TECHNOLOGY: A SIGNIFICANT FACTOR FOR 
DEVELOPING EDUCATION

DISSERTATION

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The problem to which this study is addressed is that of education in a technological age. The principal concern is for the recognition of technology in developing general education for the student with particular reference to industrial arts education.

The purposes of the study are to assess technology's significance for education, concepts of education which postulate technology as significant, and the impact of technology on education. Finally, the study discusses critically the implications of these assessments for industrial arts education.

Four categories of sources provide the data: the history and philosophy of technology, social sciences, the work of generalists, and education. Selection of data includes both common and divergent viewpoints of facts and judgments. The data are formed into a composite structure of ideas which have implications for education in a technological world.

The significance of technology for education is constituted by the common interrelatedness of technology and education with concepts of culture, consciousness, knowledge, and identity. Education as a function of these concepts in which technology is so central is an institutionalized expression that disseminates the ideology and sentiments and values of technology.
There exist concepts of education which deal critically and crucially with the theory, practice, and values of technology. These concepts of technology education are interdisciplinary in nature, proceed from critical value questions, and affirm human purposes and social goals.

Technology impinges on the structure, purpose, curriculum, and instruction of education. This impact is both pervasive and inextricable.

Implications of this study for Industrial Arts pertain to definition, objective, instruction, and curriculum. Industrial Arts, as general education, is that part of education which deals with technology and the consequences of the technological nature of society. Its objective is to foster technological literacy. Its instruction occurs in multi-purpose facilities through personal and group inquiry. Its curriculum is multidisciplinary, includes both physical and social technology, and proceeds from critical value questions of means and meaning.
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PART I

TECHNOLOGY AND EDUCATION
CHAPTER I

INTRODUCTION

Technology is a dominant and pervasive characteristic of modern society. It has produced enormous changes in man's life and institutions. The biologists Thomson and Geddes list technodrama along with the other dramas of human life, cosmodrama, biodrama, politodrama, and autodrama (67, p. 1419). Social critic Mumford regards technology as a "formative part of human culture as a whole" (50, p. 415). Similarly, Ellul, the exegete of the technological society, believes that modern man's state of mind is completely dominated by technological values (26, pp. 127-128).

Education also is an important ingredient in modern society. In it society defines, articulates, and transmits its ideology or system of beliefs and sentiments and values to the next generation. As a social process, education takes place in a particular historical setting. There are many influences at work. Brubacher, in his book *Modern Philosophies of Education*, written in 1939, revised in 1950, discusses major forces influencing education and the educative process. Generic traits of existence, theories of knowledge, values, politics, economics, and various other forces all, according to Brubacher, shed light on the study and practice of education (12, pp. 5-6).
In recent years another sociocultural phenomenon that increasingly influences the various forces at work upon education has come to be recognized in the modern world. That phenomenon is technology. The philosopher Harry S. Broudy, in his book *The Real World of the Public Schools* (1972), devotes a full chapter to education in a technological society. Broudy's concern is reflected in his statement that "the demands of modern technological society on education is the implicit question around which controversies about the schools revolve" (11, p. 176).

Generally speaking, technology is thought to be linked to education through educational technology, that is, the apparatus of technology in the service of education. The products of technology, instructional technology, and the technology of teaching are all part of the educational technology concept. This relationship of technology to education is well documented. The relationship of technology to education in this study, however, is conceived in much broader terms than mere technology in the service of education.

Bode defines a philosophy of education as "a generalized program or policy, based on reflective, critical review of available data, for the guidance of educational procedure" (4, p. 368). Today, education occurs within a milieu permeated with technology. Technology is among the "available data" for educational thought. It is the relation of technology to education to which this study is
addressed—the broader aspects of education in a technological age. From the available data of selected sources, this study will attempt to clarify meanings, develop concepts, establish frames of reference, and provide a general perspective for the relationship of technology and education.

Statement of the Problem

The problem of the study is to define the role of technology as a significant factor for developing education which, with particular reference to industrial arts education, will contribute to the general education of the student.

Purpose of the Study

The purposes of the study are as follows:

1. To assess technology as significant for education,
2. To assess concepts of education which postulate technology as a significant factor,
3. To assess the impact of technology on education,
4. To discuss critically the implications of the above assessments for industrial arts education.

Questions to Be Answered

The following questions are related to purpose number one regarding technology as significant for education. What is the significance of technology for education as seen in
1. The concept of culture,
2. The concept of consciousness,
3. The theory of knowledge,
4. The concept of identity?

The following questions are related to purpose number two regarding the concepts of education which postulate technology as significant. What are the concepts of education that postulate the significance of technology as

1. Suggested by individuals,
2. Proposed by groups,
3. Implemented by educational institutions?

The following questions are related to purpose number three regarding the impact of technology on education. In what way does technology

1. Modify the structure of the educational institution,
2. Affect the nature and needs of the student,
3. Govern the materials to be taught,
4. Influence the methods to be used?

The following questions are related to purpose number four regarding the implications of the assessments in the study for industrial arts. What are the implications of the observations, findings, and conclusions for

1. The definition of industrial arts,
2. The rationale of industrial arts,
3. The curriculum of industrial arts,
4. The teaching methods of industrial arts?
Background and Significance

Man has long felt the impact of technology on his life and his social institutions. In the past, however, technology's influence was for the most part hidden, implicit, and unconscious. Now that the focus is turning more to it as a central element in contemporary society, many perceive technology not only as a technical phenomenon but also recognize it in its interrelatedness with all of man's existence. Boulding is cognizant of this relationship:

Changes in technology produce changes in social institutions and changes in institutions produce changes in technology. In the enormously complex world of social interrelations we cannot say in any simple way that one change produces the other, only that they are enormously interrelated and both aspects of human life change together (8, p. 9).

Since it occupies such a dominant position in man's life, it is reasonable to assume that the phenomenon of technology and its relationships in the life of man must be properly understood and, moreover, that it be subjected to rigorous philosophical inquiry.

A Concept of Technology

It was during the 1960's that modern technology became a reality for most Americans. Peter Drucker has this reflection on that period:

The decade discovered technology. Until then, technology was something that could be left to technologists. Engineers built dams; "humanists" read Joyce or listened to Bach or found "laws of nature." Humanists were quite willing to enjoy the "fruits of technology"—whether an airplane ride or a telephone call. But their work, its meaning, its
importance, and its course, were not affected by
technology or only marginally so, as when the
steel-nib pen made unnecessary the trimming of
goose quills, or when electric light bulbs made
possible reading at late hours without eyestrain.
Suddenly, in the 1960's, technology was seen as a
human activity; formerly it was always a "technical
activity, carried out by God knows whom or what,
presumably by "elves in the Black Forest."
Technology moved from the stage of history to which
the "humanist" had always consigned it, and began
to mingle freely with the actors and even, at
times, to steal the spotlight (25, p. 245).

Drucker concluded that technology was a "new reality" that
had to be "integrated with metaphysics and culture,
aesthetics and human anthropology—and indeed it was at the
core of human anthropology and of the self-knowledge of man"
(25, p. 246).

The staggering amount of literature on technology
produced in the twenty-five years from 1955 to 1980 is
evidence of the significant role played by technology in our
daily lives, institutions, and values. A comprehensive
bibliography of technology will reveal the broad range of
topics linked with it: ethics, politics, man, society,
civilization, economics, labor, futurology, law, ecology,
transfer and assessment, to name only a few. Unfortunately,
the mass of material about technology provides little
consensus as to its nature and meaning. There is confusion,
for example, concerning relationship between science and
technology. Mitcham and Mackey cite an example.

While most philosophies of science identify
technology with applied science, some philosophies
of technology argue that modern science is
essentially theoretical technology. Both
tendencies blur our common sense distinctions, so
that sometimes a thinker will use the term "science" to refer to what might more popularly be designated "technology" and vice versa" (46, p. XIV).

**Definitions of technology.**—Mitcham, in his etymo-philosophical study of the word "technology," discovers one of its cognates in the work of Aristotle. The ancient Greeks generally used the word *techne*, usually translated as "art," "craft," or "skill." For Plato and Aristotle *techne* is a "special knowledge of the world which informs human action accordingly" (45, p. 175). Mitcham comments on the writings of Aristotle:

Yet while continuing to stress the epistemic character of *techne*, Aristotle thinks of it not solely as a kind of knowledge, but partially returns to the common-sense Greek notion of *techne* as a type of activity. *Techne* is not strictly activity, but it is a capacity for action, founded in a special kind of knowledge (45, p. 175).

Mitcham suggest that technology acquired its present English denotation in the last half of the seventeenth century. He points out that the term appeared in John Kersey's 1706 edition of Edward Phillips' dictionary and referred to "a description of arts, especially the mechanical arts," while in the 1658 edition of that dictionary the definition does not appear (45, p. 184). Further, he calls attention to Jacob Bigelow's use of "technology" in his *Elements of Technology* published in 1831. Bigelow had adopted this word which he found in some "older dictionaries" in order to refer to "the principles, processes, and nomenclature of the more conspicuous arts, particularly those
which involve application of science" (45, p. 184). Modern definitions of the term technology range from simply "tools and machines" to "rationality" in the broadest sense (44, p. 24).

Max Born proposes that technology is only a verbal label for the thousands of techniques and inventions. Man recognizes technology primarily through the change brought about by it. Born names the steps in this change: first, there is a theoretical discovery; second, the new knowledge is put to work; and third, the results enter into culture to modify human behavior. In other words, technology translates the laboratory to the shop floor and the living room (14, pp. 15-18).

Kranzberg states that the commonly accepted definition of technology as how things are commonly done or made and what things are done or made is "too loose," while the definition man's rational and ordered attempt to control nature is "too tight" (38, p. 5). He prefers this definition:

In its simplest terms, technology is man's efforts to cope with his physical environment--both that profided by nature and that created by man's own technological needs . . . . Technology, then, is much more than tools and artifacts, machines and processes. It deals with human work, with man's attempts to satisfy his wants by human action on physical objects (38, pp. 4, 6).

Hunt understands technology to be "various things done, with or without tools and machines, to transform inputs into outputs" (33, p. 239). Similarly, Boulding sees
technology to be a process. It is a "complex set of ways of doing things with both human and material instruments" (6, p. 336). Daniel Bell defines technology as "a systematic, disciplined approach to objectives" (2, p. 643). Similarly, Simon Moser, the application of theoretical knowledge of nature to the diverse areas of life in the interest of objectives set by man" (49, p. 543).

Denis Goulet defines technology as "the systematic application of collective human rationality with a view to achieving greater control over nature and over human processes of all kinds" (28, p. 39). He finds a structure for diverse technologies in a variety of matrices, some of which are product-embodied technologies, while others are process-embodied ones. Both product-embodied and process-embodied technologies are included in person-embodied technologies (28, p. 39).

A similar classification is given by Winner who understands technology to consist of three elements: apparatus, technique, and organization. By "apparatus" Winner means the physical devices such as tools, instruments, machines, appliances, weapons, and other gadgets. "Technique" applies to technical activities such as skills, methods, procedures, and routines. By "organization" Winner means the technical social arrangements such as factories, work shops, bureaucracies, armies, research, and development teams (74, pp. 11-12).
Still another set of subconcepts for technology is presented by Hickson, Pugh, and Pheysey: operations technology, materials technology, and knowledge technology. Such classifications are often used in management theory (32, p. 380).

Technology is often defined in terms of rationality. Lynn White, an historian of technology, defines technology as "the way people do things" (71, p. 1). Hannay and McGinn define technology as being a specific "form of human cultural activity," just as are religion, sport, medicine, science, art, and philosophy, but one in which the output "consists of material products and procedural systems for the production, management, and use of material artifacts, and for the control and enhancement of other forms of human activity, created with a view toward expanding the realm of practical human possibility" (30, p. 26).

Spengler defines technology not as implements but as purposive activity. It is never of things, but what one does with things. His phrase "tactics of living" summarizes his thinking about technology (63, p. 10).

For Ong, a Jesuit scholar, human thought rather than physical matter is the raw material for technology. "Technology," he states, "has to do with the ordering of the possession of the minds" (55, p. 4). "Systems of purposive rational action" is a pithy, tidy phrase that serves as an extremely suggestive definition of technology as given by Habermas (29, p. 4).
Jacques Ellul, in *The Technological Society*, chooses to use the term *technique* rather than the term *technology* because *technique* is not "an isolated fact in society" as technology implies (26, p. XXVI). "Technique," states Ellul, "is the totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity" (26, p. XXV). He is in substantial agreement with H. D. Lasswell's definition of technique as "the ensemble of practices by which one uses available resources in order to achieve certain valued ends" (26, p. 18). Charles Susskind, reflecting on the Ellul concept of technique, makes this comment:

This omnibus definition extends the concept of technique far beyond its ancestor, machine technology (which is pure technology), to embrace all social, economic, and administrative life, including, for instance, the social sciences, organized sports, propaganda, and in fact all that the historian Arnold Toynbee calls "organization" and Burnham calls "managerial action" (65, p. 89).

Ellul finds three principal subdivisions of modern technique. First, economic technique is given over to production. This division ranges from organization of labor to economic planning. Second, the technique of organization refers to the great masses in commercial, industrial, administrative, and political relationships. Third, human technique related to man as an object of technique in medicine, education, propaganda, and so on (26, p. 22).

For purposes of this study, the definition of technology used by the Harvard Program on Society and Technology and
recorded in Mesthene's book *Technology Change, Its Impact on Man and Society*, will be employed. The Harvard Program defined technology as "the organization of knowledge for the achievement of practical purposes" (44, p. 25). This definition avoids the limited concept of technology as merely tools, and, at the same time, avoids the other extreme of making technology equivalent to rationality.

Technology and the emergence of man.—Man as we know him probably would have never evolved and survived without his technology. Man managed (through his technology) to adapt to his environment and improve his living. *Homo sapiens*, man the thinker, cannot be separated from *Homo faber*, man the tool maker and user. The very terms by which the advance of civilization is measured—Stone Age, Bronze Age, Iron Age, and Atomic Age—testify not only to the direction of tool complexity, but also to the importance of *Homo faber*. It is significant that in the development of man he has not only developed technology, but that technology has influenced the nature and direction of his development. "Man," submits Kranzberg, "made tools; but tools made man as well" (38, p. 8). Spier would enlarge the influence of tools on man to include dependence: "Man, possessed of this extrabiological means by rapid adaptation, has now become dependent upon tools, not any given tool but the fact of tools generically" (64, p. 3).
Arnold Toynbee has pointed out that the technological stages of history are food gathering, food production, and industrialism. Although he does not believe that these stages correspond to the cultural stages of history or that there is any correlation between progress and recession in technology and the progress and recession in culture, Toynbee does acknowledge that "every technological revolution is also a social one in the sense that technological changes are both consequences and causes of social change" (70, p. 337).

Lewis Mumford, who used the term technics rather than technology, in his historical account of technology, divides history into three areas to correspond with power sources and basic materials used. He designated the earliest period "eotechnics" which utilized water and wood. The paleotechnic period which used coal and iron is the middle era. The neotechnic era or modern period utilizes electricity and alloy (52, pp. 109-110).

Modern technology was touched off by the industrial revolution. This coincided with the alliance of science, the knowledge of nature, and technology, the art of invention, during the nineteenth century. This marriage of science and technology ushered in with rapid, successive steps modern technological development. Hans Jonas identifies these states as mechanical, chemical, electrical, electronic, nuclear, and biological (36, pp. 75-80).

The first distinctive mark of modern technology, according to Jonas, is the artificially generated and
processed nature of forces for the powering of work-producing machines. "In the mechanical stage," he states, "the goods produced were much the same as those produced manually. Changed, however, was the mode of their production and therewith the whole condition of human labor" (36, p. 75).

In the chemical stage of technological development, scientific and technological progress "come together definitely and inseparably" (36, p. 76). The dye, fertilizer, and pharmaceutical industries are an intervention into the workings of nature in a greater depth. Jonas explains that intervention.

In the chemical stage, man does more than construct machinery from materials and use forces as sources of power. In chemistry he changes the substances of nature and even comes to synthesize substances which nature never knew . . . . Man steps into nature's shoes, and, from utilizing and exploiting he advances to creating. This is more than merely shaping things. Artificiality enters the heart of matter (36, p. 77).

The electrical stage of modern technological development, according to Jonas, was "wholly and unilaterally science-generated. Whereas steam and heat can be observed, electricity is an abstract entity, disembodied, nonmaterial, unseen; and to all practical intents . . . it is entirely an artificial creation of man" (36, p. 78).

The electronic stage of development also marks a new creation of objects imitating nothing and is progressively added to by pure invention. The electronic stage makes possible communication engineering to meet the information and control needs in the modern world civilization.
An appropriate comment from Jonas in another context elucidates the implications of this stage of technology.

Modern technology, going beyond the mere production and application of power, tends increasingly to couple the power engine with robot mechanisms—mechanisms that replace man's arms in supplying the moving force. The difference lies not only in the function but also in the technology; automatic control is a branch of communication engineering, as distinct from power engineering. It is the rise of these servo-mechanisms, and the fact that they supersede human functions very different from those superseded by the mere power engine—generally speaking, higher functions—which causes Wiener and others to speak of the second industrial revolution (35, p. 109).

Jonas chooses to bypass a discussion on nuclear physics in favor of what for him is a conceivable last stage in technological development. This stage of development has become a theoretical possibility with the advent of molecular biology and its understanding of genetic programming (36, p. 79). The dilemma posed by genetic engineering along with other technologically-related problems such as the ecological complex is at the very heart of Jonas' philosophic concerns—the ethical significance of technology.

Philosophy of technology.—Among modern philosophers, it was Freidrich Dessauer, in his major work, *Philosophie der Technik*, who first recognized technology as a metaphysical problem of philosophy (45, p. 171). Other thinkers who have confronted the philosophical problem of technology include Henri Bergson, Oswald Spengler, Jose Ortega y Gasset, Karl Jaspers, and Martin Heidegger.
Donald Brinkman has classified the various philosophical approaches to the problems of technology as being applied science, economics, means, and human power. Each of these, in his opinion, presents an insufficient concept of technology. While not providing a sufficient alternative, Brinkman does encourage further critical reflections as a way to confront the philosophical challenge of technology (10, p. 128).

Mitcham and Mackey suggest that technology can be analyzed as a problem of knowledge, considered in relation to the nature of man, and characterized as the thought and action of modern society. These scholars designate these three as epistemological, anthropological, and sociological approaches to the analysis of modern technology (47, p. 2).

Bunge proposes that, since technology is a major organ of contemporary culture, philosophers should pay far more attention to it than has previously been done until a fully developed philosophy is constructed. Bunge identifies some typical problems in the philosophy of technology that include the character of technological knowledge, the ontology of artifacts, and the value systems and the ethical norms of technology. Moreover, he advocates as search for the philosophy of technology among the ideas of technology, a search guided and controlled by methodological rules and by epistemological, ontological, and ethical principles (15, p. 263).
Bunge argues that "modern technology grows out of the very soil it fertilized, industrial civilization and modern culture" (15, p. 266). As such, technology strongly interacts with the other creative components of contemporary culture, namely the humanities, mathematics, sciences, and the arts. In his discussion of this point, Bunge states:

Not only does technology interact with every other living sector of contemporary culture... but it overlaps partially with some of them. Thus, architecture and industrial design are at the intersection of technology and art; much of physics and chemistry is as much engineering as it is science; applied genetics is hardly distinguishable from pure genetics and even some of metaphysics is at the intersection of technology and philosophy... (15, p. 280).

Because of the conceptual richness of the technological process and the interaction of technology with the other components of culture, Bunge advances the premise of the centrality of technology to modern culture. Few would deny that technology is central to industrial civilization, but it is sometimes denied as an essential part of modern intellectual culture. In Bunge's view, technology is ignored by culture at the risk of the health and perhaps survival of that culture. It is a word of caution, even a veiled warning, that he states:

Indeed, it is often held that technology is a mistake, one which betrays a total ignorance of the intellectual richness of the technological process, in particular of the innovating one. The mistake has obnoxious consequences, for it perpetuates the training of scholars with a traditional (preindustrial) cast of mind and conceptual equipment, contemptuous and afraid of whatever they do not understand about modern life. When they wield power in governmental or educational
institutions, such people try to isolate the technologist as a skillful barbarian who must be kept in his modest place as the provider of material comfort. By behaving in this way, those scholars in fact deepen the gaps among the various subcultures and miss the chance of contributing to steering the course of technology along the path beneficial to society as a whole (15, p. 279).

The problem of technology.—It is the opinion of Juenger that one of the most vital and controversial issues of modern day is "the meaning and the destiny of the technical age" (37, p. 1). Gendron, in an excerpt from his book Technology and the Human Condition, puts into focus the problem of technology.

The public debate initiated in the 1960's over the social impact of technology has not yet subsided. The issues are overwhelming, and no resolution is in sight. The following questions are primarily being asked: Is technology a progressive force? Does it on balance contribute to the amelioration of human pain, suffering, oppression, and exploitation? Has it really enabled us to enrich our existence, and to expand our powers over our own fate? Or, on the other hand, has it proved on balance to be a regressive force? Has it dehumanized us, alienated us, or generally impoverished our daily lives? Has it undermined our relations with each other and with nature? Or, alternatively, is technology "neutral?" Are we and not technology responsible ultimately for the goods or evils which appear to have been visited upon us by our technology? But do we really control technology or does it control us? And, indeed, are its social effects as widespread as they initially appear? (27, p. 1).

