence shows that the people of the Tigris-Euphrates Valley of the Middle East used this same method five thousand years ago (Flory, 1982).

Counting boards were similar in concept to the abacus, and they were in general use in Europe until the late 1700's (Flory, 1982). A counting board was divided into sections representing place values, and markers were moved around on the board much as beads are used on an abacus. The instructions to use the data were stored in the operators mind rather than in the machine.

Analog Calculators

Analog calculators work with quanities that represent numbers (Flory, 1982). Three dips of ice cream placed in a dish are precise units that can be added, removed, or counted individually and therefore represent the digital concept. The three melted dips of ice cream can be measured in terms of volume, rate of flow, or weight. The melted ice cream cannot be measured in precise units. These numbers would represent the analog concept (Flory, 1982). The slide rule, developed in the 1600's was a common analog device. This calculating aid was used by the engineering profession until it was replaced by the pocket calculator.

The Early Mechanized Devices

The first mechanized device was developed in France in 1642, by Blaise Pascal. This mechanical arithmetic machine added and subtracted by the means of rotating toothed wheels (Flory, 1982). In the 1830's, Charles Babbage, an English Mathematician, developed the idea of a digital computer that was powered by steam (Brooks, 1984). He never completed his machine. However, the computers of today are based on many of the principles used in Babbage's design. In the 1930's, a Harvard University Professor, Howard Aiken, outlined plans for a machine that was to be known as an Automatic Sequence Controlled Calculator (Flory, 1982). The machine was called the Mark 1 and was used by the United States military until the end of World war II. The machine was basically an electro-mechanical device.

First Generation Computers

It is generally agreed among the authorities that the First Generation computer was the electronic digital computer that used vacuum tubes rather than electrical relays (Goddy, 1984). This computer was completed in 1946 at the University of Pennsylvania, and it used over 18,000 vacuum tubes and could perform 5,000 additions or up to 500 multiplications per second (Flory, 1982). The first of these computers to be built for commercial purposes was the Universal Automatic Computer. This new computer, known as the UNIVAC I, was immediately put to work processing the 1950 census data.

The Second Generation Computers

In the late 1950's and early 60's transistorized computers were developed forming a Second Generation of computer technology (Flory, 1982). Transistoriized arithmetic units became 1/200 the size, operated 50 to 100 times faster, and could be manufactured for a fraction of the cost of their vacuum tube predecessors (Flory, 1982). At the end of the Second Generation, computer-based information networks spanned the United States.

The Third Generation Computers

Computer technology has developed so rapidly that the identifying of computer patterns is difficult. However, in the early 1970's the microprocessors, which are integrated circuits on silicon chips, were considered the new technological development of the Third Generation (Goddy, 1984). These "computer on a chip" approached the computational power of the large computers of the late 40's, and were introduced by Intel Corporation and Texas Instruments Corporation (Flory, 1982). The microprocessors are small and fast, and use integrated, and miniaturized circuits that reduce the computer's size, cost and power requirements while increasing overall reliability. The integrated chips introduced the development of communication industries that process, call up and shape information, or produce equipment that does.

Fourth Generation Computers

The introduction of large scale integration of circuits on chips has basically been designated the beginning of

the Fourth Generation (Goddy, 1984). This "now" generation was established in 1981 and is expected to overlap into the 90's. The 1980's will be a time to have a computer in every home and computer access for every school child. Computer development will not stop with the introduction of the Fourth Generation and its applications. The future electronic equipment may thrust the technological industry into the Fifth and Sixth generation before the turn of the century. Phases of these proposed new generations are already being observed.

Fifth Generation Computers

Artificial Intelligence is seen as the major development of the Fifth Generation concept along with Japan's computer challenge to the United States and to the world. The new intelligence needs to be improved in three areas. The most critical problem is getting the knowledge, and the rules employed for using it, and finally to get it out of the heads of the experts. The computers are expected to be true knowledge systems in that they will be able to combine one set of facts with other sets to produce sophisicated new solutions (Grieves, 1983). The Japanese are only two years behind the United States, however, it was emphasized that both nations could contribute to his new development. It needs to be remembered that whichever country wins, this feverish race will become the world leader in knowledge technology.

Summary

When the computer revolution is compared to the motor power revolution, it is found that it took more than 200 years of de-

velopment of motor power to industrialize society based on mass consumption of goods and services (Goddy, 1984).