Gendron categorizes the major proponents of the utopian viewpoint, those who believe that technology is altruistic and will eliminate both scarcity and social ills, and of the dystopian viewpoint, those who hold that technology is the cause of cultural ills by undermining freedom and democracy,


The issue of whether technology is altruistic, demonic or neutral is unresolved and the problem remains unsolved. Spier has suggested that "the world is too valuable, too
unique, to be left to the care of ungoverned technologists" (64, p. 33). On the other hand, he asserts that "a counter-technological view must exist to promote other kinds of solutions to the problems" (64, p. 33). For example, Spier questions whether or not it would be "a bit out of character for a consulting engineer to suggest to a client that prayer would be the best response to the problem of a bridge grown dangerous by advancing age" (64, p. 32). Spier concludes that "A balance must be struck between the needs of society, the capabilities of technologies, and the resources which are supple to both" (64, p. 32).

**The Matrix of Technology and Education**

Eric Ashby described four revolutions in education. The first occurred when education became professional and was shifted from home to school; the second occurred when writing was invented and adopted by education; the third occurred when the printing press was invented; and the fourth is the contemporary application of technology in the educational process (1, pp. 32-34). As these revolutions are contemplated, it is enlightening, if not startling, to see how they interface and interrelate with technology.

In the first revolution, schools were made possible due to groups of people coming together in towns. This development of civilization was made possible because of the technological development in agriculture which made a food surplus available and made society, therefore, less
precarious. With a more settled way of life, a larger number and a larger proportion of society's resources were available to be devoted to education and to the pursuit and transmission of knowledge (7, p. 32).

The second revolution, the invention of writing, went along with and enhanced the schools in providing a new instrument for cultural transmission (7, p. 32). The third revolution's debt to technology with reference to the printed book is self-evident and merits little comment. The fourth revolution mentioned by Ashby is the conscious, explicit application of technology to education. It is the full and integrated use of all of the resources of the technological age directed toward education (23, p. 21). One example of this fourth revolution technology is microprocessing. The advent of this technology--called "the computer on a chip"--is comparable to the invention of the printing press and promises to bring about vast change. This fourth revolution, according to a Carnegie Commission forecast, will not be complete until the last decade of the Twentieth Century (16, pp. 93-94). In a very direct sense, then, technology has played an active role in the revolutions of education.

Although this direct application of technology as a means of education seems to be becoming more commonplace, it is extremely important to keep in mind a concept presented in the OTA Priorities Bulletin for 1979. "Technology will affect not only the medium of education, but also the message
Technology as a major cultural subject, rivaling history and English in importance, is basic to a healthy democracy" (54, p. 19). Technology may be said to be related to education not only as a medium of education but also as a message of and a meaning in education.

The reception of technology as a medium has a continuum that runs from optimistic promise to absolute rejection. Pressey nearly fifty years ago predicted the coming "industrial revolution in education" where machines would revolutionize education as they did in industry to facilitate manufacturing (58, p. 672). Drake, on the other hand, feels that the machine can never replace the teacher who guides, stimulates thought, because successful teaching depends upon "the quality of mind reflected in the personality of the teacher" (24, p. 57). The Carnegie Commission gives weighty support to the medium approach with its catalogue of hard and soft technologies. The new teaching machine technology will change instruction from the "historical requirements-met-through-teaching approach to a resources-available-for-learning approach" (16, p. 2).

Technology as a message indicates a study of technology in and for itself. DeVore, for example, has outlined a conceptual model for the modern disciplines of knowledge that give meaning to contemporary experiences. He structures man's knowledge in the disciplines of science, humanities, and technology. Technology as a discipline is built around the three technological universals of production,
communications and transportation. Thus, for DeVore, technology is a legitimate portion of the structure of knowledge (20, p. 24).

Technology as a meaning is developed by two areas of research and inquiry, namely, history and philosophy of technology. Kranzberg places the history and philosophy of technology in the juvenile stage of growth, while the philosophy of technology is still in swaddling clothes (39, p. XIII). These branches of study of technology involve the complex interrelationships of technological development with social, economic, political, intellectual, legal, military and archaeological ones. The questions addressed in these studies have to do with technology's significance in relation to these areas. The question should be asked, what is the interrelationship of technological development to education.

Fifty years ago John Dewey recognized the relationship of technology with culture. "The problem," he wrote, "of the relation of mechanistic and industrial civilization [technology] to culture is the deepest and most urgent problem of our day" (22, pp. 124-125). In Democracy and Education, Dewey stated the problem in the context of education:

The manufacturer, banker, and captain of industry have practically displaced a hereditary landed gentry as the immediate directors of social affairs. The problem of social readjustment is openly industrial, having to do with the relations of capital and labor. The great increase in the social importance of conspicuous industrial
processes has inevitably brought to the front questions having to do with the relationship of schooling to industrial life. No such vast social readjustment could occur without offering a challenge to an education inherited from different social conditions, and without putting up to education new problems (21, pp. 366-367).

For Dewey, the nature of industry was in the process of change. Industry was no longer a customary, simple procedure. It had shifted to a technological technique based on mathematics, physics, chemistry, and so on (21, p. 370).

Dewey was well aware of the danger of a public school dominated by the money-motif of an economic system that would produce "efficient industrial fodder" and "citizenship fodder" to support the existing society. He described the situation as a "kind of intellectual immaturity" due to "enforced mental seclusion" which provides little concern for the "underlying social problems of our civilization... [and] largely evades serious consideration of the deeper issues of social life" (22, p. 128).

The hope for the educational situation, in Dewey's opinion, was the gradual reconstruction of school materials and methods to bring about the ideal education which he envisioned.

An education which acknowledges the full intellectual and social meaning of a vocation would include instruction in the historic background of present conditions; training in science to give intelligence and initiative in dealing with material and agencies of production; and study of economics, civics, and politics, to bring the future worker into touch with the problems of the day and the various methods proposed for its improvement. Above all, it would train power of readaptation to changing conditions so that future
workers would not become blindly subject to a fate imposed upon them (21, p. 372).

With few exceptions, philosophers of education have failed to take Dewey's lead in pursuing the problem of technology's impact on education. Park suggests that philosophers who work in education find other concerns more pressing, such as analyzing the works of Plato, Aristotle, or Rousseau to see how present-day education measures up. It could be that these philosophers enjoy the method of linguistic analysis of some concept such as freedom, equality, justice, or teaching. Again, it could be, as Park points out, that time is spent in studying the nature of the logic used in certain arguments or attempts to generate solutions to questions about what to do in education (57, pp. 411-412). These, for some, more pressing problems take priority over the impact of technology on society and education.

Meanwhile, engineering schools continue to train students who become powerful agents of change. Yet engineering curricula rarely consider or require the study of historical, social, and philosophic aspects of technology. "With similar insensitivity," write Bugliarello and Doner, "schools of liberal arts and sciences exclude what should, on the contrary, be mandatory: curricula that consider what benefits technology offers humanity and what problems it can pose" (13, p. VII). To this point Charles Reich in his *Greening of America* makes this observation:
We have vastly underestimated the amount of education and consciousness that is required to meet the demands and organization of technology. Most of our 'education' has taught us how to operate the technology and how to function as a human component of an organization. What we need is education that will enable us to make use of technology, control it, and give it direction, cause it to serve the values we have chosen (59, p. 390).

The classical humanist Robert M. Hutchins also questions the educational theory that simply provides human resources for other social institutions and promotes technological development. He argues against practices that victimize the student by directing him toward a specialization of knowledge or occupation rather than providing him with insight into mankind, nature and living. "We need education," he states, "in science and technology in a scientific age not to train us for the work we have to do but to understand the world in which we are living" (34, p. 65).

It is the thesis of this study that technology is a legitimate factor, circumstance, presupposition, and assumption of educational thought. As such, technology should be given its appropriate place in developing education. Study of technology that leads to stark technological development without critical examination of social consequence is absolutely untenable. The human element in technology is not just an appendage. Human problems are woven in the very fabric of technology. The social problems faced by technology cannot be answered simply by further technological pursuit in the technician's lab but
in dialogue on the study of man, his aspirations and struggles, his conflicts and dreams, and his insights into life and purpose.

Eric Ashby's sober conclusion is that "an undergraduate class in technology which does not include a serious element of humanities and social sciences is simply not meeting the needs of society" (1, p. 42). Likewise, an educational philosophy which takes notice only of the gadgets of technology is equally without justification. Technology is widely diffused in the common culture. Yet the philosophy of "idea-ism" has not accepted it as a portion of the cultural heritage and, thus, has denied it as an essential form of humanism. One simply has to look to medical technology as an example of technological expression of humanism (1, p. 41). Ashby astutely comments that the idea of not studying technology unless one is going to become a technologist is deserving of contempt. It is like saying that one does not study history unless he is going to be a historian. "No man," he states, "can regard himself as adequately educated if he does not understand some principles of technology (1, p. 29).

Educational workers are oftentimes caught up in and acquiesce to a spirit of competition and conformity and are led by a philosophy of education built on casual contacts, stereotyped concepts, and popular slogans rather than thoughtful design. This attitude has allowed a lag in the schools and a cultural overhang in education to develop.
This lag/overhang is evident with respect to the relation of technology to education. Therefore, the intention of this study is to provide a prolegomena to a philosophy of education which will give credence to technology as one of the presuppositions. Perhaps, then, man can better understand his culture, deal honestly and decisively with the economic, political, and social systems, realistically and fearlessly face controversial issues, and live his own personal life as an individual of integrity, courage, and compassion.

Related Literature

Thinking about technology has become a necessity. The rate of technological change and the potential of new technological systems are sources of concern among many people. Hence, there is a growing body of technologically related literature. Because of the magnitude of technology, the literature originates from nearly all disciplines and from every field of human endeavor. It is interesting to note that few professional philosophers have investigated the problems connected with technology. Perhaps it is due to their preoccupation with language systems and linguistic analysis concerns. Most of the discussion, therefore, concerning technology has come from historians, anthropologists, policy scientists, sociologists, generalists, and, surprisingly, engineers.
An important and growing bulk of literature goes under the rubric of philosophy and history of technology. Much of this material deals with the interrelatedness of technology to social and cultural processes. Occasionally the educational aspects are included. Mitcham and Mackey (48) and Bugliarello and Doner (14) are two excellent collections. In their history of technology, Kranzberg and Purcell (40) provide a vast amount of social interplay along with the development of technology. Two individuals who have made significant contributions to the history and philosophy of technology are Lynn White and David Noble. White (71), in his *Medieval Technology and Social Change*, has related technology to the culture of the Middle Ages. Noble's work, *America by Design*, deals with industrial revolution in America during the twentieth century. He argues the case of social transformation through technical change and mutual dependence on industry and education (53). Among the professional journals of this area, *Technology and Culture* is the most popular and influential (66).

An appropriate place to begin the study of technology and its social interrelatedness from the perspective of the social scientists is Kenneth E. Boulding's *The Meaning of the Twentieth Century* (7). This slender but thoughtful volume covers a broad range in its discussion. Boulding sees mankind in a great transition from civilized to a post-civilized society. He argues that a viable strategy for this new society is cautious and critical acceptance. Boulding
is in the "invisible college" that sees hope for mankind in
the enormous potential in spite of the dangers that lie
ahead. He also gives helpful insights in his book *The Impact
of the Social Sciences* (7).

The basic historical world context from which this study
is built is provided by R. R. Palmer and Joel Colton in
*A History of the Modern World* (56), William H. McNeill in
*The Rise of the West* (43), and C. E. Black in *The Dynamics of
Modernization* (3). The American scene is set by chronicler
and interpreter Max Lerner in *America As A Civilization* (42).
Additional insight on the social implications of the
technological age is provided by Stuart Chase's *The Proper
Study of Mankind* (17), Robert L. Heilbroner's *An Inquiry Into
the Human Prospect* (31), and Christopher Lasch's *The Culture
of Narcissism* (41).

Substantial contributions to the understanding of
technology in the life of man have been done by generalists.
Lewis Mumford, who, according to Lerner, produced "the
greatest American work on technology and its consequences"
(42, p. 20), has two major works, *Technics and Civilization*
(52) and *The Myth of the Machine*, Volume I, *Technics and
Human Development* (51), and Volume II, *The Pentagon of Power*
(50). These works reveal a creative mind that articulates
the anthropological view of the development of technology.
Another individual who, although a scientist, writes with the
perceptive and sensitive mind of the humanist is Norbert
Wiener. In his non-technical books, such as *The Human Use of
Human Beings (72), Wiener is particularly concerned about the social implications of cybernetics as the heart of technology. In this generalist category mention must be made of Ellul (26) and his classical study, *The Technological Society*. Hans Jonas also has written several important and noteworthy papers and essays which are collected in *Philosophical Essays: From Ancient Creed to Technological Man* (36). Alvin Toffler has written two important, popular works that deal with the impact of technology on social institutions. They are *Future Shock* (68) and *The Third Wave* (69).

About the time of the Great Depression, some of John Dewey's disciples in the pragmatic philosophy of education formed a new movement call reconstructionism. They felt that not only were the materials and methods of education in need of reconstruction but that the times also demanded that all society was in need of reconstruction. *Dare the Schools Build A New Social Order?* (18) was an expression of the concern over social issues. Brameld (9) maintained that progressive education had served its usefulness, but the hope was in a cultural reconstruction. Another book of the 1930's, *The Great Technology* (60), by Harold Rugg, argues a similar utopian view of cultural reconstruction. Rugg, the engineer turned educator, believed in "modes and norms of living of a potentially great culture which looms just over the horizon" (60, p. X). The way to the new epoch was the
way of education—adult, child, and youth education (60, p. 287). He outlined the kind of education that is needed.

- To justify the assumptions underlying government by the consent of the governed and thus to bring about the successful union of technology and democracy.
- To teach men how to apply the scientific method to the Man-Man relationships as they have to the Man-Thing relationships.
- To teach men how to grasp and appreciate life as it passes as well as to prepare for the problems of tomorrow.
- To produce a race of artists and craftsmen as well as an army of efficient technicians (60, p. 257).

The problems, according to Rugg, to be solved for educational reconstruction are the developing of a new philosophy of life and education, producing a new race of educational workers, making new activities and curriculum, and developing a new eclectic psychology (60, p. 258).

Technology in education is most familiar in the use of devices used in instruction. They range from routine audio-visual techniques, to computer assisted instruction, to systems approaches. The Wittich and Schuller (75) text is a handy reference. Pressey (68) followed by Skinner (61) are noted for the teaching machines and developing programmed instruction. Their real import came, however, not in school practice, but in educational research and curriculum, equipment for performing teacher tasks, and in computer system instruction (23, p. 21).

A recent study by Smith (62) looks at the confrontation between humanism and the technological pressures on school and society. She explores the emerging capitalistic society
through the works of Weber and Fromm as a source for technology. For theoretical interpretation of the modern technological society, she turned to the writings of Marcuse, Habermas, and Ellul. After distinguishing between education as art and education as science, she concluded that the educator must educate as a humanist in a technological atmosphere.

It is in relation to such concerns as the foregoing, along with others who have studied the question, that this dissertation will be developed. Utilizing the selected sources, it is the intention of this study to define the role of technology as a significant factor for the development of education.

Definition of Terms

Technology—for a working definition, technology denotes "the organization of knowledge for the achievement of practical purposes" (44, p. 25).

Education is the "deliberate, systematic, and sustained effort to transmit, evoke, or acquire knowledge, attitudes, values, skills, or sensibilities, as well as any outcome of that effort" (19, p. VIII).

General education is that portion of education deemed desirable for all students without particular reference to work, occupation, or professional role.

Industrial arts refers to "those phases of general education that deal with industry—its evolution,
organization, materials, occupations, processes, and products—and with the problems resulting from the industrial and technological nature of society" (73, p. 16).

Delimitations

1. The study focuses on the period of time from 1957-1980.

2. A fully developed philosophy of education in the technological age is beyond the scope of the study, and one is not developed.

3. The implications of the study are developed in relation to the American society.

Basic Assumption

The data have been collected from the various disciplines. However, they are assembled in such a way as to form a composite structure of ideas which has implication for education and for the subject of inquiry presented in the study.

Procedures for the Study

The inquiry into the area defined by the statements of purpose and the related questions constitutes the substance of the study. Each statement of purpose and its related questions is developed as a separate chapter.

The problems raised by the statements of purpose and research questions are investigated in the literature of reputable and respected scholars who speak to the
interrelatedness of technology and education. There are four categories of sources from which the data are derived:

1. The History and Philosophy of Technology,
2. Social Sciences - History, anthropology, sociology, psychology, economics, political science,
3. Work of Generalists,
4. Education.

Relevant data have been collected from these sources. Selection of data includes common and divergent viewpoints of facts and judgments in order to provide balanced understanding and perspective.

The study is presented as critical, philosophic research. It is be presented in two parts. Part I consists of Chapters I, II, and III. Chapter I has been an introduction to the problem. Elements of this chapter were the statement, purpose, and background and significance of the problem, and the research questions that are derived from the problem. Chapter I also has included the definition of terms, delimitations, basic assumption, related literature, and the procedures of the study.

Chapter II relates to purpose number one regarding the assessment of technology as significant for education. This chapter is an inquiry into the concept of culture, the concept of consciousness, a theory of knowledge, and the concept of identity.

Chapter III relates to purpose number two and will report the concepts of education that postulate technology as
significant. Data have been sought from the sources as to the suggested, proposed, or implemented concepts by persons, groups, or institutions of such concepts.

Part II consists of Chapters IV through VIII. Chapters IV through VII relate to purpose number three, regarding the assessment of the impact of technology on education, and is an inquiry into that impact on the organizational structure of education, the nature and needs of the student, the curriculum, and instruction respectively.
CHAPTER BIBLIOGRAPHY


CHAPTER II

THE SIGNIFICANCE OF TECHNOLOGY

FOR EDUCATION

It was Robert Hutchins who named the plastic cup, and not Cellini's Cup, as the symbol for the modern scientific and technological age. The plastic cup, a product of technological efficiency, will hold liquid as well as Cellini's masterpiece, and it can do so for millions of previously cupless people (25, pp. 76-77). The Cellini's Cup/plastic cup analogy may well hold for education. The sociocultural conditions and education produced Cellini's Cup yesterday. Today, the sociocultural condition and education produce the plastic cup. It is important, therefore, to investigate the sociocultural situation and education that have wrought this change.

The Cultural Imprint of Technology

Culture is a learned way of behaving and thinking. A knowledge of culture is important because it is an aid to the understanding of behavior. Education has a direct link to the cultural phenomenon in that it provides a system for deliberately transmitting a way of behavior, that is, the culture. It is from culture that education derives and identifies its content. Brameld expresses the relationship
of education to culture in this way: "It is from the stuff of culture that education is directly created and that gives education not only its own tools and materials but its reason for existing all" (5, p. 6). What, then, is culture? What insights can be gained from culture regarding education?

**Concepts of Culture**

Anthropologist Alfred Louis Kroeber defines culture as "the mass of learned and transmitted motor reactions, habits, techniques, ideas and values—and the behavior they induce" (30, p. 8). Kroeber declares that "culture is the special and exclusive product of men, and it is their distinctive quality in the cosmos" (30, p. 8). Nida asserts that culture is "all learned behavior which is socially learned, that is, the material and non-material traits which are passed on from one generation to another" (37, p. 28). Culture, for Nida, is a way of behavior, thinking, and reacting. "We do not see culture," he states. "We see manifestations of culture in particular objects (things made or used by people) and actions (what people do or say)" (37, p. 29). Nida is careful to explain the subtle difference between culture and acts and artifacts.

Culture should not be confused with the acts of behavior or the material artifacts. That is to say, culture is manifest in acts and artifacts but does not consist of them. In its broadest sense, culture (as used by anthropologists) includes the ways of life or "designs for living" employed at any time by all mankind. However, one can speak of a culture as being the ways of life characteristic of a single society or of a group of closely related societies. One can also use the term "culture" in
referring to the particular patterns of behavior of a distinctive segment of some highly complex society, in which case we often speak of a subculture. One exception to the above usage occurs in the phrase "material culture," which includes the material artifacts as well as the skills employed in making and using them" (37, p. 281).

Cultures may be broken down into a number of traits. Various cultures emphasize different traits and, although they may differ in details, all cultures have certain things in common. Wisser, in 1923, gave a general outline of culture universals that is still relevant. In his scheme, culture could be comprehended under nine heads—speech, material traits, art, knowledge (both mythological and scientific), religion, social systems, property, government, and war. These may be subdivided. For example, social systems include marriages, kinship, inheritance, social control and games. Food, shelter, transport, dress, utensils, weapons, and industries are listed under material traits (52, pp. 74-75). Coon reports that there are about 3,000 living or extinct forms of cultural patterns into which men have shaped and arranged their lives. The generalized traits common to all living cultures, according to Coon, are technology (to satisfy the needs for food, shelter, and protection), thought (symbols and language), institutions (family, division of labor, etc.) arts (expression through movement and poetry), and values (regulation of life) (10, p. 23).

In describing culture, the early anthropologists such as Tylor looked at culture in general and pictured it as the sum total of human achievement. Then, anthropologists, such as
Wisser, began to distinguish between culture in general and separate cultures of individual groups of people. Further development came in the work of functionalists such as Radcliffe-Brown and Malinowski. Presently, cultures are treated as living and functioning systems. This approach is seen in the works of Kroeber, Benedict and Kluckhohn. In such a concept of culture an emphasis is placed on the system of value developed by the particular culture as well as the influence of the culture on the individual personality in the culture. In this manner it may be said that culture exhibits distinctive qualities and definable characteristics, even personality. While there are variations and exceptions among peoples of subcultures and societies, there are certain dominant features of respective cultures that seem to characterize the thinking and reactions of the peoples. In ancient Greece the dominant aspect was philosophy and the arts. The Chinese traditionally have prized classical education. In ancient Hebrew life the theocratic considerations were valued, and in medieval Europe, the ecclesiastical viewpoint was predominant (37, pp. 229-230). Nida, however, would counsel against describing cultures in terms of a single dominant and integrating drive in favor of treating culture in "terms of its 'themes', those explicit or implicit factors which tend to control behavior and to stimulate activity" (37, p. 297).

Kluckhohn has described the culture of the United States on the basis of theme and ethos. High in priority for
Americans are physical comforts, bodily cleanliness, financial capitalism and materialism. There is strong faith in the rational (even moralistic rationalization). High value is given to optimism, a romantic individualism, a cult of the common man, a quest for pleasure, and change (29, p. 229ff). Kluckhohn summarizes the forms of culture in the United States in the following words:

Suppose that an intellectual Australian aborigine, who was also a trained anthropologist, were to write a monograph on our culture. He would unequivocally assert that machines and money are close to the heart of our system of symbolic logics. He would point out that the two are linked in a complex system of mutual interdependence. Technology is valued as the very basis of the capitalistic system. Possession of gadgets is estimated as a mark of success to the extent that persons are judged not by the integrity of their character or by the originality of their minds, but by what they seem to be so far as that can be measured by the salaries they earn or by the variety and expensiveness of the material goods which they display (29, pp. 242-243).

A Cultural Focus

Melville J. Herskovits in his work, *Man and His Work, the Science of Cultural Anthropology*, takes the position that the study of technology is essential for an understanding of culture. "Technology," he maintains, "is the only aspect of culture susceptible of objective evaluation" (23, p. 241). Herskovits, like Kluckhohn, believes that cultures have themes, foci, and ethos that tend "to exhibit greater complexity, greater variation in the institution of some of its aspects than in others" and "to develop certain phases of life" and that are used to characterize the whole culture
For Herskovits, the cultural focus is "a people's dominant concern . . . that area of activity or belief where the greatest awareness of form exists, the most discussion of values is heard, the widest difference in structure is to be discerned" (23, p. 544). Historical illustrations of cultural focus cited by Herskovits are Egypt, with its economic and politico-religious concerns, the truth-seeking democratic society of Athens, Rome's political organization, supernaturalism of medieval Europe, secular learning and arts of the Renaissance and the industrial revolution of the twentieth century centering on technology and economics (23, p. 544). According to Herskovits, the focus of modern American culture is technology. "The boy who tinkers with an automobile, or plays with a chemical set and so on," he states, "is merely responding to a deep-seated enculturative drive" (23, p. 549).

In Leslie A. White's analysis of man and culture, technology plays a prominent part. The difference between the man and the animal is not necessarily a matter of brains, skill, or inventive ability. "The fundamental difference," states White, "consists in the fact that the use of tools among men is a cumulative and progressive process . . . ." (51, p. 44). Coupled with this progress and repertory of tool behavior, man has the ability to put tools in symbolic form. Man not only has tools and concepts of tools, but he has and uses words for tools--axe, knife, hammer, and so on. It is White's feeling that "it was the introduction of symbols,
word-formed symbols, into the tool process that transformed anthropoid tool-behavior into human tool-behavior" (51, p. 45). According to White, the "tool-experience in man is continuous and enduring" (51, p. 46). As man knows and wields tools, they for man are not merely material objects or sensory images. A tool for man is also an idea. White explains this concept:

It is a part of that timeless inner world in which man lives. It is not something that exists for the moment only; it functions in the living past and is projected into the unborn future. The tool in man's mind, like Plato's ideas in the mind of God, is eternal. Hence tool-experience for man is more than a series of disconnected episodes, a grasping and using tools and laying them down again. These overt acts are merely occasional expressions of an ideational experience within him that is continuous and unbroken (51, p. 47).

Culture is for White an organized, integrated system. In his analysis of culture, White distinguishes three subdivisions or aspects with the cultural system. The three subdivisions are technological, sociological, and ideological systems. White explains that the technological system is composed of "the material, mechanical, physical, and chemical instruments, together with the techniques of their use, by means of which man, as an animal species, is articulated with his natural habitat" (51, p. 364). The sociological and ideological systems are "made up of interpersonal relations expressed in patterns of behavior" and "ideas, beliefs, knowledge, expressed in articulate speech or other symbolic form" respectively (51, p. 364). White views cultural systems in a series of three horizontal strata with the top layer
being the idealogical layer, the sociological layer in the middle, and the technological layer on the bottom. In White's opinion, this arrangement expresses their respective roles, because he is persuaded that the technological system undergirds all human life and culture. He states this position in these words:

The technological system is basic and primary. Social systems are functions of technologies; and philosophies express technological forces and reflect social systems. The technological factor is therefore the determinant of a cultural system as a whole. It determines the form of social systems, and technology and society together determine the content and orientation of philosophy (51, p. 366).

From this stance, White concludes that technology is a key to an understanding of the growth and development of culture, because it is the means of articulation between man and the cosmos (51, pp. 366-367). In White's sketch of the evolution of mankind, technology is the hero of the piece, and it shall be for the future. Although technology may destroy—and White thinks it eventually will—it can also be the creative power to open a way to a fuller and richer life (51, pp. 390-392).

The Environment

Sociologist William F. Ogburn pointed out two concepts that are relevant in the context of this study—the notion of inventions influencing history and technology as environment. In a paper written in 1942, Ogburn pursued the thesis that inventions affect the size of populations and in this manner
influence history. Ogburn uses invention in its broad meaning to include mechanical invention, discoveries in applied science (such as antitoxins and germ theory of disease) in their practical application, and social invention (such as new types of social organization and new religion forms). In his theory, Ogburn sees inventions as a force in social history. Ogburn means by "the force of invention" or "technological forces" that invention or technology "serves as a new stimulus for groups of individuals to behave in different ways" (38, p. 67). An illustration of his theory is drawn from the settlement of the Great Plains. At first, populations passed it by because their established woodland culture could not be adjusted to its settlement. The settlement of the Great Plains came later largely through three inventions—the six-shooter pistol, barbed wire, and the windmill (38, p. 65). Another example of this theory is seen in the building of railroads. They were a force in building the cities. It is in this sense that "inventions become a force in history," states Ogburn. "They stimulate human activity" (38, p. 67). After sketching a number of inventions in history to argue his thesis, Ogburn comments that "it is to be expected that these same forces will shape the future as they have shaped the past" (38, p. 77). He does not speculate on particular inventions as cultural forces, but he mentions broad categories of probable inventions that may come from electricity, chemistry, communications, and transportation (38, p. 77). From the perspective of the 1980's, witnessing
the inventions from these fields adds to the strength and reality of Ogburn's analysis.

After briefly discussing the natural environment and the social environment, Ogburn, in a paper of 1956, introduced another environment—technology as environment. Using a brief definition of environment as something to which to adjust and technology as objects of material culture, Ogburn takes the technological environment to mean that environment which "consists of such fabricated objects as buildings, vehicles, processed foods, clothing, machines, ships, laboratories" (38, p. 79). He suggests that just as an animal is surrounded by a natural environment, so a man in a factory surrounded by technologically-produced objects may be said to work in a technological environment. In a technological environment, there are individual elements to which man must adjust, such as the tin can of processed food and the digital computer. When individuals or groups adjust, it implies changes in social activities such as religion, education, marriage, political and productive occupations. Ogburn suggests that adjustment to the technological environment may be direct, indirect, or derivative. The direct adaptation comes from direct use of a technological product. The indirect or secondary or derivative adaptation comes as the result of changed customs and institutions coming directly from their use (38, p. 83). Ogburn elucidates this process of adjustment:
Men must adjust to the steam engine by letting it drive their tools for them. Consequently, they work away from home in factories. The family, a social institution, adjusts to the absence of workers and to the new production and to the additional source of income. The adjustments in the family are the decline in the authority of the husband and father, the removal of economic production from the home, the separation of husband and wife, and the different type of education for the children. These are not the direct adaptations to the steam engine, but are adaptations to the uses of steam-driven tools away from the homestead (38, p. 83).

Ogburn considers the derivative adjustments far more numerous than the direct ones. "For any one direct adaptation to a technological element," he states, "creates a change in a custom or an institution to which several other customs or institutions will adjust" (38, p. 84). The most complex adaptation to technological environment involves a cluster of elements rather than a single element. The cities, for example, were extensive adjustments to agriculture technology, transportation technology, and tools of industry. Modern times present an almost impossible task in adjusting to a changing technology (38, p. 85). Ogburn set the grim reality of the task in comparing it to a biological adaptation which implies varying degrees of adaptation suggested by terms like "strain," "tension," "nervousness," "vitality," "energy," "illness," and "strength" and "where the measure of adjustment is living and the lack of adjustment is death" (38, p. 80).

Similar to Ogburn's technological environment concept is the idea put forward by Idhe. His word "technosphere" is an attempt to describe the world which man experiences through
machines (26, p. 7). In his analysis of man's relationship to technology, man experiences embodiment relations, hermeneutic relations, and background relation. In this general framework man's experience is transformed in that self-experience is experience through machines, other-experience is experience with machines, and field-experience is experience among machines. Idhe refers to it as "technological totalization" (26, p. 15). Idhe explains the concept.

Machines become, in technological culture, part of our self-experience and self-expression. They become our familiar counterparts as quasi-other, and they surround us with their presence from which we rarely escape. They become a technological texture to the world and with it they carry a presumption toward totality. In this sense, at every turn, we encounter machines existentially (26, p. 15).

The technological totalization of the technosphere, according to Idhe, is like an envelope or cocoon of astronauts and deep sea investigators who use, work with, and live surrounded by technological artifacts. Idhe used a satirical illustration to convey this point.

The technological American plans a camping trip to the American West. He begins by encasing himself in a large camper-bus, complete with flushing toilet, shower, color television, air conditioning, and the lot. As he drives westward, nature becomes a "spectable" to be viewed through the picture window of the bus, and at night he finds an instant suburbia in a crowded campground inhabited precisely by his similars, who gather in the evening to compare notes on the latest improvements to camping equipment. Here the "technosphere" is nearly complete and has become portable for the astronaut on his own planet (26, p. 14).
In a real sense Idhe's world of technosphere is a world "inside a machine." This idea reminds one of the fascinating short story of E. M. Forster, "The Machine Stops." The idea of technosphere also causes one to recall the comments of Rene Dubos, a biologist, who has pointed out that an environment conditioned by technology is a world where man is artificially related and the fundamental needs are not met.

Man in such a condition is like animals in a zoo--fed, clothed, and protected--but alienated from the deepest layers, his fundamental self (13, p. 16). To accept uncritically the view that man's future is linked to technology and that man's dependence on the machine as an essential part of his evolution, in Dubos' opinion, can become dangerous. The world of the future, according to Dubos, will reflect less the projections of the technologist, the sociologist, and the economist, but must take into account the inexorable, vital needs, urges, and limitations of biological man (13, p. 30).

**A Master Activity**

The historian Arnold Toynbee has questioned the wisdom of putting technology in the prominent position in the affairs of men. In fact, he would discourage any "master-activity" in man's history. Technology looks like man's master-activity, especially in the prehistoric age of mankind's career. Technology has produced revolutionary social effects--population explosion, global urbanization,
and consequent congestion, and mechanization, regimentation, and consequent boredom (48, p. 201). Toynbee, however, thinks that a similar case could be made for economics, politics, study, recreation, education, or religion. "The different activities," Toynbee states, "are so closely interconnected that it is impossible to deal with any one of them without also having to take account of at least one or two of the others" (49, p. 658). Religion would be Toynbee's choice for a master-activity, if indeed there were such a thing. Religion must be qualified, he believes, in that its claim as a master-activity can be vindicated only by being put in terms that transcend it. Religion is man's master-activity only in the sense that religion embraces all man's other activities in itself (49, p. 663).

Lauda agrees that "technological determinism cannot account for 100 percent of our beliefs, values, and so forth, but he does affirm that it does explain a great deal about our society. "A culture, he notes, is not just ideas. We could not exist on ideas alone. We must translate our ideas into purposive action . . . . Our technological culture constitutes a large part of our reality" (32, p. 7).

Two Shaping Institutions

It is interesting to compare the two following statements:

Every individual of the human species is born into a cultural environment as well as a natural one. And the culture into which he is born embraces him and conditions his behavior . . . .
Human behavior is . . . always and everywhere, made up of these two ingredients: the dynamic organization of nerves, glands, muscles, and sense organs that is man, and the extra-somatic cultural tradition.

The human organism is born into the culture which has patterns of social, economic, and civic import. Much of his early learning is in the socialization processes. In the process of being indoctrinated by many educational influences, the individual adjusts and adapts to the mores and values of the culture, and yet he experiences many activities for developing his motor coordination and challenging his thinking.

The former quotation is from Leslie White, an anthropologist (51, pp. 122-123), and the latter from Charles Shoemaker, an educator (43, p. 129). The interesting thing is that both speak of an individual, a culture, and the shaping of the individual by the culture. One difference is that the shaping institution, education, takes place within the framework of the shaping institution, culture. These two statements converge in the thought of Kroeber. "Through being born into a society, every individual is also born into a culture. This culture molds him, and he participates in it. The molding is taken for granted, accepted, uncritically, and unconsciously. The deliberate part of the process we call education" (30, p. 288).

Those who study culture and its impact on individuals attest to this relationship. To Kluckhohn, culture systems may be considered as products of actions, and as conditioning influences upon further action (28, p. 73). Again, Kroeber states that culture allows for a certain set of activities to go on, but by its very existence "inevitably induces certain
habits in the members of its society" (30, p. 325). The "deliberate part of the process" in culture, as has already been pointed out, the part that "influences" and "induces" is education. Besides reading and arithmetic, as Kroeber draws attention to, "education inevitably imparts an ideology, a system of beliefs and sentiments and values, which if accepted, is all-important for its influence on conduct. An ideology or system might also be called a pattern or configuration; that is, a way of arranging things" (30, p. 293). As pointed out above, the major focus in American culture is the configuration of technology.

The same, then, may be said for education. Spier in discussing technology defines it as "the complex of learned behavior which gives rise to the material culture." Moreover, he states that "the knowledge, attitudes, and customs of technologies are as much a part of the cultural baggage of man as his political or religious behavior" (45, p. 1). This cultural baggage of technology is available to every young person in nonliterate societies where the technology of the people is simple, and they become proficient over the whole range of it. Also, in the nonliterate societies competence in the technologies comes at an early age, perhaps because the machine culture has less content and less complicated implements. Thus, the young can be trained at an earlier age (23, pp. 311-312). In highly literate, more advanced cultures, White submits the cultural baggage of technology is available only to those who are specially trained in a certain
area because of the increasing differentiated and stratified nature of technology. Atomic bombs, 200-inch telescopes, 100-ton cyclotrons and so on demand requisite training. As a consequence, White contends, exceptional ability and the biological diminish in significance. It is no longer possible in the advanced technological cultures for a few gifted individuals to do the technical jobs. It takes the collective labor of hundreds of skilled technicians. In White's words, "It is not the soloist that counts so much today--although public and press still have and feed an appetite for primadonnas--it is the whole symphony orchestra" (51, p. 225).

Theodore Brameld, in his work Cultural Foundations of Education, suggests that the nature of the environment is "the prime conditioner of education's limitations and restrictions as well as of its possible creative opportunities" (5, p. 5). This line of thought leads him to the view that education takes place on the "stage of experience which man himself has fashioned through his own amazing ingenuity, his fears, his dreams, and his wants .... This stage is culture" (5, p. 6). To be "cultured" is to be "educated." Brameld's analysis in this book is built around three problems--human order, human process, and human goals. His second problem is pertinent to this study. Since process is defined as change, development, invention, and practice, Brameld supposes education to be a process. It is basically a process in culture which is said to be discovery and invention,
diffusion, acculturation, assimilation and innovation (5, p. 23). Brameld places his discussion of technology under the causal factors at work upon the evaluation of schools as cultural institutions. He calls for a "technological interpretation of education" after the pattern of Leslie White. Brameld believes that such "operational utilization of causal hypotheses such as the technological could help education to know, if not the way the schools will move, then certainly the more likely ways" (5, p. 156).

**The Phenomenon of Technology**

Traditionally, philosophy had been the handmaiden of theology, but during the 19th and 20th centuries, philosophy has become the handmaiden of science. It has not questioned the assumptions of science, but only served to clarify concepts in scientific activities and to solve problems of logic (46, p. 5). At the turn of the 20th century, however, there was a revolt against this accommodation approach, and a "reclamation strategy" known as Phenomenology appeared on the scene. Phenomenology, under the development by Edmund Husserl, "responded to the autonomy of science by claiming a need to reformulate the foundation of science itself" (26, p. XVII). Michael Polanyi viewed the movement as far reaching in its influence as a "systematic attempt to safeguard the content of unsophisticated experience against the effects of a destructive analysis" (40, p. 221).
The Primacy of Perception

General themes of phenomenology purport to be a return to the traditional tasks of philosophy, the search for a philosophy without presuppositions, the intentionality of consciousness, and the refusal of the subject-object dichotomy (46, p. 5). The question What is phenomenology? is given an answer by Maurice Merleau-Ponty in the preface to his book, The Phenomenology of Perception.

Phenomenology is the study of essences; and according to it, all problems amount to finding definitions of essences: the essence of perception, or the essence of consciousness, for example. But phenomenology is also a philosophy which puts essences back into existence, and does not expect to arrive at an understanding of man and the world from any starting point other than that of their "facticity." It is a transcendental philosophy which places in abeyance the assertions arising out of the natural attitude, the better to understand them; but it is also philosophy for which the world is always "already there" before reflection begins—as an inalienable presence; and all its efforts are concentrated upon reaching a direct and primitive contact with the world, and endowing that contact with philosophic status (34, p. VII).

Two notions out of Merleau-Ponty's definition are relevant to the study at this point—consciousness and perception.

Phenomenology challenges all rational assumptions and principles. It suspends judgment until that is founded on a more certain basis. Therefore, it begins with a description and clarification of consciousness. Consciousness is always intentional, and it is always directed toward an object. "Consciousness is consciousness of" is very near the heart of phenomenology. "Consciousness of" implies a shift in emphasis from the question of reality of the world to the
meaning of that which appears to consciousness. By shifting from reality to meaning phenomenology overcomes the distance between cogito and cogitatum, that is, consciousness and content (46, p. 8).

The structure of consciousness consists of an activity called noesis, a Greek term meaning intelligence or thought. The essence of the noesis is correlated to noema, meaning a thought or perception, or that which is perceived. The noetic/noematic relationship is not to be confused with the subject/object way of thinking. The noematic is not an empirical or physical experience. It has to do with the meaning of these processes. The eidos is the essence of what a thing perceived is while the horizon is the context of one's experience in changing things, expectations, emotions, ideas, and so forth. In the perceiving of an object it stands out or rises up into horizon. The perceived object becomes the theme for understanding the larger context, that is, the object thematizes the horizon. In this manner the sense data and the object, rather the act of perception and the object perceived are connected, and that which is perceived, is the real world (46, p. 36). At this point, another notion of phenomenology needs to be discussed—perception. A relevant analysis of perception is given by Maurice Merleau-Ponty.

The Phenomenology of Perception is Merleau-Ponty's magnum opus and likely to become a classic of twentieth century philosophy (14, p. XV). In this work, he gives
primacy to perception, and he writes nearly five hundred pages to explain its meaning. Merleau-Ponty establishes first that the world is there before anyone's analysis. Therefore, the real must be described and not artificially constructed or formed by analytical construction. The world is not an object that one may hold in his possession, but it is the natural setting and field for thoughts and explicit perceptions. Perception, then, is not a science of the world or an act, or a position to be taken. "Perception," states Merleau-Ponty, "is the background from which all acts stand out, and is presupposed by them" (34, p. XI). Perception owes nothing to the physical world, stimuli, sense experience, or objective thought or any category of causality. These simply provide at every moment a perceptual field, a point of contact with the world and a permanent rootedness in it. Perception, accordingly, presents itself as "a re-creation or re-constitution of the world at every moment . . . . All knowledge takes its place within the horizons opened up by perception" (34, p. 207).

Kwant understands that Merleau-Ponty's concept of perception is used in the sense of pre-conscious, pre-personal and anonymous. "Perception," according to Merleau-Ponty, he states, "is our primordial contact with the world, and that, therefore, the world is first given to us through perception . . . . Perception penetrates into our bodily being at the most profound and primordial level of our existence as giver of meaning" (31, p. 3). A passage from
Phenomenology of Perception seems to sustain Kwant's interpretation.

The fact that my earliest years lie behind me like an unknown land is not attributable to any chance lapse of memory, or any failure to think back adequately: there is nothing to be known in these unexplored lands. For example, in premature existence, nothing was perceived, and therefore there is nothing to record. There was nothing but the raw material and adumbration of a natural self and a natural time. This anonymous life is merely the extreme form of that temporal dispersal which constantly threatens the historical present. In order to have some inkling of the nature of that amorphous existence which preceded my own history, and which will bring it to a close, I have only to look within me at that time which pursues its own independent course, and which my personal life utilizes but does not entirely overlay. Because I am borne into personal existence by a time which I do not constitute, all my perceptions stand out against a background of nature. While I perceive and, even without having any knowledge of the organic conditions of my perception, I am aware of drawing together somewhat absentminded and dispersed "consciousnesses": sight, hearing and touch, with their fields, which are anterior, and remain alien, to my personal life. The natural object is the track left by this generalized existence. And every object will be, in the first place, and in some respect, a natural object, made up of colors, tactile and auditory qualities, insofar as it is destined to enter life.