Computers speed up change and experts are expecting them to "informatize" our society in a lifetime (Goddy, 1984). The computers of the future will be able to use artificial intelligence programs that will be able to draw conclusions based upon stored data. These machines will create a global revolution in the handling of information. The idea of thinking machines is likely to develop fears in many peoples of the world. Herbert Simon (as cited by Newhaus, 1981) a Nobel Prize winner for his research on human decision making stated,

> There are those...who are nervous about the advent of AI. They dread the spectre of a society overrun by machines clever enough to take over from people...I don't see any great reason to fear this kind of knowledge(p. 42).

CHAPTER III

COMPUTER HEALTH HAZARDS

Computers are found in the offices, homes, and schools and with this prevelant use it becomes necessary to determine the hazards to the physical health of these users. The computer monitor, technically known as a cathode ray tube, CRT, or video display terminal, VDT, emits microwave radiations and has been accused of causing health risks ranging from eye-strain to birth defects.

1981 Radiation Emission Survey

The Bureau of Radiological Health, BRH,(1981) has the responsibility for carrying out programs under the authority of the Radiation Control for Health and Safety Act of 1968 to protect the public from unnecessary exposure to radiation from all types of electronic products. The BRH had developed a performance standard that limited the x-ray emission from television receivers to 0.5 millroentgen per hour at 5 centemeters from the surface of the set. It was required that television manufactures certify that their products conformed to the performance standards prior to introducing the equipment into the commercial market in the United States. The VDT's are also covered under the general provisions of the Act, even though it does not directly state a standard performance for this area.

By 1979, the Bureau had received so many inquiries from other government agencies, unions and private citizens about radiation levels that they ordered a survey of 278 potential manufactures to determine emission of ionizing and nonionizing radiation.

The results were published in May of 1981 by the Bureau of Radiological Health. The probe had determined that the emission values from the display terminals tested, fell within the guides lines. A few units emitted radiation in an excess of that allowed under the television receiver standard and the models were either corrected or withdrawn from the market.

'This evidence was presented in May, 1981, at a Hearing of a House of Representatives Science subcommittee. Chairman Representative Albert Gore, (as cited by Kirchner, 1981) reported,

> the prevailing scientific opinion seemed to be that adequate precautions had been taken by manufactures to ensure that the levels of non-ionizing radiation emitted by these instruments were very low (p. 15).

The decision had been reached after two days of hearing involving representatives of the makers of the tubes, federal health agencies, newspaper publishing and labor union groups. Gore also suggested before the sub-committee that there should be continued studies in the area of skin and eye radiation hazards.

Birth Defects

The alleged link of miscarriages to the cathode ray tubes was not referred to in the 1981 report made by the bureau of Radiological Health, however, Dr. Arthur J. Salisburg (as cited by Sheldon, 1984) of the March of Dimes stated that,

> Cluster of miscarriages and birth defects (and other health problems) can and do occur purely by chance...There are so many women of childbearing age who work near VDT'S today that some coincidental VDT-linked clusters of problem pregnancies are to be expected (p. 12).

Salisbury added that the VDT-linked birth defects did not resemble the kinds of fetal damage that would be caused by any type of radiation.

Dr. Marcus B. Bond, (as cited by Kirchner, 1984) a representative from the American College of Obstricians and Gynecologists stated,

> that the college had concluded that radiation emitted from VDT's was insufficient to cause spontaneous abortions, birth defects or any other adverse effects on the reproductive function (p. 2).

The National Institute of Occupational Safety and Health is preparing a large study of pregnant women who work with video terminals (Harvard, 1983). The results are to be available in 1985.

Visual Difficulties

The American Optometric Association has determined that eye stress can be caused by prolonged periods of time at a computer screen, especially if the VDT is a television set and an eye condition is already prevalent (Sheldon, 1984). The association recommended that the user have regular eye examinations and that the lighting and the monitors should be properly adjusted.

All video display terminals use a cathode ray tube that emits a small amount of radiation (Jones, 1982). The same

tubes are used in television sets but viewers of TV sets do not as a rule, sit within eighteen inches of the screen for six to seven hours a day. However, the public needs to be aware that three medical scientist from the Veterans Administration Medical Center, in Washington, reported that,

> TV sets manufactured before January 15, 1970, (the date after which radiation standards for TV manufacture went into effect) may cause excessive radiation exposure when used close-up as a computer or video terminals in the home (Jones, 1982, p. 132).