Just as nature finds its way to the core of my personal life and becomes inextricably linked with it, so behavior patterns settle into that nature, being deposited in the form of a cultural world. Not only have I a physical world, not only do I live in the midst of earth, air and water, I have around me roads, plantations, villages, stores, churches, implements, a bell, a spoon, a pipe. Each of these objects is molded to the human action which it serves . . . In the cultural object, I feel the close presence of others beneath the veil of anonymity. Someone uses the pipe for smoking, the spoon for eating, the bell for summoning, and it is through the perception of a human act and another person that the perception of a cultural world can be verified (34, pp. 347-348).
In a study entitled "Primacy of Perception," a study done shortly after the publication of *Phenomenology of Perception*, Merleau-Ponty attempted to summarize and defend the central thesis of that work. Regarding the essence of perception, Merleau-Ponty states:

By the words, the "primacy of perception," we mean that the experience of perception is our presence at the moment when things, truths, values are constituted for us; that perception is a nascent logos; that it teaches us, outside all dogmatism, the true conditions of objectivity itself; that it summons us to the tasks of knowledge and action. It is not a question of reducing human knowledge to sensation, but of assisting at the birth of this knowledge, to make it as sensible as the sensible, to recover the consciousness of rationality (35, p. 25).

When Merleau-Ponty discusses the concept of freedom, it is again the theme of the pre-personal in relation to the givenness of the world which dominates. "I can no longer pretend to be a cipher," he states, "and choose myself continually from the starting point of nothing at all." (34, 452). Consciousness can refuse to acknowledge its starting point and to be anything in the world, but that general refusal is, in itself, still one manner of being which has a place in the world (34, p. 452).

I may defy all accepted form, and spurn everything, for there is no case in which I am utterly committed: but in this case I do not withdraw into my freedom, I commit myself elsewhere. Instead of thinking about my bereavement, I look at my nails or have lunch, or engage in politics. Far from its being the case that my freedom is always unattended, it is never without an accomplice, and its power of perpetual tearing itself away finds its fulcrum in my universal commitment in the world. My actual freedom is not in the hither side of my being, but
before me in things . . . A consciousness for which the world "can be taken for granted," which finds it "already constituted" and present even in consciousness itself, does not absolutely choose either its being or its manner of being.

What then is freedom? To be born is both to be born of the world and to be born into the world. The world is already constituted, but also never completely constituted; in the first case we are acted upon, in the second we are open to an infinite number of possibilities. But this analysis is still abstract, for we exist in both ways at once. There is, therefore, never determinism and never absolute choice, I am never a thing and never bare consciousness. In fact, even our own choices of initiative, even the situations which we have chosen, bear upon us once they have been entered upon by virtue of a state rather than an act. The generality of the role and of the situation comes to the aid of decision, and in this exchange between the situation and the person which takes it up, it is impossible to determine precisely the "share contributed by the situation" and the "share contributed by freedom" (34, pp. 452-453).

Therefore, to understand man, Merleau-Ponty submits, one must understand pre-consciousness, for it is in the pre-consciousness that consciousness and freedom in life have their origin.

Freedom is always a meeting of the inner and the outer. There is always a "field of freedom" and a "conditioned freedom." Man chooses and is chosen. "The choice which we make of our life," he states, "is always based on a certain givenness" (34, p. 455). "Freedom," he concludes, "flounders in the contradictions of commitment" (34. p. 456). Man, then, is in an "inextricable tangle" in his involvement with the world and with others. Merleau-Ponty's last word in his book comes from A. de Saint-Exupery, "Man is but a network of relationships, and these alone matter to him" (34, p. 456).
Merleau-Ponty admitted that the *Phenomenology of Perception* was only a preliminary study. The book, however, did present a method for getting closer to present and living reality when applied to culture, history, language, knowledge, society, religion and so on (35, p. 25). His method may be applied to education. A child himself takes positions, and there constitutes and structures his world, whether it be in the cognitive or affective realm. Moreover, from his birth the child has been molded by his particular social upbringing. There is no causality inferred in this relationship—since the two phenomena cannot be isolated. The "natural" and the "acquired" are not two but one. "In reality," states Merleau-Ponty, "the two orders are not distinct; they are part and parcel of a single global phenomenon" (35, p. 108).

**The Technology of Toys**

A slightly different approach to perception is taken by Daniel Cappon in his book, *Technology and Perception*. His book concerns the relationships and interactions between technological products and cultural forms. Perception is for him largely unconscious. Perception is the way a man or a group sees the world and most of the time they hardly break the surface (8, pp. 37-38). Cappon believes that technology in its proper usage does not mean doing, but rather thinking and contemplating (8, p. 114). Cappon's impression is that modern man is unconscious of his technological ambiance. It
is simply taken for granted. However, man's perceptual values are constantly changed by technology. "Technological products, once they impinge on a society to become established in a culture," he writes, "change the culture, primarily and basically because they change modes of perception" (8, p. 3).

Cappon points out the relationship between technology and perception in terms of the developing child through the medium of toys. It is through toys the young child experiences and manipulates technological products that provide the link between technology and perception. The toys for the child today become the tools of the adult tomorrow. The whistle, the cap gun, the chemistry set, the doctor's kit, the paint and crayon, "all become the perceptual and technological milieu of childhood. Gradually the toys become more complicated and demanding and closer to the reality of adult life" (8, p. 128).

Historically, according to Cappon, there was no childhood, except for some semblance of it for the first three years. These miniature adults were expected to use the tools of the father and mother to earn their keep. Children had no separate existence until about the seventeenth century. It was only with the coming of the industrial revolution that they began to be protected. It took Dickens, the industrial revolution, modern medicine, and affluence to create adolescence (8, p. 129). The traditional toys, then, were not exclusively for children. Dolls, puppets, musical instruments, and so on were for the enjoyment and entertainment
of adults as well as for children. There was nothing that belonged especially to childhood or was built for and used exclusively by children. There were, however, playthings that seemed to be favorites of children—hobby horses, tops, and hoops.

Children today are, in contrast to earlier days, exposed to the "perceptually enriched data by the technology of toys and the milieu of adult life, with its massive information" (8, p. 128). Cappon maintains that the bombardment of the sensory experience and orientation has some built-in hazards due to the fact that children do not easily transcend sense data except in the context of what he calls "realistic knowledge." Consequently, insight, intuition, and imagination are sacrificed in favor of the factual and documentary. This leads Cappon to surmise that generation gap is in reality a "yawning experiential gap in basic sensor sensuousness," that is, "a revolution of the senses" (8, p. 129).

Certainly the years spent kinetically with the hoop and hobby horse, with the wooden swords in combat, and the years listening to grandfather's tales have shrunk into years of passive visualization and push button electronic control mechanisms. In the swinging, beatlemanic adolescent and preadolescent world society of today, with child-centered values dominating the mid-twentieth century, the intimate world of the child is being perceptually fragmented and restricted to passive vision and its few sensory linkages. Childhood is becoming digit conscious and abstract. In a world congregating children in vast pseudo-educational enclosures where they stifle in contiguity, the age of uninvolvment and disarticulation has dawned on childhood. The occasional play-therapist tries vainly, with the
tools of an alienating modern technology, to mend
the fences. But the child is father to the man and
well prepared, as always, for the tasks assigned to
him by each sinning generation" (8, p. 132).

Cappon's contribution, then, is that he calls attention to
the shift in the perceptual world from a kind of stable and
static world of dolls, wooden toys and fairy tales for young
and old to unstable, ever-changing universe of electronic
toys and science fiction with vastly extended perceptions of
time and space (8, p. 43).

The Social Construction of Reality

One approach to the question of reality is a method
known as the sociology of knowledge. This approach has to do
with specific social context and social relativity which
order the shape of "reality" and "knowledge." A sociology of
knowledge deals with the empirical variety of "knowledge" in
human societies and the processes by which that knowledge is
socially established as "reality." Since "knowledge" is
developed, transmitted and maintained by social situations,
sociology of knowledge will attempt to understand what makes
this "knowledge" to be taken for granted as "reality" by the
people of the particular society. In the words of two
proponents of this approach, Peter Berger and Thomas
Luckmann, "Sociology of knowledge is concerned with the
analysis of the social construction of reality" (2, p. 3).

Max Scheler, one of the pioneers in the sociology of
knowledge movement, recognized technology as an important
resource in the affairs of men that exposed and explained one
of the innate drives in the character of western man.

Scheler considered the following statement to be one of the important propositions in the sociology of knowledge.

Technology is not a subsequent "application" of a theoretical, contemplative science characterized by the idea of truth, observation, conservative, pure logic, and mathematics; rather, the more or less prevailing will to control and direct this or that realm of existence (gods, souls, society, organic and inorganic nature) co-determines the methods of thought, and, indeed, it co-determines as though behind the back of the consciousness of individuals . . . . This proposition is just as firmly proved by the history of cognitional theory and developmental psychology as by the factual history of science and technology (42, pp. 101-102).

In his investigations, Scheler traced the traits of the founders of modern thought and values through men such as Galileo, Descartes, Kepler, Newton, and so on. He found them to be men who were nominalists in their thinking, emphasized man's will as dominant in his nature, put stress on the problems of consciousness and certitude, gave primacy to freedom of investigation and judgment of truth independent of traditional dogma, and held to a dualism between mind and flesh, soul and body, and God and the world (42, p.107).

Scheler contrasts this emphasis with that of other civilizations which embody themes which are important from the standpoint of the sociology of knowledge:

Buddhist metaphysics and its ethics . . . also developed a will to control, which was no less than in the West. But this will to control was not directed toward outer material production, and it entailed neither an increase in population and material needs nor a perpetuation of them. It was inwardly directed toward mastering the automatic flow of psychic processes and all processes of the
lived body—directed toward mastery for the sake of
mortifying inner desire. This explains, to use an
example contrary to the way it is with us, the
adaptation of a child population to static relations
of production, say, by killing young girls, etc., an
extraordinary psychic and vital technique but not a
significant technology of production or war . . . .
Also, Greek religion and metaphysics likewise, but to
a lesser degree, excluded strong will and any positive
valuation of production techniques that made use of
machines, even after the development of the very rich
pure mathematics and investigations into nature . . . .
True, Greek metaphysics and religion, in principle,
affirms the world, its nature and existence, but
neither as an object of human work, human building,
ordering or prediction, nor as an object of a divine
creative architectural deed which man has to
continue. Rather, their world is the realm of
living and noble energetic forms to be seen and
contemplated and to be loved. It is also here,
then, that the prevailing religion and metaphysics
exclude any inner connection between mathematics and
studies of nature, between studies of nature and
technology, between technology and industry; a
connection which is the unique and powerful stamp of
modern civilization . . . . In China all powers of
the ruling classes were directed toward the
cultivation of human existence, mores, and inner
dispositions. This occurred during the reign of
Confucianism, with its humanistic classicism, with
its official ethics, spanning throughout the magical
solidarity of nature with the emperor and up into
the order of the heavens, and, not the least
significant, with its hieroglyphics, conducive to
rigidity and inflexibility in thought and linked to
the books of the great classical writers. Very
little mental energy was left here for extensive war
production, technology, and systematic
science—despite strong economic incentives,
population increases, and eagerness for possession"
(42, pp. 103-104).

Kenneth Stikkers wrote in the introduction to Scheler's
book, Problems of Sociology of Knowledge, that there are but
two basic technics for thinking whether it be scientific,
religious or philosophic. First, there is the Western heroic
attitude. This activity is characterized by vital drive,
brute strength, and rationality. The attitude toward
knowledge in this scheme is a rationalistic concept of conquering reality, that is, to bring reality under the rule of abstraction and logic, principles, and laws, to technologize it. Second, Stikkers identifies the technique found in Eastern mysticism, such as Buddhism, Taoism, and some forms of Christianity. This technique seeks to block or dissolve the vital urge and thereby cancel the world's resistance. It is the opinion of Stikkers that all phenomenology is based on this attitude, because such an attitude he states, "seeks to let essences come forth and show themselves." It is a technique for letting the world "ontologically and essentially be" (47, p. 11). Stikkers admits that perhaps both approaches are needed. For example, modern techniques of medicine may be able to relieve a child's suffering when he is ill, but it can have nothing to say to the mother about the meaning of his suffering if the child should die in his suffering. "Modern medicine," observes Stikkers, "may prolong human life but cannot address the meaning of that life" (47, p. 12). Formulation of "world formula" or "biological life" carries no meaning. It is a void that only the nonscientific mode of thinking can fill (47, p. 12). From his analysis of the situation, the judgment of Stikkers is that the modern West is obsessed with gaining knowledge of control—which follows Bacon's maxim that "knowledge is power."

Modern man drives, controls, and manipulates rather than lives in, his body in much the same way he drives his automobile. And modern education,
confusing itself with technical training, aims at developing such control, thereby producing human fuel for society's technological and bureaucratic machinery rather than cultivating free personal spirits (47, p. 28).

In the sociology of knowledge, although there are differences in details, there has been general agreement that it is concerned with "the relationship between human thought and the social context within which it arises" (2, p. 4). The taken-for-granted knowledge in society is the framework for other knowledge and that which is not yet known, but will be in the future. "This is the knowledge," state Berger and Luckmann, "that is learned in the course of socialization and that mediates the internalization within the individual consciousness of the objectivated structures of the social world" (2, p. 62). For example, a body of knowledge is developed that refers to the particular activity of hunting. A vocabulary designates various modes of hunting, the weapons used, the animals that serve as prey, and so forth. A collection of recipes will be learned in order to hunt correctly. The dynamics of the social construction of the reality of the institution can thus be described:

As the institution of hunting is crystalized and persists in time, the same body of knowledge serves as an objective (and, incidentally empirically verifiable) description of it. A whole segment of the social world is objectified by this knowledge. There will be an objective "science" of hunting, corresponding to the objective reality of the hunting economy . . .

Again, the same body of knowledge is transmitted to the next generation. It is learned as objective truth in the course of socialization and thus internalized as subjective reality. This reality in turn has power to shape the individual.
It will produce a specific type of person, namely the hunter, whose identity and biography as a hunter have meaning only in a universe constituted by the aforementioned body of knowledge . . . . In other words, no part of the institutionalization of hunting can exist without the particular knowledge that has been socially produced and objectivated with reference to this activity. To hunt and to be a hunter implies existence in a social world defined and controlled by this body of knowledge. Mutatis mutandis, the same applies to any area of institutionalized conduct" (2, pp. 62-63).

The principle just explained in the specialized institution of hunting holds true for consciousness in everyday life. The ordered reality of everyday life is thus apprehended as the reality. The prearranged patterns of everyday life seem independent of one's apprehension and they impose themselves on that apprehension. "The reality of everyday life," Berger and Luckmann point out, "appears objectified, that is, constituted by an order of objects that have been designated as objects before my appearance on the scene" (2, p. 21). This "givenness" may be illustrated by language, geographically designated places, tools that designate technical capacities of the society from can openers to sports cars, and a web of human relationships from chess club to citizenship (2, p. 21). In conclusion, Berger and Luckmann state that the reality of everyday is organized around the "here and now." This "here and now" is the focus of my attention to the reality of everyday life," they assert. "What is 'here and now' presented to me in everyday life is the realissimum of my consciousness" (2, p. 22).
Carriers of Consciousness

In a later book, *The Homeless Mind, Modernization and Consciousness*, Berger again pursues the consciousness theme in terms of modernization, as indicated by the subtitle.

All social reality has an essential component of consciousness. The consciousness of everyday life is the web of meaning that allows the individual to navigate his way through the ordinary events and encounters of his life with others. The totality of these meanings, which he shares with others, makes up a particular social life world (1, p. 12).

Consciousness is explained here as not ideas and theories, but rather pre-theoretical that originates with the systematic patterns and fields of everyday people in everyday life. It is a subjective phenomenon but one that can be objectively described. Sociology of knowledge, then, becomes that which describes specific constellations of consciousness (1, pp. 12-13). Berger argues that the structures of consciousness are linked to particular institutions and institutional processes. He believes that an analysis of specific institutions and institutional processes provide the social base for not only the specific structures of consciousness, but also the carriers of consciousness (1, p. 16).

Key phenomena for modern consciousness, according to Berger, are technological production and bureaucracy, with the former being relevant to this study. Berger analyzes in considerable detail the characteristics of technological production—componentiality, interdependence of components, their sequences, separability of means and ends, implicit
abstraction, segregation of work from private life, anonymous social relations, assumption of maximalization, and multirelationality (1, pp. 27-37). He considers the primary carriers of the modern consciousness to be the processes and institutions that are directly related to technological production. In developed societies in which technological production provides the economic foundation of society as a whole, the carry-over or results are enormous. There is a continuous bombardment on the consciousness from the material goods produced and the consciousness of their production. Even though many people are not directly engaged in technical production, "it is not necessary to be engaged in technical work in order to think technologically" (1, p. 40).

Secondary carriers of modern consciousness are defined by Berger as "the processes and institutions that are not themselves concerned with such [technological] production" but serve as transmitting agencies for the consciousness derived from this source" (1, p. 40). He identifies two important ones:

The institutions of mass education and mass communication generally may be seen as the most important of the secondary carriers. Through school curricula, motion pictures and television, advertising of all sorts, and so on, the population is continuously bombarded with ideas, imagery and models of conduct that are intrinsically connected with technological production (1, p. 40).

A New Consciousness

The foregoing discussion has pictured the world as a world which is already present. Into this established world
enters a child who would in the light of the established world constitute for himself a world as he perceives it. A child begins to perceive certain things in his world because his attention is drawn to them. "The fact that his attention is drawn to these things and not to others," comments Kwant, "is connected with the entire history of the people among whom he grows up" (31, p. 78). The reality of this is vividly experienced at the point of cross-cultural interaction. There is a tendency "to underestimate the degree to which the technological mentality pervades our perceptions and thought until we try to introduce technology to a population that perceives the world via a nonscientific mentality," observed Broudy (6, p. 31). Giving technological products to people who are ill prepared technologically to receive them produces some "anomalous results," such as machines used in ritual or washing a thermometer in harmful bacteria-filled water. "Even relatively uneducated people in a technological culture," quips Broudy, "think scientifically about natural phenomena, the current craze for the occult notwithstanding" (6, p. 31). A similar situation not unlike the confusion of a cross-culture interaction occurs when a new technology is introduced into a culture. McLuhan regards this to be the present situation in Western culture with the new electric technology.

With electric media Western man himself experiences exactly the same inundation as the remote native. We are no more prepared to encounter radio and TV in our literate milieu than the native of Ghana is able to cope with the
literacy that takes him out of his collective tribal world and beaches him in individual isolation. We are as numb in our new electric world as the native involved in our literate and mechanical culture (33, p. 31).

During the 1960s Marshall McLuhan brought public attention to the effects of electric technology and mass technology and mass communication on consciousness. Working on the assumption that all technologies are but extensions of man's physical and nervous systems to increase power and speed, McLuhan attempts to show that man is rapidly approaching the final stage of extension—the technological simulation of consciousness (33, p. 19). McLuhan believes that the type of communication used by man determines and shapes society. Alphabet and type produced linear thought that led Western values to be built on the written word. However, this mode of thought and value system is considerably altered by electric media of telephone, radio and television (33, p. 85). According to the McLuhan vision, the new media are transforming the "linear" into a "spacial" culture. Three thousand years of explosion through mechanical technology in the Western world produced increasing specialization, fragmentation, detachment, noninvolvement, and alienation. Now, electric technology is extending man's central nervous system to a global embrace, into a global village. The consequence of this dramatic reversal on consciousness is enormous. McLuhan explains:

In the electric age, when our central nervous system is technologically extended to involve us in the whole of mankind and to
incorporate the whole of mankind in us, we necessarily participate, in depth, in the consequences of our every action (33, p. 20).

McLuhan believes that the aspiration of our times is for wholeness, empathy, and depth of awareness. "We are suddenly eager to have things and people declare their beings totally," he states. "There is a deep faith to be found in this new attitude—a faith that concerns the ultimate harmony of all being" (33, p. 21).

Thus, McLuhan is hopeful. His confidence rests in the possibility of winning man's understanding necessary to bring these new forms into orderly service. Yet, McLuhan recognizes the risks in such a challenge. He knows that there exists the possibility of "the numbing or narcotic effect of the new technology that lulls attention while the new form slams the gates of judgment and perception" (33, p. 68) that brings "technological trauma" (33, p. 71). The consequences of the surrender of man's senses and nervous systems to private manipulation, of the leasing of man's eyes, ears, and nerves to commercial interests, and of the leasing of man's central nervous systems to various corporations are to meet the challenge of the new technology with a "sort of banana-skin pirouette and collapse" (33, p. 73). In regard to Archimedes' famous saying, "Give me a place to stand and I will move the world," McLuhan suggests that today he would have pointed to modern electric media and said, "I will stand on your eyes, your ears, your nerves, and your brain, and the world will move in any tempo or pattern I choose." This leads McLuhan to
comment, "We have leased these 'places to stand' to private corporations" (33, p. 73). Like Forster's delightfully grim fantasy, "The Machine Stops," men become victims of their creation:

We created the Machine, to do our will, but we cannot make it do our will now. It has robbed us of the sense of space and of the sense of touch, it has blurred every human relation and narrowed down love to a carnal act, it has paralyzed our bodies and our wills, and now it compels us to worship it. The Machine develops—but not our lives. The Machine proceeds—but not to our good end."

Forster ends his tale when the machine stops—"the entire communication system broke down, all over the world, and the world as they understood it ended" (17, p. 183).

The Technological Theory of Knowledge

The quantum physicist Werner Heisenberg, in The Physicist's Conception of Nature, relates a story from Chuang-Tzu, an ancient Chinese sage, which describes how technology can affect man's patterns of thought and valuation and habits of life.

As Tzu-Gung was travelling through the regions north of river Han, he saw an old man working in his vegetable garden. He had dug an irrigation ditch. The man would descend into the well, fetch up a vessel of water in his arms and pour it out into the ditch. While his efforts were tremendous, the results appeared to be very megre. Tzu-Gung said, "There is a way whereby you can irrigate a hundred ditches in one day, and whereby you can do much with little effort. Would you not like to hear of it?" Then the gardener stood up, looked at him and said, "And what would that be?"

Tzu-Gung replied, "You take a wooden lever, weighted at the back and light in front. In this way you can bring up water so quickly that it just gushes out. This is called a draw-well."
Then anger rose up in the old man's face, and he said, "I have heard my teacher say that whoever uses machines [cunning instruments] does all his work like a machine. He who does his work like a machine grows a heart [cunning in dealings] like a machine, and he who carries the heart of a machine in his breast loses his simplicity [not pure and corrupt]. He who has lost his simplicity becomes unsure in the strivings of his soul [restless in spirit]. Uncertainty in the strivings of the soul is something which does not agree with honest sense [Tao]. It is not that I do not know of such things; I am ashamed to use them (21, pp. 21-22).

How different is the mentality of the ancient gardener, who spurned the machine, from the mentality of men in the techno-world where the machine "has become a purpose in operation, a mechanism of purpose, whose complex processes represent the conditions under which values are to be realized" (36, p. 301). Surely man has not lost entirely his "simplicity," but just as surely "uncertainty in the strivings of his soul" aptly describes man's condition in the modern crisis. It would be unfair to place the blame totally on technology for the crises of the modern age, for it was largely through the development of tools that the human race has survived. Why, then, was the gardener so fearful of the machine? Why does the technological man of today think the old gardener odd, even foolish, for not taking advantage of a faster, easier, and more efficient means to accomplish his work? The answer to the problem posed here might be sought in the area of what has been called a technological theory of knowledge.
The American Temper

The Puritans, the young republicans, the transcendentalists, and the pragmatists are, according to Richard Mosier, in his book *The American Temper, Patterns of Our Intellectual Heritage*, are the four main creative movements in making of the American mind. Moreover, Mosier argues that the experimental temper and the instrumental purposes of pragmatism, along with the concepts of social Darwinism and America's tremendous technical achievements in tools and inventions, led to the establishment of a philosophy of technology. This philosophy of technology, he writes, "constitutes the unique contribution of America to twentieth century thought" (36, p. 258). At the heart of the American philosophy of technology is the pragmatic notion of the instrumental theory of knowledge. Scheler has drawn attention to this theory as he identified it as being the very genius of American pragmatism. He pointed out that in this theory knowledge neither precedes man's experience of things (*ideae ante res*), as in Platonic idealism, nor follows from experience and is based on the correspondence of a proposition with an objective world (*ideae post res*), as claimed by the empiricists (e.g., Aristotle). Rather American pragmatism for Scheler provided the first significant alternative to the idealist and empiricist to conditions in suggesting that knowledge resides in concrete human acts (*ideae cum res*) where it becomes functionalized (47, p. 21). For discussion of the
instrumental theory of knowledge that it is proper that attention be given to the work of John Dewey.

A Fatal Separation

Dewey's thesis in *Quest for Certainty* is that practically all important ideas in philosophic questions flow from the separation between theory and practice, knowledge and actions (11, p. 24). "Why this invidious discrimination?" asks Dewey (11, p. 5). Dewey argues that the separation is in the interest of the quest for absolute certainty. Practical activity is marked by uncertainty. Men act at their peril. Through thought, however, men might escape the perils of uncertainty (11, p. 6). Practical activity involves change in which man is a part. Because of man's lack of confidence, he turned to thought to the fixed, immutable and self-transcendence. "Safety first," then, played a role in knowledge superior to doing and making (11, p. 7). Men found, according to Dewey, that the "quest for complete certainty can be fulfilled in pure knowledge alone" (11, p. 8). Dewey summarized his arguments in the following statement:

Perfect certainty is what man wants. It cannot be found by practical doing or making; these take effect in an uncertain future, and involve peril, the risk of misadventure, frustration, and failure. Knowledge, on the other hand, is thought to be concerned with a region of being which is fixed in itself. Being eternal and unalterable, human knowing is not to make any difference in it. It can be approached through the medium of the apprehensions and demonstration of thought, or by some other organ of the mind, which does nothing to the real, except just to know it (11, p. 21).
Dewey proposes a way of escape from peril and uncertainty. He argues for the rejection of the tradition notion that action is inferior to knowledge. Rather, Dewey would have a constant and effective interaction between knowledge and practice. This view would involve the conviction that security can be achieved by active control. Thus, man's quest for certainty is not to be found in thought alone, but in the interaction of knowledge and action, theory and practice. In Dewey's words:

Action, when directed by knowledge, is method and means, not an end. The aim and end is the securer, freer, and more widely shared embodiment of values in experience by means of that active control of objects which knowledge alone makes possible (11, p. 37).

It is well to note in passing that Dewey is careful to avoid over-reaction by making practice superior to knowledge. He makes a special effort to remind his readers that "the essence of pragmatic instrumentalism is to conceive of both knowledge and practice as means of making goods—excellencies of all kinds—secure in experienced existence" (11, p. 37).

As an aside to Dewey's discussion, it is interesting to be aware of the historian's approach in the development of knowledge and action. Ralph Turner, in his The Great Cultural Traditions, The Foundation of Civilizations, distinguishes between the high-intellectual and the low-intellectual traditions. He thinks that the intellectual structure of traditional Asiatic and European urban groups began with the use of writing. From the oral traditions
there stemmed literate traditions which Turner refers to as a core tradition. The small groups possessing writing created a high intellectual tradition. This tradition controlled the liturgical, meditative, decorative and the operational segments of society. Of course, this period was before the printing press, but even as a "Script Culture," as instruments of social interaction, "literary learning contributed significantly to the development of the modes of interaction, and these modes became, in turn, important factors in shaping thought" (50, p. 1273). From the folk traditions which were shaped by hunting and by peasant village cultures came the low intellectual traditions. Turner speculated that the low intellectual tradition had a considerable body of factual information that was "built up mainly by technological developments and was organized almost exclusively by the technological procedures of daily life" (50, p. 1278). Turner explains the situation:

Except as this knowledge was carried on in the technological skills which were passed down from generation to generation of laborers, it had no existence; at the same time, however, it was the actual basis of economic production and consequently the chief factor in the maintenance of the economic surpluses upon which all urban cultures rested. No one recognized its importance, for the original neglect of factual information by primitive men persisted among both the low and the high intellectual traditions (50, p. 1278).

To return to Dewey's discussion, he argues that the assumption that knowledge was superior to practice was formulated in a period when "knowing was regarded as something which could be effected exclusively by means of the
rational powers of mind" (11, p. 106). With the arrival of the scientific revolution in the sixteenth and seventeenth centuries, however, there was a "revolution in the attitude of man toward natural occurrences and their interactions. This transformation means ... a complete reversal in the traditional relationship of knowledge and action" (11, p. 85).

**Experimental Inquiry**

The new attitude gave rise to scientific and experimental inquiry. Dewey sketches the three outstanding characteristics of experimental inquiry:

The first is the obvious one that all experimentation involves overt doing, the making of definite changes in the environment or in our relation to it. The second is that experiment is not a random activity but is directed by ideas which have to meet the conditions set by the need of the problem inducing the active inquiry. The third and concluding feature, in which the other two receive their full measure of meaning, is that the outcome of the directed activity is the construction of a new empirical situation in which objects are differently related to one another, and such that the consequences of directed operations form the objects that have the property of being known (11, pp. 86-87).

Therefore, for Dewey, "Knowing is itself a mode of practical action and is the way of interaction by which other natural interactions become subject to direction" (11, p. 107). Thereon, the sum and substance of his argument is that "we frame our conception of knowledge on the experimental model" (11, p. 106).
Dewey discusses the implications of the theory of ideas that follow from the experimental method. His notion of ideas at work are most instructive in understanding the technological theory of knowledge.

From the standpoint of the operational definition and tests of ideas, ideas having an empirical origin and status. But it is that of acts performed, acts in the literal and existential sense of the word, deeds done, not reception of sensations forced on us from without. Sensory qualities are important. But they are intellectually significant only as consequences of acts intentionally performed. A color seen at a particular locus in a spectral band is, for example, of immense intellectual importance in chemistry and in astro-physics. But merely as seen, as a bare sensory quality, it is the same for the clodhopper and the scientist; in either case, it is the product of a direct sensory excitation; it is just and only another color the eye has happened upon. To suppose that its cognitive value can be eked out or supplied by associating it with other sensory qualities of the same nature as itself, is like supposing that by putting a pile of sand in the eye we can get rid of the irritation caused by a single grain. To suppose, on the other hand, that we must appeal to a synthetic activity of an independent thought to give the quality meaning in and for knowledge, is like supposing that by thinking in our heads we can convert a pile of bricks into a building. Thinking, carried on inside the head, can make some headway in forming the plan of a building. But it takes actual operations to which the plan, as the fruit of thought, gives instrumental guidance to make a building out of separate bricks, or to transform an isolated sensory quality into a significant clew to knowledge of nature (11, pp. 112-113).

Dewey thus asserts that ideas are acts performed, deeds done, actual operations to direct the activity and control the thinking so that genuine knowledge will be produced. Dewey now raises the central question: "What determines the selection of operations to be performed? There is but one
answer—the nature of the problem to be dealt with . . . " (11, p. 123). The problem is any troublesome situation that is perplexing. Ideas are put to work, and eventually a new situation is found or known, and the problem resolved. This experimental method holds true for the simplest of matters or the most elaborate laboratory.

In principle, Dewey points out the experimental inquiry in the scientific field is not different from putting ideas to work in the evolution of industry.

Something needed to be done to accomplish an end; various devices and methods of operation were tried. Experiences of success and failure gradually improved the means used. More economical and effective ways of acting were found—that is, operations which gave the desired kind of result with greater ease, less irrelevancy and less ambiguity, greater security. Each forward step was attended with making better tools. Often the invention of a tool suggested operations not in mind when it was invented and thus carried the perfecting of operations still further (11, p. 124).

As Dewey explains, to say a certain type of machine is the best way to do a certain task is a correct statement as far as it is actually the best instrumentality. "It has to be proved," states Dewey, "by working better than any other agency; it is in the process of continuous revision and improvement" (11, p. 135).

What is really happening is that in the experimental method, objects are reduced to data. This being the case, objects as experienced things are divested of their qualities. They are no longer finalities that call for
thought only in definition, classification, logical arrangement, and the like. Dewey states:

> By data is signified subject-matter for further interpretation; something to be about. . . . Data signify "material to serve"; they are indicators, evidence, signs, clues to and of something still to be reached; they are intermediate, not ultimate; means, not finalities" (11, p. 99).

As data, then, the objects are but one part of the whole operation. Objects, and in like fashion, thoughts, accrue value dependent on the outcome of the operation. The value of thoughts, like objects, as data are not based on the characters already possessed but they are judged as "potentialities of what they become through an indicated operation" (11, p. 137). The meaning of this argument on the relation of knowledge and action is quite evident and best seen in Dewey's own comments:

> Ideas that are plans of operations to be performed are integral factors in actions which change the face of the world. . . . Ideas are worthless except as they pass into actions which rearrange and reconstruct in some way, be it little or large, the world in which we live. . . . To seek after ideas and to cling to them as means of conducting operations, as factors in practical arts, is to participate in creating a world in which the springs of thinking will be clear and ever-flowing" (11, p. 138).

**The End of the Quest for Certainty**

The quest for certainty ends in perfecting of methods of inquiry, linking of knowledge and action, by which secure values can be realized. Technologically speaking, ideas are embodied in a technique, and, thus, in every advance in
technology. The instrumental theory, therefore, becomes a technological theory both of knowledge and value (36, p. 301). Technological theory not only makes possible a technological civilization, but also it means that man participates in his own destiny. Mosier summarizes the sequence of this activity:

The unity of theory and practice, of ends and means, through machine production, is only revolutionized by the introduction of more and more complex machines, and to this succeeds a further revolutionizing of technology by means of technology. Technology is thus both end and means; it is both a value in itself and a means to the realization of further values (36, p. 302).

The educational implications of such a technological theory become quite clear. Students, through the development of a problem-solving attitude or mind, in turn develop a technological attitude of thinking and action. The curriculum becomes technologically oriented. Progress, change, and novelty in technology become conscious and unconscious expectation. Truth becomes a technological product. Value becomes a more efficient, more complex technology for more service to more people. Spier observes that technology has a tendency to feed on itself in order to increase in content and complexity. Part of the force of time tendency is no doubt due to the same force that motivates mountain climbers—"because it's there." However, technicians generally choose their professions because they enjoy working with technical things. Yet they have learned to think technically and thus to seek technical solutions to life's
problems (45, p. 31). The question must be asked, where did these technicians learn how to think?

The Identity Crisis

Cora DuBois, in her discussion of dominant values in American culture, lists four premises on which they rested: the universe is mechanically conceived, man is its master, men are equal, and men are perfectible (12, p. 77). The values derived from these four premises, according to Du Bois, are effort-optimism, material well-being, and conformity (12, pp. 76-83). Psychologist Karen Horney has discussed three value conflicts in American society: aggressiveness that cannot be reconciled to Christian brotherhood, desire for material goods which could never be satisfied, and freedom which does not square with the restriction on men (24, p. 155). The premises and values as given by DuBois might very well be entitled the "Technological Values in American Culture," and Horney's list might very well be entitled "Technological Value Conflicts in American Culture."

Phillip E. Slater, in his analysis of the American scene in his book, The Pursuit of Loneliness, American Culture at the Breaking Point, examines the severe gap between "fantasies Americans live by and the realities they live in."

He suggests that there are three desires that are deeply and uniquely frustrated by the American culture: the desire for community, the desire for engagements, and the desire for dependence (44, p. 5). "Technological change, mobility, and
individualistic ethics," asserts Slater, "combine to rupture the bonds that tie each individual to a family, a community, a kinship network, a geographical location—bonds that give him a comfortable sense of himself" (44, p. 7). Private houses, separate rooms, telephones, televisions and cars, gardens, laundries, self-service stores, and do-it-yourself skills all tend to isolate and alienate—the more privacy, the more alienated. "An enormous technology," Slater observes, "seems to have set itself the task of making it unnecessary for one human being ever to ask anything of another in the course of going about his daily business" (44, p. 7). A good illustration of the lonely, the uncommitted, the alienated is to be found, according to Slater, in the book and movie, The Graduate. Themes of this story reflect sources and consequences of intergeneration hostility, love over culture, and the battle between social forms and human feelings.

Kenneth Keniston studied the problem of alienation and technology in The Uncommitted, Alienated Youth in America. He concluded that this age was not one of synthesis, constructive hopes, and commitment, but one of analysis, awful destructive potential, and alienation. Alienation, although a vague term, expresses something characteristic of the times that leaves one with an "inarticulate sense of loss, of unrelatedness, and lack of connection" (27, p. 4). The study of the roots of alienation is also, according to Keniston, inevitably a study of the human toll in a
technological society. He describes the technological era as a time in which there is a concern with techniques, glorification of technical competence, systematic application of scientific knowledge to problems of production and consumption. It is Keniston's opinion that the two phenomena, alienation and technology, are related. "I cannot summarize my conclusions in a sentence or paragraph," he states, "except to say that the new alienation is intimately bound up with the technological society in which we live, and we cannot understand alienation or our society, without understanding both together" (27, p. 11).

Erich Fromm, in *The Revolution of Hope, Toward A Humanized Technology*, analyzes the new specter of contemporary times. He finds "a completely mechanized society, devoted to maximum material output and consumption directed by computers; and in this social process, man himself is being transformed into a part of the machine, well fed and entertained, yet passive, unalive, and with little feeling" (18, p. 1). Henderson also finds the modern period full of contradictions which produce increasingly high levels of "cognitive dissonance" (22, p. 145). Slater suggests that if modern man's body can be used as a working machine and a consuming machine, it can also be used as an experience machine by the utilization of drugs (44, p. 93). He adds that man is "punch-drunk" from production and propaganda (44, p. 131). Donald Cook, in a doctoral dissertation, looked at the impact of technological change on psychological...
change and modern man's ability to accommodate it. He found that man sees himself a victim of technology and living a confused life as a pawn of facts. Man has no control over the technology which controls his life. Cook doubts that man could act, and if he could, he wonders if it would make any difference. Cook refers to Maslow's idea that one is "reduced to a seeker of safety" because of his inability or unwillingness to interact effectively with the environment (9, p. 97). Fringe groups and sub-cultures are not immune to the technological trauma. Kluckhohn described the plight of American Indians who frequently acquire modern technology (including the verbiage) without having either absorbed or even become aware of the values that accompany it. Kluckhohn reports that "social friction" results because the value premises are essentially incompatible between the folk and technical cultures (28, pp. 339-342).

The foregoing has drawn attention to value conflicts, alienation, depersonalized and impotent man, and social friction. These are among the crises for man of the technological age. They may be subsumed by what Fromm calls the major problem in the technological society--the identity crisis (18, p. 82). It is not an "ego" problem, but an "I" problem, because "ego" has to do with having, and "I" refers to the category of being (18, p. 83). Berger believes the identity is the key element of subjective reality, but it is formed by social processes. The processes by which identity
is crystallized, maintained, modified, and even reshaped are determined by social relations and social structure (2, p. 159).

Identity Formation

A definitive study of identity is *Identity, Youth and Crisis*, by Erik Erikson. Crises exist in many situations such as in individual development, in the emergence of a new elite, in the therapy of an individual, and in the period of rapid historical change. Erikson defines crisis as "a necessary turning point, a crucial moment, when development must move one way or another, marshalling resources of growths recovery, and further differentiation" (16, p. 16). He define identity as "a loss of sense of personal sameness and historical continuity" (16, p. 17). In a positive sense, identity is "a subjective sense of an invigorating sameness and continuity" (16, p. 19). Used in the positive sense, identity is not only something quest after, but more, that which "comes upon you"--that is, a recognition (16, p. 19).

Erikson's concern in his book centers around psychosocial identity (16, p. 135). To him, identity is a process located both in the core of the individual and the core of his communal culture:

*Identity formation employs a process of simultaneous reflection and observation, a process taking place on all levels of mental functioning, by which the individual judges himself in the light of what he perceives to be the way in which others judge him in comparison to themselves and to a typology significant to them while he judges their way of judging him in the light of how he perceives himself in comparison to them and to types that*
have become relevant to him. The process is, luckily, and necessarily, for the most part unconscious except where inner conditions and outer circumstances combine to aggravate a painful, or related, "identity consciousness."

We cannot separate . . . personal growth and communal change, nor can we separate . . . the identity crisis in individual life and the contemporary crisis in historical development because the two help to define each other. In fact, the whole interplay between the psychological and the social, the developmental and the historical, for which identity formation is of prototypal significance, could be conceptualized only as a kind of psychological relativity (16, pp. 22-23).

Erikson argues that "man's need for a psychological identity is anchored in nothing less than his sociogenetic evolution" (16, p. 41). Sociogenetic evolution is characterized by what Erikson calls "authority-accepting." He submits that authority that exists within a defined group identity cannot be separated from individual identity formation (16, p. 41).

Erikson's concept of personality development is that individuals move through the life cycle of eight stages to mature, meaningful old age. The individual proceeds through each successive stage according to his "readiness to be driven toward, to be aware of, and to interact with a widening radius of significant individuals and institutions" (16, p. 93). Each stage, Erikson explains, becomes a crisis, that is, a turning point. Each successive stage, in turn, presents a potential crisis because of the radical change in perspective (16, p. 95).
Identity and the School

When children reach school age, they begin to attach themselves to teachers and parents of other children. They watch and imitate people of occupations which they can grasp--firemen, policemen, gardeners, plumbers, garbage men, and so on. In school they receive systematic instruction to make them literate. The more complex and specialized the culture, and the more complicated the social reality, the more the school becomes a world all by itself with its own goals (16, pp. 122-123). The school years carry the student from learning to master the technology of toys and things to a sense of making things well, even perfectly. This is what Erikson calls the "sense of industry." The student is beginning to realize that he must become something of a worker and provider--a rudimentary parent. In Erikson's words: "He now learns to win recognition by producing things. He develops perseverance and adjusts himself to the inorganic laws of the tool world and can become an eager and absorbed unit of a productive situation" (16, p. 123).

Following the sense of industry, the wider society becomes increasingly important to the student as roles are given to prepare him for actual participation in technology and the economy. It is a critical period. Good teachers and good parents are needed during this time. The child's budding sense of identity is in danger of "identity confusion" due to a sense of inferiority caused from unresolved conflict, lack of a good model, lack of
opportunity to learn, a premature fixing of his identity, or, according to Erikson, the most common one, "that throughout the long years of going to school a child will never acquire the enjoyment of work and pride in doing at least one kind of a thing really well" (16, p. 125). Erikson believes this period of a developing sense of industry is also the most decisive stage socially. During this time a sense of the technological ethos of a culture--involving doing things beside and with others as a sense of division of labor--is developed. Erikson recommends that the "configuration of culture and the manipulations basic to the prevailing technology" reach into school life in a meaningful way in order to support every child with a feeling of competence. In the "free exercise of dexterity and intelligence in the completion of serious tasks unimpaired by an infantile sense of inferiority," states Erikson, "is the lasting basis for cooperative participation in practical adult life" (16, p. 126).