The following information concerning optical radiation has been taken directly from the 1981 Bureau of Radiological Health document:

> A CRT phosphor is the source of optical radiation. The phosphor is a coating of flourescent material that emits optical radiation (Primarily visible radiation) when it is irradiated by a beam of electrons within a cathode ray tube. During electron beam excitation, fluorescent radiation is emitted from the phosphors and this is followed by phosphorescense with a continued emission after the exciting electron beam is terminated (p. 20).

The BRH test results showed that the optical radiation intensities measured were very low. The video display terminals emitted radiation in the visable range, and some were also emitted near ultraviolet or near infared radiation. No effects on the eyes or the skin have been observed. Emissions from the terminals were considerable lower than the standards and guidelines presently in effect for near ultraviolet and visible light.

A similar series of findings were reported by the National Institute for Occupational Safety and Health, (NIOSH). The wheels had been set in motion in 1977 by two editors from the New York Times, who constantly used VDT's in their work and were

diagnosed as having cataracts caused by VDT radiation (Jones, 1982). The newspaper people were presistent and brought about a comphrensive study here in the United States.

The NIOSH Board of Arbitration ruled against the editors when they found, that the measurements determined that the VDT's posed no health problem (Jones, 1982). They also made the explicit statement that,

> possible exposure to x-ray, radiation-frequency, ultra-violet, and visible radiation was well below that of current occupation exposure standards and, in many cases, below the detection capability of the survey instruments(p. 132).

The fact remains that increased use of VDT's has resulted in many reports of adverse reactions for users. If radiation remissions is not responsible, then what is?

> Most experts agree that any exposure to radiation can have genetic effects. In other words, from a genetic stand-point any dose of radiation is an overdose but experts don't agree on whether exposure to low radiation levels can cause non genetic damage such as cancer. Some say, that any dose of radiation is harmful if they are below a certain threshold level. Until this controversy is resolved, human radiation exposure standards must be set as low as possible while still allowing for some benefit for exposure such as medical x-rays (Miller, 1982, p. 320).

Musculoskeletal Difficulties

Even the manufactures of VDT's tend to agree that poorly designed terminals can aggravate or even cause problems for the user and that the terminals of optimun design can also cause damage when used in a poor working environment (Harvard, 1983).

The daily use of video equipment eliminated the need to move around, and the long periods of sitting puts a strain on the back and neck, slows circulation to the legs, and reduces a general muscle tone. The shoulder, neck and

back complaints are common among the users and is caused by the sheer immobility of the person and it weakens the postural muscles.

The video keyboards have an exceedingly fast action and it is impossible to "out-type" them. Repeated rapid striking of the fingers on a surface, may lead to inflammation of parts of the hand and wrist (Jones, 1982). In some cases, a worker may experience the "carpal tunnel syndrome of pain, weakness, and tingling, usually involving the thumb and first two fingers" (Harvard, 1983, p. 5.).

Many of these personal probems may be relieved by having adequate lighting, adjustable chairs, and the working areas designed to fit the individual size. The user must also take the time to know about the safe and proper use of the product.

Summary

The Bureau of Labor Statistics estimates that by 1985, there will be ten million video display terminals in use in our work, and that personal computers will be used in most of our homes (Jones, 1982). As computers are implemented in schools, continued effort needs to be made in the regulation of the control of radiations and nonradiation hazards to our students and also the adult users.

Today's students use of classroom computers is usually for a short period of time, and as the time is extended, it will become necessary to train these users to relieve their

stress and tensions. Classroom teachers may find it necessary to allow the student to exercise for a brief time before they continue work. All video display operators need to have frequent breaks to be able to move around, to work at a variable pace, and to meet requirements set by the human capacity, not by the computer. All VDT operators must try to avoid becoming a terminal case.

CHAPTER IV

PSYCHOLOGICAL HAZARDS

As the computer technology has developed from the Peking man, to today's Pac-Man the psychologists are finding that our users are faced with new environmental stresses. The computer is causing the user to think about the differences between man and machines and at times it becomes more comfortable to be with machines.

Computer Stress

Computer critics argue that computers threaten the users intellectually and perhaps spiritually. Joseph Weizenbaum, a professor of computer science, contends that we are being encouraged to abdicate aesthetic and even moral judgement to computers (Wilkes, 1984) Craig Brod, psychologist, supports Weizenbaum, with case studies of what happens to the thought and behavior of people who, willingly or unwillingly, inhabit a computer's electronic space (Wilkes, 1984). Brod has also identified new terms that explain the various areas of computer stress.