Erikson illustrates the contribution of school age to the problem of identity by calling attention to the two poles in American grammar school education. One extreme is the "extension of grim adulthood" back to the school, while the other extreme is the "extension of natural tendencies of childhood" up through the school. The former emphasizes "prescribed duties" while the latter permits the children to not "learn anything anymore." Each extreme has its strength. The former may develop a strong sense of duty, but it may
also be a costly self-restraint that will affect the life later. The latter permits freedom to learn what one wishes. Erikson points out that children at this stage like a sense of genuine reality:

Children of this age do like to be mildly but firmly coerced into the adventure of finding out that one can learn to accomplish things which one would never have thought of by oneself, things which owe their attractiveness to the very fact that they are not the product of play and fantasy but the product of reality, practicality, and logic; things which thus provide a token sense of participation in the real world of adults (16, p. 127).

According to Erikson, this situation places one in the midst of identity problems: on the one hand there is the firm initial relationship to the world of skills and tools, while on the other hand childhood is coming to an end. If the over conforming child in his sense of duty sees work as the only criterion for worthwhileness at the expense of imagination and playfulness, then he submits to "craft-idiocy" and becomes a "slave to technology" (16, p. 127). The school contributes to a sense of identity that says, "I am what I can learn to make work." This, explains Erikson, becomes a beginning but also a limitation to identity. "The majority of men," observes Erikson, "have always consolidated their identity needs around their technical and occupational capacities, . . . leaving it to special groups . . . to establish and pursue those 'higher' institutions without which man's daily work has always seemed an inadequate self-expression, if not a mere grind or even a curse" (16, pp. 127-128). It may be at this point that the
identity problem in our time becomes both psychiatrically and historically relevant. For as man can leave some of the grind and curse to machines, he can visualize a greater freedom of identity for a larger segment of mankind (16, pp. 127-128).

Education as Technology

In the early decades of the twentieth century Thorstein Veblen discerned a shift taking place in American education. Knowledge sought apart from any ulterior use, "idle curiosity," as Veblen called it, was being replaced by a technological system of knowledge. Veblen wrote:

The habits of thought induced by workday life impose themselves as ruling principles that govern the quest for knowledge; it will therefore be the habits of thought enforced by the current technological scheme that will have most (or most immediately) to say in the current systematization of facts (53, p. 4).

The shift was not an abrupt change of circumstance or a sudden intrusion of an alien element, but rather, as Veblen saw it, "by force of gradual and unintended scarcely perceptible, shifting of emphasis ..." (53, p. 10). The "tone-giving dominance" of the practical interests of the day, according to Veblen, would govern the detail lines of academic policy, the range of instruction offered, and the character of the personnel, governing boards, and academic administration (53, p. 45). Specifically, Veblen pointed out that the matter-of-fact character of technology resulted in the matter-of-fact, mechanistic complexion of modern learning; the personal equation that was the central and
The more emotional and spiritual virtues that once held the first place have been overshadowed by the increasing consideration given to proficiency in matter-of-fact knowledge. . . . The modern technology, and the mechanistic conception of things that goes with that technology, are alien to the spirit of the "Old Order." The Church, the court, the camp, the drawing room, where those elder and perhaps nobler virtues had their laboratory and playground, have grown weedy and gone to seed. . . . But that power of aspiration that once surged full and hot in the cults of faith, fashion, sentiment, exploit, and honor, now at it best comes to such a head as it may in the concerned adulation of matter-of-fact (53, pp. 6-7).

By mid-century Ellul could argue that rational judgment has entered into the tentativeness, unconsciousness, and spontaneity of technical operation and has transformed it into a technical phenomenon. The clear, voluntary, and reasoned concepts of technical phenomenon multiply the possibilities of new methods, tools, and operations to a higher degree of diversity. From the many possibilities, a selection is made of the one or ones most efficient to bring about the desired end. Thus, according to Ellul, "the multiplicity of means is reduced to one: the most efficient" (15, p. 21). Ellul sees the quest for the one best means,
which he calls the "technical means," occurring in every field. The aggregate of technical phenomenon produces the technological civilization (15, p. 21). Ellul's opinion is that technical means are absolute. He, therefore, points to a technological imperative from which no human activity escapes. Organizations, friendships, swimming, and so on have their techniques. "In fact," asserts Ellul, "nothing at all escapes technique today. There is no field where technique is not dominant" (15, p. 22). From this stance, Ellul analyzes society, including education.

Ellul views progressive education as a rigorous educational technology. With its emphasis on the "happiness" of the child, bright classrooms, understanding teachers, relaxed and balanced learning activities, all point to the one best means (15, p. 345). In like fashion, Ellul looks at the Montessori method. This method prepares to free the child from slavery of the school and family and enter a new cycle of freedom as "joyful selfdom." Ellul maintains that this precise regulation and forced orientation toward method is a technique of a social force directed toward a social end (15, pp. 346-347).

Jerome S. Bruner pictures education as social invention. He argues that because of new circumstances and new knowledge, every generation must define for itself the nature, direction, and aim of education for future generations. "It is in this sense," states Bruner, "that education is in constant process of invention" (7, p. 468).
From this standpoint, education in itself may be considered a technology.

From the viewpoint of phenomenology, as pointed out by Stewart, education is more than simply teaching and learning or problem solving. It is necessary for the phenomenologist to know the values on which educational institutions are based. Stewart explains what this implies:

Without an understanding of its traditional footing, education accepts this tradition uncritically and is incapable of any genuine newness in the future. If education is understood as a process of training technicians for an industrialized society, without understanding the basic values of that society, the outcome may be tragic in that the technicians will be incapable of evaluating these traditions in the light of society's movement towards the future (46, p. 128).

Grant, in his book Technology and Empire, is concerned at this same point. He describes it as the "tight circle" in which modern men live in that the present forms of life have diminished the ability to think about standards of excellence and yet there is imposed a monolithic technology which asserts standards in its own terms. The university curriculum is used to illustrate Grant's point:

Thus, the university curriculum, by the very studies it incorporates, guarantees that there should be no serious criticism of itself or of the society it is shaped to serve. We are unable seriously to judge the university without judging its essence, the curriculum; but since we are educated in terms of that curriculum it is guaranteed that most of us will judge it as good. The criteria by which we could judge it as adequate in principle can only be reached by those who through some change have moved outside the society by memory or thought. To so have moved means that one's criticisms will not be taken seriously from within the society (19, p. 131).
Comments from John Platt on this topic stem from his concern over lack of diversity and neglected fields of study, particularly in science, while others are overstudied as a result of the tendency to "bandwagoning." Although he feels that the courses are more thorough and systematic, they are not tailored to the individual's curiosity and enthusiasm. Many colleges and universities have almost eliminated electives from the curriculum in favor of so called "honors programs." Platt suggests that these programs should be called "narrows programs" for what they make is one-dimensional men (39, p. 16). Platt's concern is for not only the immediate consequences of such trends, but also for the secondary, future consequences:

It particularly worries me that physics and chemistry majors and other science majors have now lost most of their free electives. Scientists are now rising to executive positions in business and industry and are becoming advisors on major international and military matters. About one-third of all physicists eventually become administrators. I do not want—and I do not think any sane person wants—a world in which the major decisions on technological and military and international affairs are made by one-dimensional men, men who have never had time to explore art or music or history or philosophy or literature or the non-technical achievements of mankind (39, p. 16-17).

Technological Ideology in Educational Policy

C. A. Bowers discusses technological ideology as it appears in educational policy. Instrumental reason, technological consciousness, technocratic ideology, and technocracy are terms to indicate technological ideology which, according to Bowers, arises from positivism,
bureaucratic procedure, and scientific technique. This ideology has become our everyday sense reality and the expression of modernity and inevitable progress (4, p. 36). The technocratic world view is seen in the grammar and terminology, even among non-professional, and non-specialized vocabulary—input, systems, component, interface, functional, output, administration process, feedback, and so forth. Bowers presents three examples of recent educational policy which reveal the technological ideology.

First, he examines the concept of behavior modification. "It is," he states, "the most explicit example of a theory shaped by the assumptions of technocratic ideology" (4, p. 40). The behavioral modification concept, according to Bowers, attempts to socialize the student to a particular world view, that is the positivists' view of reality and a mechanical view of relationship. Behavior is not conceived as a result of consciousness, but in the environment of reinforcers through which the individual moves. What really matters, continues Bowers, is to exhibit the socially approved behavior rather than a personal sense of identity, self-worth or values. The students are conscious of doing what the teacher, that is, authority, tells them in order to receive rewards. The lesson, according to Bowers, is that "conforming behavior enables them to participate in the middle-class cult of consumerism" (4, p. 41). The teacher, meanwhile, works by specified objectives and tasks analysis to reach objectives and evaluate the outcome in an atmosphere
of caring and sharing. In regard to the teacher, Bowers states:

The irony is that the behavior modifier perceives himself as a social reformer dedicated to equipping people to participate more effectively in the technocratic society. But he appears to be blind to the technocracy's dehumanizing effects on people's lives and, in a larger context, its disruptive impact on the ecology (4, p. 42).

The teacher, then, serves as a carrier of the technological consciousness in the classroom. Bowers, in summarizing behavior modification, gives three of its claims: an aura of non-partisanship, the promise of quantifiable outcomes, and an alchemy of transforming existential issues and problems into technological ones (4, p. 44).

Second, Bowers considers career education as a carrier of technological ideology. Textbooks of career education speak of "the thrilling experience of a job," "freedom from parents," "joining other consumers" and "use earnings for success" which reveal its purposes: to articulate between education and work, a commitment to the consumer society, and to socialize the students to present organization of work. Success is assured if the student chooses to work, to consume, and to organize life around the principles of the technological society (4, pp. 45-46). The vocabulary--reliable, loyal, optimistic, punctual, tactful, advancement--is a language adjustment, naive acceptance and mystification that carries an employer bias. Moreover, it is not the language of sociology, philosophy, or one that deals with the issues in technology (4, p. 48). Bowers states that
students "are not encouraged to look critically at the social and psychological implications of the different forms of work" (4, p. 47). Bowers records what he terms the ultimate irony:

As students are socialized into believing the myth that says they are in control of their own destiny (as long as they exhibit the proper moral attitudes), they are acquiring a speech code that dis-equipds them to symbolize work in any meaningful way . . . . They will lack the vocabulary and concepts necessary for articulating the sources of vulnerability they will experience as workers in a class society (4, p. 48).

Third, Bowers takes a look into Competency-Based Education as a technological ideology of school policy. The linkage of CBE to the technological world is admitted readily by its adherents as a "revolutionary breakthrough in education" by the application of systems theory to the teaching process. Bowers lists some of the vocabulary used in this concept, and comments that they represent "education's special contribution to the lexicon of the systems movement" (4, p. 50)--performance, objectives, referencing instruction, instructional packages, modules, data-based decision making, practice decision making, and multiple program options. Liberal education ties education to economic and social progress, but, states Bowers, "places special emphasis on the worth of the individual," but with CBE there is a shift. CBE points to the individual as a component in the system (4, p. 51). In closing, Bowers admits that if it were not the technocratic world view that education dissipates, it would be some other one. His
preference is one of critical consciousness that does not subordinate the individual to technology (4, p. 52).

The Crucial Issue

Jurgen Habermas, in his book *Toward A Rational Society*, cites a news report regarding a new university created in a desert region in Israel for the purpose of industrial development. Habermas acknowledges that a university does have a task to fulfill in the system of social labor, and to transmit "technical exploitable knowledge," as well as produce it. However, Habermas stoutly affirms that "the university cannot define itself with regard to society exclusively in relation to technology" (20, p. 4). When education defines itself in such a manner, one recalls Melville's Ahab who said, "All my means are sane, my motives and my purposes are mad." Again, such a definition is like the Eskimo of Boas' study who believed himself to be free when all along he was but hemmed in on all sides by automatic reactions, knew no alien forms, and to think and believe differently never entered his mind (3, p. 37). In relating education to the technological society, as Bowers points out, "The relationship between cultural literacy and freedom is the crucial issue that educators and the public must confront" (4, p. 54). Roberts draws attention to a Boas assumption: "Knowledge of cultural alternatives makes freedom possible and that education must incorporate such knowledge if cultural determinism is to be avoided" (41, p. 6).
CHAPTER BIBLIOGRAPHY


CHAPTER III

CONCEPTS OF EDUCATION WHICH POSTULATE TECHNOLOGY

The following concepts of education that postulate technology as a significant factor are creations of individuals, groups, and universities. Some of the concepts reported are yet in the conceptual stages, while others are in various stages of implementation. Each takes a serious view of technology as a significant factor for developing education, and each makes a contribution to that end.

Concepts Suggested by Individuals

Recent educational critics and reformers, in the opinion of C. A. Bowers, look into the future through a rear-view mirror. On the one hand, the radical revisionist educational historians such as Hofstadter, Katz, and Bowles and Gintis, with their respective state-anxious, elite-domination, and correspondence theories, focus on the capitalism/class conflict of the 19th and early 20th centuries. On the other hand, the neo-romantics of the alternative school movement like A. S. Neil and Ivan Illick who stress freedom and the innate goodness of human nature and its corruption through
social institutions look back to Rousseau and Freud. Bowers contends that these critics have a "prearranged agenda for change" based on a rear-view image of reality, and, consequently, defocalize the reality of the emergent nature of technological ideology and its existential and ecological implications. Neither the educational revisionists by their preoccupation with class struggle nor the neo-romantics through their simplistic critique of technology and their naive, alternative lifestyle stimulate serious discussion concerning the complexity and problematics of the technological culture. Moreover, these groups provide no theory that could serve as a guide for curriculum development that would help students acquire the tools needed for reconceptualizing their culture experience of technological consciousness (2, pp. 272-286).

There are, however, competent thinkers whose analyses take seriously the impact of technology on education. John R. Platt, for example, taking seriously the insights of McLuhan's concept of "electronic surround," asks some hard questions concerning the process of education.

In an electric-typewriter world, how much handwriting does a child need to learn? With the best TV-teaching, how much of our reading-comprehension becomes clumsy and obsolete? With 7-place pocket calculators for less than $5, and computers at every check-out counter, how much rote-multiplication, long division, complex fractions, or logarithms are desirable, to frighten most children away from mathematics? Or at a higher level, if most jobs will be information-handling, what vocational skills should we teach, animal husbandry and video-reporting, shorthand or
word processing, double-entry bookkeeping or computer-programming? In the hard vocations themselves, should students learn particular skills, or learn to learn, with updated video instructions when needed for new materials and processes? Shall it be geometry or engineering drawings, or ingenious electronic space-games and the construction of Fuller domes? Language-texts or tapes? History and art and music lectures, or great systematic series of videocassettes (16, p. 3).

When scholars deal with technology as a factor in education, they find themselves on a continuum between the position of critics who, as Bowers has suggested, feel other issues more pressing and the position of Platt who, as indicated by his questions and subsequent discussion of them, feels keenly about the gravity of the technological issue.

**Education for the Most Probable World**

Stuart Chase sketches his concept of education for the technological world in his book *The Most Probable World*. These thoughts on education grew out of Chase's experience of a lifetime, and seem to him the best fitted to prepare young people for dealing with the effects of technology that advances at an exponential rate. Chase recalls that his experience of life in technology has been lived through an "era of shuddering change" which ranges from the first electric light ever installed on his grandfather's New England farm and the first automobile on the road outside to the present space age. He traces his interest in technology related to the human condition to the undergraduate days at the Massachusetts Institute of Technology. This concern was expressed in two books, *Men and Machines* and *The Economics of*
Abundance. Chase sees virtually every area of society and personal life vitally affected by the impact of science and technology. "Technology," he states, "is enforcing changes so rapidly that one must write as he runs" (4, pp. VIII-IX).

The Most Probable World proceeds from the question of whether or not Western technology is a "juggernaut riding over us and depressing the human spirit or carrying us to Doomsday" (4, p. 1). The volume is based on two kinds of probabilities—the rigorous mathematical and the more subjective "degree of belief." The former one is established by facts and figures of ten trends that, according to Chase, are beyond challenge. The latter is based on the hope that a positive resultant can be achieved and that man can weather the "shockfront." Chase admits that the race is close, but he feels that there is "a small probability in favor of the positive, though even the canniest computer could not assess all the variables and give us a mathematical resultant" (4, p. 200).

Chase's list of ten trends—total technology, population, living space, megalopolis, energy, mixed economy, automation, arms race, nationalism and one world—are all derived from modern science and technology. These trends, in the opinion of Chase, are "bound to affect man's future over and above his several preferences and ideologies. It may not be too strong," he states, "to call them jointly the technological imperative" (4, p. XI). The glimmer of hope to which
Chase holds is education. It is a race between education and catastrophe. "The final resultant," Chase believes, "depends more on human knowledge, and its application by human beings, than it does on the curves of technology. It goes back in the end to people" (4, p. 200). He follows H. G. Wells, whom he quotes: "There is no path but knowledge out of the jungles of life" (4, p. 209). The "path of knowledge" as given by Chase is what follows.

Chase refers to a proposal made by the National Education Association and the American Association of School Administrators that seven attributes—a desire to know, an impulse to question, the search for data, the demand for verification, respect for logic, awareness of premises, and evaluation of consequences—define an orientation for education which may be called the "spirit of science." This scientific attitude does not imply that every student is educated as a scientist or that all subject matter reflects some branch of science. The spirit of science which would include every field, including the humanities, is, according to Chase, a "method of thinking" (4, p. 211).

Chase lists and discusses eight fundamental studies for the curriculum, all of which are to be oriented around the "spirit of science" attitude. Cultural anthropology should begin early in education as a protection against and solvent for rigid ideologies and dogma. For Chase, "anthropology is a cardinal tool for understanding people of all races, all
cultures, all times" (4, p. 213). Cultural anthropology also provides tools to outmaneuver cultural lag (4, p. 214).

Communication theory is a primary tool to be learned through education. Students must know how communication furthers understanding as well as corrupts it. They must know constructive ways to use mass media, the satellite, the computer, the conference, and the official statement in order to avoid the entanglements of double-talk of commercial advertising, image-making, publicity appeals, economic forecasting, stock market analysis, traditional diplomacy, foreign policy pronouncements, selling the package rather than what is in it, propaganda and campaign oratory (4, pp. 214-215). "Reasonable men always agree if they understand what they are talking about," is a motto Chase recommends—that is, with a slight question mark at the word "always" (4, p. 215).

Chase chooses for a laboratory science, biology. Biology is important because of the insight it provides on the delicate structure of the organism and its intricate physiological balance. Also involved are the values of ecology, the economy of nature, and the hazards of its disruption. Lastly, biology can make one wary of "brash" predictions such as the human process and "half-baked" generalizations about human beings from the behavior of animals (4, p. 215).

History is important for it is there where machines, ideas, money, geology, climate, hunger, fear, high hope, and
other non-logical elements enter to shape human life. History creates a sense of the past without which the present and the future lack meaning. The student also may learn to be cautious of historical analogies in the light of the high rate of technological change, especially since the advent of the nuclear weapon (4, p. 216).

In another suggestion for curriculum Chase advocates a study of the history of science and technology beginning with Galileo. If major problems arise from a developing technology, as Chase's book insists, then students must deal with technology by understanding its process through a good working knowledge of the technical arts. The importance that Chase places in regard to these matters is reflected in that the first two chapters of his book deal with this issue (4, p. 217).

Social Psychology is a discipline on which the student must have a firm grasp. Frustration-agression, techniques of agreement, concepts of coexistence, crowd psychology, and opinion research are among the issues that social psychology can supply useful knowledge (4, p. 217).

The new economics is an essential in Chase's scheme of education. The new mixed economies, GNP, unemployment, inflation, recession, and money are all important factors for proper understanding. Chase recommends a good grounding in statistics in understanding the new economics (4, p. 218).
Lastly, Chase suggests a study of international and supranational law. Who should control space? Space traffic? Sea minerals? What about property rights on the moon and planets? Also, the most important question is how to expand international law to establish a workable structure for world peace (4, p. 219).

To the question of how to study, Chase refers to a study reported in Science of a teaching situation in Nepal. It was found that scientific explanations were simply tacked on to "folk" explanations. This led Chase to reflect that in Nepal, as anywhere else, memorizing scientific facts will be useless. Chase agrees with the conclusion of the authors of the Science article that "the scientific attitude can be taught only by setting up simple laboratory tests, where children use their hands and eyes, with a strong appeal to the child's innate curiosity" (4, p. 221).

Chase admits that anyone of these fields could occupy the lifetime of the specialist, but Chase insists that the student be a generalist as well as a specialist in a given field. The generalist tries to get all the major pieces of information before coming to a conclusion. He looks "over the walls" as well as "breaks down walls." The generalist constantly asks: "How does this relate to that? How does automation relate to leisure, and how does leisure relate to human nature? How does cheap nuclear energy relate to the hunger of the hungry world" (4, p. 212)? The product of
Chase's educational program might well be said to be the scientist/philosopher:

One could sleep better at night if some such screening bureau [some program of technological assessment] were at work in its laboratories and in the field, manned by scientists who are also philosophers. It would give political leaders, furthermore, firm ground on which to stand, and make decisions. The path of knowledge might really begin to open, and the jungle to be pushed back (4, p. 223).

Comprehensivist Education

Richard Buckminster Fuller is not easily professionally classified. He has had degrees awarded to him by leading universities as Doctor of Arts, Doctor of Design, and Doctor of Humanities. Usually, Fuller is considered a designer or inventor due to many of his prime inventions having been granted patents in many countries of the world. Among his discoveries are the famous geodesic dome and the Dymaxion Airocean World Map. At Canada's World Fair, EXPO 67, the United States Pavilion was his 250-foot diameter Geodesic Skybreak Bubble. As of 1979, over 200,000 of his structures were built in many countries around the world. However, Fuller could well be classified as an educator. He holds a professorship. He has been invited as lecturer, critic or experimental seminarist in universities around the world. Several of the appointments have been repeated: Princeton nine times, M.I.T. eight times, North Carolina State eight times, University of Michigan five times, and Cornell four times. It is fitting that the thought of a scholar
and technologist such as Fuller should be included in this study.

Fuller's philosophy, as well as his education, came largely from his own inquiring, experimenting, and self-disciplining, but its direction was derived in part from his experience as a student at the Naval Academy during World War I. There he learned that one of the prime strategies of the navy was to select the bright students and train them as comprehensivists rather than as specialists as was the practice of the public universities and military academies. The comprehensivist concept was a carry-over from the passing era when naval power ruled the earth. Everything that people knew was concentrated to produce the highest hitting-power navy. As Fuller observes:

The navy represented the focused objective for application of all that humanity knew about science, about mathematics, chemistry, and physics. All science was reduced to versatile, mobile practice in the Navy . . .

[The nation] needed admirals and officers in general who could take a great navy halfway around the world from home bases and build a new naval base . . . who understood technology in every way, who could handle thousands of men, millions of dollars, thousands of technical and psychological and economic problems--very comprehensive men, the antithesis of specialists (11, p. 66).

The Navy scheme was to pick the brightest students and send them through a complex training experience to learn a comprehensive patterning. Promotion was on the basis of who was the most comprehensively capable person. The coming of centralization by means of modern communications brought an end to the concept of comprehensive capability and the need
for comprehensivist educational systems (11, p. 67). Fuller saw represented in this comprehensivity of navy strategists "great anticipatory design science, enormous vision, and supreme economic-wealth-investing-initiative" that he considered inadequate to apply only to the Navy. "I intended," states Fuller, "that comprehensive anticipatory design science might be applied also to the larger question of how we can make life on earth a general success for all people instead of . . . for the rare and fortunate few."

Thus, Fuller became a comprehensive generalist (11, p. 68).

As he worked toward the comprehensive strategy and capability, Fuller was brought to the generalized and powerful tool of mathematics. "Mathematics," he states, "has been on highest priority in my grand strategy" (11, p. 68). Fuller's explorations into mathematics have disclosed, for him, "extraordinary and comprehensive mathematical patterning of nature." He is confident that he has discovered "the arithmetical, geometrical, topological, crystolographic, and energetically vectorial system employed by nature itself." This "omnirational coordinate system" Fuller has named "synergetics" (11, p. 93).

Fuller believes that as a consequence of knowing nature's pattern and the ability to alter this pattern through thought, which results in physical actions, changes occur in the relationship of human beings to the universe which give them "consciously appreciable, advantage increase"
with respect to their total environment (11, p. 79). Fuller elucidates his philosophic premises:

During one-third of a century of experimental work, I have been operating on the philosophic premise that all thoughts and all experiences can be translated much farther than just into words and abstract thought patterns. I saw that they can be translated into patterns which may be realized in various physical projections—by which we can alter the physical environment itself and thereby induce other people to subconsciously alter their ecological patterning. My own conclusion is that we have been given the capability to alter and accelerate the evolutionary transformation of the a priori physical environment—that is, to participate objectively, directly, and consciously in universal evolution—and I assume that the great, complex integrity of omnicoordinate and interaccommodative yet periodically unique and nonsimultaneously cooperative generalized principles, and their myriad of special case realizations . . . is an intellectual invention system which counts on our employing those capabilities (11, p. 18).

Fuller's "technically objective philosophy" allows him a wide variation of first-hand experiences and practice in mechanics and structures. As an engineer, physicist, chemist, and mathematician, he is able to translate his philosophic concepts into physical inventions. At this point, Fuller's humanist spirit is recognizable. His physical inventions fill gaps in areas where, as he states, "there have been no previously recognized function whatsoever—where people have not thought of the problems as being solvable by some device, but solvable only by social procedure reforms" (11, p. 23). As a comprehensive designer, Fuller organizes "all the data and challenges and problems in such a manner that they may be solved by inanimate technology . . . rather than by organization reforms" (11, p. 54).
Again, Fuller's inventions make it possible to do more with less. The principle is his concept of "Dymaxion," the maximum gain of advantage from the minimal energy output (11, p. 110). Fuller's technically objective philosophy is illustrated by his geodesic dome. They are unprecedented in structural engineering theory, yet they fill an enclosure need. These domes "enclose environments at about one percent of the invested weight of resources of comparable volume enclosed by conventional structures" (11, pp. 23-24). Just as was learned long ago, when the length of a ship is doubled, there is four times as much surface and eight times the volume. In like fashion, when the size of the dome is doubled, there is four times as much surface area and eight times as much volume. This means that "every time I double the size of a dome," affirms Fuller, "I halve the amount of surface through which an interior molecule of atmosphere can gain or lose energy as heat" (11, p. 186). The principles derived from his technically objective philosophy prompt him to contend that every human being in the world could be cared for, peacefully, in a condition of life which he calls "livingry." Fuller expresses the optimistic possibilities that he feels:

Within the realm of design science and engineering, it is now incontrovertibly demonstrable that if humanity employs the sum of its knowledge and pools all the world's resources, we now have aboard our spaceship earth more than ample capability to take care of all humanity for all generations to come and to do so at higher standards of living and individual freedom than any humans have thus far experienced and even dreamed
of, while in no way endangering the ecological integrity of our planet (11, p. 152).

The comprehensivist nature of his philosophy is revealed in the Harvard invitation to be the Charles Eliot Norton Professor of Poetry in 1961. Harvard fills this one year appointment with people who are artists, playwrights, authors, architects and poets. The general qualification for this professorship is the demonstrated capability in the integration of ideas. Fuller filled this honored post as a poet, which in the context of this professorship of poetry is understood to mean a person who puts things together in an era of great specialization where in most people are differentiating or "'taking' things apart" (11, p. 16).

Fuller conceives of education as being twofold: first, man is being "educente (led out from) the monological fixations of ignorance" and, second, he is being "led into, intro-ducente, (introduced to) the new awareness of the dynamic fluidity of the infinite persistence of complex-yet-systematic interaction of universal principles" (11, p. 91). Education is primarily concerned with, in Fuller's opinion, "exploring to discover not only more about Universe and its history but also about what Universe is trying to do, about why human beings are part of it, and how they may best function in universal evolution" (11, p. 91). This concern is a change from the educational system today which seems to have the priority on how to get a job, earn a living and survive. Fuller is convinced that the "how to
earn a living" problem is going "to go out the historical window." He believes that "education is going to be disembarrassed of the unseen 'practical' priority bogeyman" (11, pp. 47-48). The broad scope of educational concern as seen in Fuller’s statement reveals his basic comprehensivist philosophy as opposed to a philosophy of specialization. His approach would produce the philosopher-scientist-artist rather than "more deluxe-quality technician-mechanics" (11, p. 104).

Fuller contends that the present global civilization requires an educational approach that moves from the whole to the particular. Due to the vast, complex, and detailed nature of knowledge, it is necessary to restructure it into "assimilable wholes, to be imparted even at the most elementary levels in terms of whole systems" (11, p. 92). Thus, Fuller suggests that from the very outset, education should utilize "the most comprehensive review of fundamental 'generalized' principles" (11, p. 92). Furthermore, Fuller calls attention to the fact that "comprehensively the world is going from a Newtonian static norm to an Einsteinian all-motion norm" (11, p. 39). He argues, then, that one can "no longer think in terms of single static entities—one thing, situation, or problem—but only in terms of dynamics changing processes and series of events that interact complexly" (11, p. 92). It follows, therefore, that traditional education is, according to Fuller, for a large part useless or worse and educational institutions and disciplines obsolete. Restructuring for wholeness is required—nature has only one department (11, p. 92).
Fuller faults educational theory that starts students off with elementary components and gradually increases their complexity until it leads to the whole. The scheme should move from the particular to the whole, but the whole is never reached (11, p. 77). Fuller sees the whole, present educational process taking children who have "an innate comprehensive coordinate capability" and giving them differentiated parts and elements with which to work. "We get them to school, and we say forget the universe, and we give them A, B, and C. We go toward the very opposite of comprehensiveness. We go to specialization right away," he quips (11, p. 69). However, Fuller is heartened in that there is a turning away from this "detoured-from-reality educational system" that would lure the would-be comprehensivist and rob him of his innate capabilities. He expresses his reason for this hope:

I think that one of the most important events of the educational revolution is the present realization that we are going to discover that children are born comprehensively competent and coordinate and that they are capable of treating with large quantities of data and families of variables right from the start (11, p. 80).

Basic to the problem of education is, in Fuller's opinion, the failure to reorganize because of pride, fear, economic and social insecurity, and the general reluctance of humanity. As a result of this failure, conventionalized education continues to mold humanity into the collective individual (11, p. 105). Fuller would counter this system with a "comprehensivity curriculum." He uses the education
of an architect for an illustration of his proposal. Fuller envisions students working on their own initiative both comprehensively and in depth in mathematics, chemistry, physics, biology, geology, industrial tooling, network systems, economics, law, business administration, medicine, astronautics, computers, general systems theory, patents, and the whole gamut of previously highly specialized subjects. His curriculum recommendation would have extensive effect for world society:

This "comprehensivity curriculum" will prepare graduating architects to gain the design initiative, performing thereafter not as economic slaves of technically illiterate clients and patron despots but as comprehensivists, integrating and developing the significance of all the information won by all the respective disciplines of the specialized sciences and humanities, converting this information into technical advantages for world society in completely tooled-up and well-organized comprehensive anticipatory livingry systems (11, p. 106).

Fuller discounts words such as "genius" and "creativity" to explain his technical and humanistic contributions. His only claim to fame is that he deliberately set out to be a comprehensivist in an era of specialization. He thinks that he was successful because there was not competition. "The potential I have since developed, every physically normal child also has at birth," he states (11, p. 111). From his own experience as an example, Fuller considers that the most important task in education is "to become as comprehensive as possible by intellectual conviction" and its resultant attribute "self-debiasing" produced through a "progressively
informed displacement of invalid assumptions and dogma by discovery of the valid data" (11, p. 112).

One particularly interesting point taken up by Fuller is in regard to the place where education occurs. He contends that children must be allowed to discipline their own minds under the most comfortable and favorable conditions. "We'd better consider mass producing 'one pupil schools'," he counsels. "That is, little well-equipped capsule rooms to be sent to all homes; or we can design special private rooms for homes. There are many alternatives but the traditional school room is not one of them" (11, p. 99). Fuller feels that the school serves as a "general baby-sitting function" and much of what goes on there is "strictly related to social experiences" (11, p. 41). Fuller recalls that his friend Einstein, when he wanted to study math or physics, did not sit in the middle of a school room at a "desk prison." That is probably the worst place he could have gone. Instead he went into seclusion to the study or laboratory (11, p. 100). Fuller, to this point, states:

The red school house--little or big--is on the way out. New educational media are making it possible to bring the most important kinds of experiences right into the home. With television reaching children in the privacy of their homes everywhere, we should bring education--school--to where the children are. This is a surprise concept--the school by television always and only in the home--if possible in a special room in the home. Ralph Waldo Emerson was right--"The household is a school of power" (11, p. 100).

Fuller is confident that the pattern of individual study at home will unfold for the elementary, high school, and college
years. Not until graduate-work days will the individual reside on campus (11, p. 53).

One principle which Fuller has learned is that he undertakes to reform the environment and not to try to reform humanity. If, he believes, the environment is designed properly, it will permit people to develop safely and behave logically without hurting others (11, p. 89). In his experimental work at his own campus, Southern Illinois University, he has learned that students young and old want privacy—a special place. In the project there, he developed small, private room-booths with windowed doors that belong to individual learners. Each contains all kinds of desirable items conducive to thought and study—a telephone privately connected to the teacher, wall charts, a world globe, a good dictionary, typewriter, and so on. The students recognized the privilege to go to this private study, Fuller reports, and they gave themselves spontaneously to study, calculation, and writing. They produced. Their minds really began to work (11, p. 91).

In preparing campuses for general comprehensive environment, Fuller recommends a concept which may be called a "circus model." The circus is an environment that can be transformed in a hurry. After enclosure against the weather, high trapezes, platforms, rings, net, and all kinds of apparatus can be put up quickly. It can be knocked down also in a few minutes. That, according to Fuller, is the way of a modern learning laboratory—suitable to all purposes like a
circus. Get generalized equipment, a crucible, a furnace or whatever is needed, rig it up, get through the experiment, knock it down, and the space is clear again. The circus concept for the laboratory is very important (11, pp. 82-83). Fuller counsels against wasting money on heavy stone masonry of the Georgian type architecture. He suggests that anything that is static, forget it. Work only toward the dynamic. Secure privacy, not with partitions, but with space between groups. Fuller recommends a large diameter geodesic dome over the entire campus and subdivide for local areas with "delicate occulting membranes," rose bushes, soap bubbles or smoke screens (11, pp. 83-84). In a concluding word about campus preparation, Fuller remarks:

> Get yourselves the right geographical bases . . . . Get lots of real estate and lots of airplanes and helicopters--get mobility. Get the most comprehensive generalized computer set-up with network connections to process the documentaries that your faculty and graduate-student teams will manufacture objectively from the subjective gleanings of your vast new world and universe-ranging student probers. Get ready the greatest new educational facilities . . . assuming that any dreamable vision of technical advance will be a reality and that humanity is about to demonstrate competence beyond our estimates of yesterday and today (11, pp. 84-85).

Fuller advocates careful and daring thinking about what equipment is and is not needed in the educational institution for research. At M.I.T., for example, he recalls that they had rooms full of special and expensive apparatus which was to put them ahead in research facilities. Room after room of that equipment is now obsolete (11, pp. 81-82). For example,
Fuller points out that in designing today, an essential of yesterday, the drawing board, is obsolete. In the past drawings were made, they were handed to craftsmen who made the physical device or structure. That is not the process today even though the schools continue teaching it. Now schematics and schedules are made, and the data goes directly to the tools and machines. The idea of drafting measured details is becoming obsolete. Fuller explains:

"We don't want any more measured detail drafting. What we want are people who get the fundamental concept, the information significance and can do some comprehensive thinking regarding that information. They will put the data into the information machines, and it will be processed by automation into physical realization of their effective thinking (11, p. 82)."

The point that Fuller is making is that educational facilities do not need the many "things" once thought necessary in schools (11, p. 82).

Fuller acknowledges that students of all ages will continue to go to "school houses" to get "social experiences" or to be "baby-sat," but he is confident that real education will come only as individuals discipline themselves spontaneously under the stimulus of their "individually unique chromosomes." Every person has his own individual chromosomal pattern. Fuller thinks, consequently, that the simultaneous curricula of traditional education are obsolete. Educational machine technology like Fuller's automated educational facility [a two-way TV and a computer geoscope] must be utilized to make all important information immediately
available and ready for the different "individual human chromosomal ticker-tapes" to call for it (11, p. 54). This again is an example of Fuller's principle of comprehensive design which solves problems by inanimate technological rather than by organization reforms; that is, meeting needs by some kind of physical apparatus.

Advances in education technology have made new tools available which make it easier and more efficient for the young to discover what really is going on in nature. The computer is making specialization for human beings obsolete. This, Fuller observes, is forcing them back into comprehensivity functioning, back into that which they were born to demonstrate. Computers with linkages via libraries and control centers are learning tools that can take over much of the "educational metabolics," and thereby free man to put his brains and wisdom to work. Fuller urges every student, the young one first of all, to have access to a computer (11, p. 94). It is television that Fuller puts forward as a great educational tool. "TV is the number one potential emancipator from ignorance and economic disadvantage of the entire human family's residual poverty-stricken 60 percent," he asserts (11, p. 100). "So the home is the school . . . and TV is the great educational medium" (11, p. 101).

Fuller envisions research and development laboratories of education in which faculty will produce video-tape documentaries. These documentaries will be the results of constant reworking that the viewer will be able to get complex
ideas quickly and firmly (11, p. 43). The documentaries will be then fed into a network of two-way TV beaming system for distribution. The child at home will select on TV dials by means of a visual species and chronological category selection device and be able to call up any information on any subject and get the latest authoritative TV documentary (11, p. 47). Fuller believes that by using the "modelability of synergetics," through the medium of two-way TV documentaries, it will be possible for children at home to make their own models. With this "fundamental structuring experience, and sensing through models," children will be able to do valid nuclear physics formulations at kindergärten age (11, p. 93).

One prominent theme in Fuller's work regarding education as already stated, has to do with why are human beings a part of the universe and their contribution to universal evolution. He suggests that man must learn "why humans have been included in the design of eternally regenerative Universe and thereafter swiftly to start fulfilling that cosmic function" (11, p. 161). Even though man has discovered some extraordinary principles he has been using them in the realm of weaponry at the cost of vast amounts of money. National defense demands employ the highest new scientific capability of humanity on how to destroy most expertly on the misconception that one has a better coping system than others and that there is not enough of life support to go around. Therefore, the great scientific principles are used for
killingry rather than making the human world work. "It was this fact, plus the new era capability to do more with the same weight," states Fuller, "that made me resolve fifty years ago to try to reverse, and to use the high technologies only for livingry" (11, p. 185). A computer game developed on the campus of Southern Illinois University called "How to Make the World Work" provides a practical expression of Fuller's idea of reverse. The side that gets into politics, and eventually war, loses the game.

Essence of "success in making the world work" will be to make all people able to become world citizens free to enjoy the whole Earth, going wherever they want at any time, able to take care of all the needs of all their forward days without any interference with any other person and never at the cost of another person's equal freedom and advance (11, p. 108).

To the end of "making the world work," Fuller proposes a design revolution "which produces so much higher technical performance per unit of resource invested as to take care of all human needs" (11, p. 153). Education will have its responsibility in this design revolution. Ninety-nine percent of humanity, according to Fuller, does not understand science or that science has found out that the universe is "the most incredibly reliable technology—that you and I are very much better technology than any of the machinery we have been able to design ourselves" (11, p. 187). The 99 percent connect technology only with weaponry or some other negative response. "From a future educational responsibility viewpoint," declares Fuller, "nothing is more challenging than the question of how
we get 99 percent to understand technology" (11, p. 188).

Fuller feels that humanity is now coming into its final examination to see whether or not it qualifies to come out of the abyss and "rebloom into a new relationship to Universe."

He puts it very bluntly, "The function of education of tomorrow is to assure that humanity qualifies to continue in Universe" (11, p. 189). The design revolution cannot be accomplished, in Fuller's opinion, by political strategy, by private enterprise's unilateral advantage seeking or by priestly intercession. The design revolution, which Fuller also refers to as an applied-science revolution, can only come through each human being, first of all, comprehending the structure, the leverage, and the mechanical advantage employed by nature can be used to attain physical success for all humanity; second, by a common understanding that this success must include all humanity; and third, by common understanding that physical success "requires development of universal scientific and technical comprehension and physically demonstrable technological competence" (11, pp. 153-154).

Technology Education

Paul W. DeVore proposes that the issue of education be approached from the critical value-questions of who are we and where are we going. In this way the focus of education would be redirected in terms of "preparing citizens in how to think rather than what to think" (9, p. 316). In another
place, and using different words, DeVore expresses the same goal of education. Education should "provide individuals with the means to find order in a complex universe and to attain the knowledge, skills, tools, attitudes, and values required to participate successfully in deciding the future," he states (6, p. 212). As a means to achieving this goal, DeVore proposes that the traditional division of the disciplines of knowledge be restructured to modern disciplines of knowledges that more adequately reflect contemporary experiences. He structures modern knowledge in the disciplines of science, humanities, and technology (7, p. 24). Therefore, for DeVore, one valid part of the educational system should be technology education.

Traditionally, education has focused on preparing people to serve the needs of technical systems through the vocational perspective, while the liberal-education perspective serves the elite in arts and literature. DeVore observes that formal education is committed primarily to training workers and managers to meet the needs of business and industry and that "the study of technology and technological systems for the purpose of preparing citizens intelligent enough to direct, manage, and control their adaptive systems--technology--for human purposes has not become a part of any serious educational effort" (9, p. 315).

Educational interest in technology generally has been tied to technological progress in questions relating to what can be done technologically. Seldom do goals of education
reflect the designing, managing, and controlling of technological systems for the benefit of humanity in terms of the question what ought to be done technologically. DeVore would redirect education in purpose, content, structure, and process in order to achieve technological literacy that would in turn redirect technology to serve human purposes and social goals. The emancipation of mankind from the technological imperative for political, economic and other such ends requires a change in perspective of education and a change of attitude toward technology. Education for emancipation would not just train people to fill roles in the industrial world or allow technology to direct society. It involves knowledge about technological and social systems that provides a critical facility to distinguish between when technology is threatening and when it is not. DeVore explains what education for emancipation at a minimum should be:

Educational programs must prepare citizens to respond intelligently to some of the more critical issues including the need to determine ways to restructure social mechanisms that will control and orient the power of our technical means. There is also the need to prepare people to make political decisions against the development of particularly dangerous technologies. Preparing people who can participate in the creation of mechanisms capable of reducing the negative side effects of technology and who can take action before crises occur has become an important educational goal (9, p. 319).

DeVore contends that education in an open society should provide for choice, not direction, freedom, not slavery. Education should produce not just workers and consumers, but self-determining and self-governing people. According to
DeVore, "An enlightened knowledge and know-how should be central to the mission of education" (9, p. 322).

One main thrust in DeVore's concept of education and technology is his notion of access to tools. He means by tools all those "devices from the most simple to the highly complex which are used by society to produce goods and services; transmit, store or retrieve information; and transport goods and services; together with the know-how of their use" (9, p. 325). In the highly complex technological systems of today, the masses of people are denied the access to those tools in favor of the experts. Common sense and simple technology of yesterday are not sufficient in an era of technological sophistication. Knowledge of this kind comes only with a discipline and systematic study. Most people have never had that opportunity. Therefore, most people have no opportunity to participate in the management of technology for social purposes because they don't have access to tools to know, to understand, and to direct (9, p. 326).