Techno-anxious

Whether the user identifies with a computer or hates them they have a problem adjusting to the new experience. Many of these people miss the sense of working with raw materials and the use of other people's experiences and calculations frustrate

their inner strivings. Brod termed those having a problem adapting as techno-anxious (Wilkes, 1983). He defined the techno-anxious as:

> The person who feels alienated by machines that can do instantly and perfectly a job that has taken the worker years to learn (Wilkes, 1983, p. 72).

Techno-centered

Generally, these users feel that they have power by controlling the computer and prefer this experience to that of the real contact with the world.

Craig Brod contends that the techno-centered, "indentifies so closely with the computer that it supplies nourishment for his or her emotions (Wilkes, 1983, p. 72).

He is also concerned that techno-centeredness is a growing problem among children. He has made the following diagnosis:

> Many become video addicts, and some become fanatic programmers. These techno-centered children are developing their sense of objective reality, their perception of cause and effect, in an electronic space that has no counterpart in the daily world. As a result, they lose hand-eye coordination, develop a distorted sense of time and gradually withdraw from friends, family and human contact in general. As children become engrossed in and adept at computers, their parents lose authority over them, much like immigrant parents who learn English slow and imperfectly while their children rapidly become fluent (Wilkes, 1983, p.72).

Summary

The advancement of computers and computer information will impose new types of phobias upon our society and at an accerlated pace. In his book, Technostress: The Human Cost of the Computer Revolution, Craig Brod offers simple advice to teachers

and school administrators on how to present computer-aided instruction to parents on how to introduce their children to computers, and to psychotherapists on treating techno-centered and techno-anxious people.

Additional incite into the implementation of computers into our schools and their effect on children can be gained through the experience of Seymour Papert and his colleague Joseph Wetzenbaum.

Seymour Papert of MIT has pioneered the use of computers. He says"computers don't force thinking into a mold but allow children to explore different ways of thinking --that they expand creativity". (Rosenthal, 1983). In other words his mission is to use computers in a positive way.

Joseph Weizenbaum does't want the computer to be used as a quick fix for all our troubles in schools. He doesn't feel at ease about putting computers in schools (Rosenthal, 1983).

The author feels that the different conclusions of Papert and Weizenbaum are representative of our experts today. There tends to be extreme fundamental differences in the opinions of how computers should be implemented and how they will effect the children. Our educational administrators need to follow sensible advice and hope our children and the use of computers will co-evolve.

CHAPTER V

SOCIOLOGICAL HAZARDS

Japan's futurologist, Yoneji Masuda has developed a future "Computopia" (Goddy, 1984). This ideal society is based on computer uses that may reshape society. Masuda feels that mass production could lead to an automation of information that would give the user more free time and a freedom from subsistence labor. He visualizes the creation of complex networks information control and evaluation that would lead to solutions of complex problems, improved chances of reaching goals, better matching of jobs and workers, and more educational opportunities. The end result of the creation of knowledge would be a more purposeful and worthwhile life. In the area of information networks, he sees the formation of utilities to sift, and provide informationa, citizens who participate fully in the government's decision making, and homogenious people living in like-communities.

The International Resource Development projects the future of home computer use by 1993. About 50 percent of the computers used in the home will be used for self-education and for office work (Jungreis, 1983). It is felt that a significant number of workers will work at home, using computers and deal with the office by electronic mail. The other uses will be divided almost equally between household management and entertainment (Jungreis, 1983).

Masuda does not recognize the probable governmental policing powers with the use of computers. The Internal Revenue could have a built in resource of information and better monitor tax collections. Likewise the author wonders if instead of double sets of accounting books for tax evasion the future tax evader will have a double set of computer program software.

Poverty Gap

In our present computer system, we have two hazards that are affecting our young people and their futures. As there is an increasing need for computer literacy, we will be widening the gap between the "socioeconomic levels."

Computers change the way people learn, and there is the fear that a new class of disadvantaged Americans will surface, those who are not computer literate. Many educators feel that computers, despite their ability to speed learning in most subjects, may actually widen the gap between the rich and the poor. To many students, computer represent one more thing they can not have, or can not control. A University of Minnesota's study found, "that the 12,000 wealthiest schools in the country are four times more likely to have micro-computers than the 12,000 poorest schools" (Williams, McDonald, Howard, Reese, and Raine, 1984, p. 96). The students in most white schools tend to learn programing while nonwhite school students are confined to rote exercise which does not give these students a sense of control over the technology. In addition it should be done by the seventh grade. Andrew Molnar (Fatlich, 1984) computer education specialist at the National Science Foundation, says, "The kids who don't get indoctrinated to computers

by the seventh grade are not going to develop the same proficiency."

Many educators see the computer as an aide for the students who are failing a subject. Computer Consultant, Charles Lecht stated, "Students who use to fail because they could not master geometry the first time around will be able to turn to the computer for relief" (Fatlich, 1984,p.10).

The general consensus is that the government needs to provide more direction and set up the needed guidelines, and Senator Lautenberg, from New Jersey, wants the national government to help poorer school districts buy computers (Goddy,1984).

When it comes to the gap caused by job loss, everyone is hoping that computers will be the pack-rat of our future. That is, for every job that is taken off the market that the computer industry can replace one. As computer-run machines take away more jobs, possibilities for unskilled workers will fade. Robots, are considered to be the greatest job-makers, as these new machines will increase productivity, cut costs and make United States products more competitive (Goddy,1984). This proficient and better competition increases the number of jobs and will require retraining of people.

Computer Hackers

Today's young people know their way around the inside of computer systems and the end result can be vandalism. The term hacker, or criminal user, has been applied to these computer terminal invaders.

In October of 1983, the FBI agents confiscated the home computers of four high school students and accused them of entering a computer network illegally (Goddy, 1984). The students said they were unaware that the network was a commercial one or that they were trespassing. Security experts all over the country have experienced the intentional criminal who can erase all traces of their theft from the computer system. A New York City bank teller used a computer to transfer $1.5 million to his personal account, leaving no trace of his theft (Brown, 1983). This event did not cause as much uproar as the incident that became front page news in August of 1983. Law enforcement groups disclosed that the "414s", a group of about ten young hackers in Milwaukee area, had penetrated the computer files of banks, hospitals, and even Los Alamos National Laboratory in New Mexico, a center for top secret weapons research (Brown, 1983). This incident concerning a computer security produced a series of congressional hearings, and State and Federal officials are considering new laws to crack down on the illegal use of computer systems. To counteract the vandalism problem, computer companies and security companies have developed devices that can be attached in 15 minutes and will safeguard the system from outside penetration (Browne, 1983).

Summary

The answers to the developing social problems will in all probability be solved and newer problems formed. It is felt that the hacker crime problem among the young people is a fad and until every system has a security device their privacy

is in jeopardy.

The general concensus concerning computer equity for poor and rich alike is that the lawmakers will try to equalize computer education and that our youth will benefit by being better educated for future computer jobs. However, our government will be feeling the pressure in their efforts to resolve our major social policies and to guide our educators as computers are implemented. The steps that are taken should be thoughtfully considered and directed so that the future employment of our students will not be jeopardized.

CHAPTER VI

SUMMARY AND CONCLUSIONS

As the history of computers has progressed from pebbles to the Fifth Generation, the concern with radiation emission hazards of the cathode ray tubes has been dispelled with the Bureau of Radiological Health's findings that the emissions from the display terminals fell within the guidelines. It has been suggested that televisions purchased before 1969, and used as terminals, should be checked for emissions.

The effects of video display terminals on the health of the user was examined in 1981 by the National Academy of Sciences. The scientists agreed that the amount of radiation emitted was too small to pose a great threat of either cataracts or birth defects. Further studies are being made on pregnant women and the results are to be presented in 1985. Many of the musculoskeletal difficulties can be relieved with adequate work areas and instruction in safe and proper use of the products.

Psychologists are diagnosing the new stesses found amoung children and adults as use of the computer becomes prevalent. There is very little information on these problems and the psychologists hope to set up guidelines as a means of prevention.

As we take a long hard look at the Computer Age and at the way it might shape our future, Masuda has urged advanced planning by the governments and business that will establish a

"Computopia." However, we are realistically facing a time when the number of computers in the education field will increase, more money will be provided and more teachers will receive instruction. There is a general feeling that as the rich children get computer smarter the poor children will get computer illiterate. A computer literacy gap will develop. There will also be a need to retrain workers as the jobs are changed in the new high-tech world. The hackers will be locked out with new security systems or become more creative. These hazards will be replaced by even greater ones as our world is transformed into a new economic and social system by the future technologies.

The writing of this report has been challenged by a "newness" factor. It has only been five and six years since computers first appeared in classrooms and the technology of the equipment changes rapidly. Most of the reference material has been printed within the past year. Previous books were concerned with the technology of computers while the recent publications are considering all the aspects of the field.

Further studies could involve, artificial intelligence, the Fifth and Sixth Generations, use of robots, or computer education in Janpan or Germany. More information and help will be available on the effects of the computer on our school students as we learn to use them.

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