Portions of education that do study technology are unfortunately so limited and so narrowly directed in job preparation that they aid very little. DeVore thinks also that the expanding base of technology has not only passed up the average person, but it has transcended most educators. Educators often look at technology as an "object," or "out there" or as an abstraction that is outside the concern of education. DeVore believes this educational muting of
technology has created what Arthur Koestler calls an "urban barbarian"—people who utilize technological products in a purely possessive and exploitive manner without comprehension and feeling and totally ignorant of the culture which supports them (6, p. 207).

The lack of technological literacy on the part of the general public by default leaves the management and control in the hands of a regime of experts and specialists, none of whom, according to DeVore, "have the responsibility or mandate to be concerned about social purpose and total systems" (9, p. 325). Even the experts, though, are limited in their understanding. They know the physical forces and principles of perhaps a portion of the system. They can control that one system, but as DeVore points out, "the issue is not the control of the single device, the issue is the understanding and control of the behavior of technological systems as a major component of our social system and as a critical factor of cultural change and disruption within society" (9, p. 326). The emphasis here is not only what the element of technology is but that it does within the system. If people are ever to regain their freedom and obtain control of society, they must be involved in the study of technology and given access to its tools. This should be the goal of education (9, p. 327).

In passing, it is instructive to note in regard to the matter of control, DeVore is persuaded that the technological imperative in sheer speed and magnitude of the past 200 years
has resulted in the loss of control of technology for human purposes. Following Ellul and Galbraith, DeVore states that:

The central purpose of society becomes one of ensuring the continuation of technological development. The control of the process, including the establishment of the goals, was vested more and more in the government, corporate enterprises, and a body of technical experts (9, p. 328).

The increasing complex and interrelated nature of technology has led some, reports DeVore, to question whether people can comprehend it and whether democracy and a free society can survive in a highly technological society. DeVore refers to J. W. Forrester who questions whether mental models based on intuition can be relied upon to guide sophisticated technological society (9, p. 328). DeVore recalls that large-scale technological systems were concerns of E. F. Schumacher. He criticized capital and energy intensive technological systems for being destructive of nature, degrading to human beings and impoverishing to civilization. Schumacher called for a new approach to technology by society which he called Intermediate Technology. The goal, comments DeVore, was not a return to the past and rejection of technology, but a more socially accepted technology. This alternative style of technology is less capital and energy intensive, more compatible with the environment and controlled to a larger extent by the people (9, p. 329). The possibility of alternative technology is also a function of technology education.
Another concept that figures prominently in DeVore's scheme is that of participatory technology. Closely related to the power and control of technology, participatory technology refers to the inclusion of people in developing, implementing, and regulating technology (9, p. 336). It is a way to make technology more responsive to the felt needs of individuals and society (6, p. 209). Participatory technology does not mean, as DeVore points out, that "every citizen must be a technologist, sociologist, biologist, or other specialist. What it does mean is that all citizens, professional and lay, must be educated as part of their basic liberal education about the interrelated behavior of technological, sociological, ecological, and ideological systems" (9, p. 337).

Education in the twentieth century goes beyond the basics of reading, writing, and arithmetic. The new type of literacy demanded today is a technological literacy. DeVore, therefore, urges a study of technology. He insists that technology is identifiable as a valid intellectual discipline. In a monograph Technology: An Intellectual Discipline, DeVore points out that technology meets all the recognizable criteria of a discipline. First, DeVore calls to mind that man's whole civilization is based on technology. Historians have recorded this fact. The criterion of a recognizable and significant tradition and history is easily attained (8, p. 11). Second, disciplines have an organized body of knowledge. DeVore points to the technological universals—communication,
production, and transportation—as an organized and objectively determined body of knowledge (8, p. 11). Third, as to the criterion of being related to man's activities and aspirations that addresses itself to the problems of man and society, DeVore calls attention to the fact of technology has become "the common denominator from which all people may draw the knowledge and devise technologies upon which the material fates and fortunes of all mankind, in some unidentified way, seem to center" (8, p. 12). Fourth, the criterion of a discipline that considerable achievement in both eminent man and significant ideas is, according to DeVore, self-evident. One has only to think of inventors and their inventions (8, p. 13). Fifth, a discipline is identified by the criterion of what it does to provide stimulation and inspiration for man to further his ideas and reach his goals. DeVore submits that man through technology continues to advance to easier, faster, and more convenient ways of doing things. "No longer does he ask," states DeVore, "whether a problem can be solved or not. His only question is how long it will take. Man faces the future with a positive mind" (8, p. 14). As a viable intellectual discipline, then, technology becomes established in education as a study essential for the proper understanding of man and his world. Moreover, it becomes an area necessary for the education of all youth (8, p. 5).

DeVore approaches the study of technology with a conceptual structure that organizes components into a single
meaningful system. His conceptual model features the interrelationships of ideological systems, sociological systems, and technological systems within the framework of ecological systems. Within the interrelationships of these systems DeVore outlines the structure for the dynamics of the system. The critical processes are valuing, enabling, and assessment. The value processes are related to the ideological systems to answer the vital question of who are we? Why are we here? And where are we going? Enabling processes are related to sociological and technological systems answer the vital question of how are we to get there? The assessment processes are related to environment as well as social indicators to answer the vital question of how are we doing? The interrelationary dynamics of the system produce an evolving society. DeVore pictures the evolving society as a feedback mechanism offering new potentials and new choices available for the self, society, and technology which requires fresh valuing, enabling, and assessment processes (9, pp 339-341).

Finally, DeVore's study of technology requires a structure to identify primary elements of technological systems and their relationships for the purpose of programs of study. DeVore's model is a matrix or a taxonomy of three dimensions. One dimension of the matrix consists of the technical and social components of technology. The technical components consist of resources, materials, tools, machines, energy, power and information. Social components are composed
of human elements such as skill, occupations, organizations, and management systems, and so forth. The second dimension concerns the different way people structure and use the components in three interrelated contexts which DeVore names communication, production, and transportation. These three contexts of technological matrix are found in every society regardless of the level of sophistication of the culture (9, pp. 339-341). The third dimension of DeVore's matrix has to do with the complexity in the evolution of technological systems. Levels of complexity progress from the simplest tools and crafts tradition to contemporary atomic and cybernetic systems. This axis may continue indefinitely into the future (9, p. 341). DeVore is persuaded that such a structure will provide a balanced study of technology which includes both facts and concepts of technology and about systems and the interrelationships.

The matrix implies very clearly that it is not possible to study technology without becoming involved with technical knowledge and technical systems and their elements and operation. The same is true for those who would prepare to study technology without becoming involved with human beings, social knowledge and social systems (9, p. 341). Technology is a critical variable in the modern world. Only by a disciplined study of its components, contexts and complexities can man hope to gain control, freedom, and participatory action to direct it to human purposes and social goals. This is the message of Paul DeVore. His enlightened prescription shows the way to accomplish the task.
Concepts Originating from a Professional Group

One part of general education that is having an increasing concern with technology is the program area known as industrial arts. Traditionally, industrial arts has focused on such things as the interpretation of industry, the development of the individual, career and occupational programs, hobby and crafts tradition, and so on. However, industrial arts educators were quite active during the 1960's and 1970's in curriculum innovation which acknowledged the role played by technology in the life of modern man. Proposals run the gamut from evolutionary to revolutionary and from local to universal. Some of the proposed programs were primarily analytical, some were speculative or philosophical, while others were action-oriented. The proposals were programmed for one grade level or for several grade levels, and some were comprehensive to include all grade levels. One such original proposal is the Texas Industrial Arts Curriculum Study.

The Texas Industrial Arts Curriculum Study which began in 1970 was sponsored by the Texas Industrial Arts Association. The study received national recognition for the unique, statewide effort. The many tangible products of the study included presentations at national conferences, newsletters, numerous conferences and workshops, doctoral dissertations, and consultations with key people in industry, labor, business, and other disciplines. The Study produced four major
documents and created a rationale for industrial arts in Texas which was also published. Paid research staff assisted in the production of materials. The Curriculum Study was funded by the Texas Education Agency and the Moody Foundation.

The criteria used to guide the Texas Industrial Arts Curriculum Study were to reflect technology, to help students adjust to the environment, to stress conceptual development, and to emphasize learner competencies. The committee in its work adhered to the policies of being interdisciplinary in nature and involving the classroom teacher (1). Although one of the basic tenets that guided the study from its inception was "focus on the learner" (15, p. IV), the first criterion—reflect technology—was given high priority.

The multivariant nature of the other industrial arts rationales challenged the Curriculum Study to project a new role for industrial arts education "based on humane technological competencies that are directly useful in the lives and careers of people" (14, p. 1). The study committee reasoned that since technology is a dominant feature of the culture, it should be a relevant part of the school environment. Learners encounter technology every day of their lives, and they are confronted with decisions pertaining to it. In order to cope adequately with it, therefore, learners need valid concepts about technology. It is to this aspect of the culture, technology, that, in the opinion of the study committee, industrial arts must focus its attention (1).
The Study's document *Psychological Base for Education* is "an effort towards a theoretical synthesis" of the "complex and multivariate nature of behavior and learning" (15, p. 20). The synthesis isolated certain psychological principles which, according to the Study, undergird a humanistic approach to education. These principles may be briefly reviewed.

Concepts are mental constructs developed through the individual's total experience in the environment. The conceptual schemata then become the critical mass that controls behavior. Because concepts consist of meanings that the individual places on his transactions with the environment, it is impossible for concepts to be transmitted. It is important for education to facilitate, therefore, conceptual development by providing experiences with the environment (15, pp. 2-4). After laying this ground work, a principle concerning learning may be derived: "Learning is the realization of new patterns of behavior through a modification or change in conceptual schemata" (15, p. 4). Other principles of behavior are enunciated. Behavior can be classified into conditioned responses, motor responses, verbal responses and conceptual affective processes (15, p. 6).

These responses cannot become isolated parts, because behavior is holistic. Organization of behavior by the individual is a natural process (15, p. 5). Behavior is shaped by its consequences. Whether or not the behavior will be repeated is dependent upon its perceived consequences (15, p. 6). Again, behavior is changed only as that behavior is occurring.
Therefore, only that behavior which is actually practiced will be learned (15, p. 7). The learner's motivation is directly proportional to the perceived needs and levels of usefulness of the activity and his confidence in his ability to succeed. "The match between confidence and perception of the activity's usefulness," concluded the Study's document, "yields a highly motivated learner" (15, p. 8). Subject-matter is to be found in the transactional area of life. This process removes subject-matter from the realm of abstraction and places it in its concrete form to be known through sensory experience, that is, a phenomenal form rather than intuition or thought. (15, p. 9). The transfer of learning of the educational world to the real world is in direct proportion to the reality in the learning task (15, p. 9). Those psychological principles outlined above claim to be "a systematic collection of the facts concerning behavior and learning" (15, p. 10).

From the foregoing psychological principles an instruction model may be developed. The process occurs as an individual performs "whole acts" (transactions with the environment) upon "whole things" (concrete entities that comprise the individual's environment) which produces consequences which in turn form concepts which mediate actions and so forth. The model becomes a self-motivating, self-correcting, cybernetic cycle (15, p. 11). Two important points in the instruction model are the "tightly cemented" unity between a given behavioral act and the phenomenal context and insistence on the holistic aspect of the behavior.
The emphasis is placed not on the change but on "the tendency of the organism to make extensive use of self-correcting tendencies that return the organism to a previous state of balance and adaption" (15, p. 13). So characterized, the learning model may be described as "Learning While Doing" (15, p. 12).

Building on the principles and the model an education system of inputs, processes, and outputs is derived. The process of the educational system is instruction and the output is a change in conceptual schemata which in turn affect behavior. The input, however, is what is particularly pertinent to this dissertation. The input is referred to as the "phenomenal curriculum." The phenomenal curriculum is composed of the "phenomena in the man-made and natural environment" and the "competencies required to completely transact with phenomena." The input or the phenomenal curriculum in the education system proposed by the Texas Curriculum Study "is composed of all the whole things and whole acts a person needs to cope with the phenomenal world, which is predominantly influenced by technology." (15, p. 17).

Given this framework, the educator is now in position to begin developing content areas by examining the phenomenal world and the competencies necessary in dealing with these phenomena. The competencies grow out of the three interwoven domains of human capacity--doing, knowing and feeling (14, p. 4). Education must involve the learner in transacting with
the phenomenal world in all three domains of human capacity (14, p. 7). The phenomenal technological world is comprised of seven transactional areas: self, communicative things, other persons, institutional things, physical things, quantitative things, and aesthetic things (14, p. 8). A study of technology, then, can be identified and organized not in terms of facts far away from their original place, or a cold dissection of technology into discrete components, or textbook abstractions, but in terms of transactions of the learner with the phenomenal technological world (14, p. 9).

Concepts Implemented by Educational Institutions

One of the significant developments in higher education during recent years has been the interdisciplinary study of technology by engineers, scientists, humanists and social scientists. An infinite variety of programs and courses have been developed under general headings such as "technology and culture," "technology in society," and, one of the most common, "science, technology and society" (STS). A report by Cornell University in 1977 identified 178 programs at 108 institutions and 200 additional schools offering STS classes for a national total of 2,300 courses (10, p. 594). Stephen Cutcliffe, STS Program at Lehigh University, reports that at the end of the last decade the interest was so intense in the academic community that over 200 formal STS programs, and a larger number of informal course clusters, serving every level
of higher education programming had been developed (5, p. 203).

Models used for the study of technology are often drawn from the various disciplinary backgrounds of the individuals or groups who are responsible for the programs. Disciplinary models include: historical models which are based on the developmental sequence of tools, machines, and cybernetic devices; aesthetic models which are based on iconographical studies in art history and the recognition that technology deals with nonverbal thinking; ethical models which are based on the idea of professional responsibility and the fact that technology tends to transform people into professionals; social science models which are based not only on Marxist philosophy but also on structuralist theory by which technology transforms man's experience of the world; and futuristic models which try to predict or assess the impact of technology on future developments and events (3, p. 78). Cutcliffe observes that the STS programs and courses take one of three topical approaches: first, the historical background for the development of the social context of technology; second, explores the social context of technology from the perspective of public policy; and third, focuses on the value questions implicit in modern technology (5, pp. 203-204). This range of diversity in STS programs is held together, in Cutcliffe's opinion, by an important common denominator--the recognition that technology is a social process. Cutcliffe means by this that "technology is the
product of a process in which abstract economic, social, and cultural values shape, develop, and implement the concrete artifacts and techniques generated by the engineer" (5, p. 203).

The STS programs bring together the humanist from liberal education and the technologists with the technical education for a common purpose. The traditional liberal educational process of developing precision of thought and language and exploring man's experiences is being lost on "the barren escarpments of technology." The traditional technological education of training for the mastering a host of "optimization techniques" has had no time to contemplate personal and social value sets or to be sensitive as to the implications of technology to life now and the future. The STS programs provide a format for the convergence of the humanists in the liberal arts path and the technologist in his technical stream to be brought together to find understanding of their "complementary function in civilization and culture" (12, p. 237). Ghali submits that Colin Wilson's notion of "self-division" of the twentieth century man is generally accepted. He points out that many scholars have tried to handle this difficult problem. Ghali concludes that all of those scholars seems to agree that "the remedy lies in a return to the concept and to the reality of whole man, total man (Fanon), complete man (Jung), undivided man, unitary man (Lancelot Law White), unified man (Mumford), integral man (Alexander Marc), integrated man (Rene Dubos)" (12, p. 237).
The STS programs project a meaningful liberal arts-technical educational process for the technological society that aims at the major problem—"the lack of any shared principle that could serve as a basis for community" (3, p. 80). An illustration of such a program is the Cultural and Technological Studies Program at the University of Wisconsin, Milwaukee.

The Cultural and Technological Studies Program (CTS) at the University of Wisconsin-Milwaukee (UWM) was created to develop an interdisciplinary, undergraduate curriculum for engineers to explore the relationships between technology and culture. Engineering educators have long realized that the technological problems that have been left to engineers in this century and especially in recent years have not only placed greater pressure on them, but that the nontechnical aspects of the development and application of technology have come to play a greater role. Recognizing this need and following as a guide the American Society for Engineering Educators' report by Sterling Olmsted, Liberal Learning for the Engineer, concerning the humanities and social sciences for engineering students, the CTS at UWM was initiated and funded by grants for a five-year development period during 1973-1978. The technological society and the Olmsted contextual approach to humanities and social sciences provided the basic premise of the program.

The contextual approach takes as a starting point the fact that all of us, engineers and non-engineers alike, live in a technological world,
and that we must understand the relationship between the technology we create and the society in which it operates. Students learn about technological systems in society and the values which underlie them, so that they will be able to understand how those industrial institutions impinge upon their own lives and work (13, p. 142).

Culture and Technological Studies is not a department and does not offer a major or minor. It is simply a program to supplement existing degree programs. The administrative structure of CTS reflects the "interdisciplinary and intercollegiality" of the program. A steering committee which includes humanists, engineers, scientists, social scientists, and an architect oversees the program. The faculty is composed of core and associate members. Core faculty are those who are recruited specifically to teach in CTS. Criteria for their selection are program needs, a commitment to undergraduate teaching, a concern for human value questions, and a genuine teaching and research interest in technology as it relates to a particular discipline. The associate faculty are those people who are already on campus and who wish to teach new courses from the perspective of technology and culture (13, p. 144). One of the implicit goals of CTS has been "to build an interdisciplinary community of scholars around a common concern--understanding the relationship between technology and culture, using various disciplines as roads to understanding" (13, p. 145). Several times a year conferences are sponsored on some aspect of technology such as work, values, energy, systems design, and communication. Outside resource people are brought for
conference leadership. These conferences are helpful to the success of the program. Merritt and Drake state:

The real value of these conferences is the exchange of ideas among our own faculty that takes place during the meetings and provides continuity for class discussion and interdisciplinary collegiality on campus . . . . Engineers and humanists often meet and talk for the first time and discover common interest. Many faculty have said that these conferences have been the most stimulating experiences of their academic careers (13, p. 145).

Bi-weekly luncheon meetings also help in building and maintaining the community of scholars which has been created. Dialogues have begun that may have never occurred otherwise (13, p. 145). The program has had a similar impact on students. Although CTS was designed for engineering students, the program apparently met the needs of other students at UWM. Engineering students comprise only about forty percent of the total enrollment for the program. There is, then, more awareness of technological systems on the part of non-engineers, more awareness of the humanities by engineers, and subsequently much more dialogue between the student groups (13, p. 146).

Cultural and Technological Studies was originally set up because engineering students found the courses in humanities and social sciences unrelated to the technical and vocational goals of engineering training. In order to remedy this situation practical curriculum goals for CTS were "first, to increase the number of humanities-social science courses open to engineering students, and second, to focus in those course
upon questions which would bear directly upon the life and work of engineers" (13, p. 143).

The curriculum is designed around three phases. Phase One courses are introductory courses called Gateway and Design. They are built around some aspect of the relationship of technology and human values. These courses are team-taught by various disciplines (13, p. 146). Phase Two courses are in-depth or case studies into specific areas of the interface of technology and culture. Areas include technology and society, technology and art, technology and the individual and technology and the environment (13, p. 147). Phase Three is called Keystone. These courses are taught only by core faculty. Keystone courses seek to link engineering, humanities, and social sciences. They focus on "the role of the professional, with the hope that a student about to enter the work stage of life would examine the technological structure of his chosen profession" (13, p. 148).

The success of CTS at UWM is seen in that after four years of development, eighteen departments in four colleges are participating in forty courses. Students from many different majors take the courses. Although CTS is basically undergraduate, and will remain such, a research unit has been added. The program will be continued after the grant expires through regular school budget. The program supplies consultants to other campuses to develop similar programs. In addition, the community at large is calling on the expertise of program participants for various services. Merritt and
Drake feel that Cultural and Technological Studies at the University of Wisconsin-Milwaukee has shown that "a contextual approach to humanities-social sciences courses for engineers is not only possible, but it is desired by faculty, students, and administrators. Their response has been gratifying" (13, p. 149).
CHAPTER BIBLIOGRAPHY


PART II

THE IMPACT OF TECHNOLOGY ON EDUCATION
CHAPTER IV

TECHNOLOGY AND THE STRUCTURE
OF EDUCATION

The impact of technology on education is evident in Grayson's historical survey of western education. The A stage is "Aristotle, Aristocracy, and Apprenticeship"; "Book, Blackboard, and Bus" comprise the B stage; and the C stage is "Computer, Cassette, and Commuter" (25, p. 117). In his books Education and the American Civilization and Social Foundations of Education, George S. Counts names technology along with the democratic tradition and natural endowments as forces acting on American society and its institutions (10; 11). The educational historian Lawrence Cremin includes technological innovation together with industrialization, urbanization, and expansion as the cause of the transformation and proliferation of American education (12).

More specifically, the interventions of technological discoveries and inventions have had an impact on education. They make subtle, sometimes violent, effects on the thinking and action which take place in schools and colleges. These products of technology bring about change in education
requiring redirection of what is done, setting new goals, altering methods, solving old problems, and raising new and often more complex ones. Transportation (airplane, automobile, mobile home), communication (telephone, motion picture, radio, television, printing), and architecture (laboratory, auditorium, field house), all products of technology, are ready examples of the impact on education (31, p. 103).

Maclean and Lee point out three ideas directly related to technology that bear on education. First, the industrial revolution is not just a historical episode long dead. It is, instead, a live, continuing, and accelerating force of which every teacher and student in this democracy must feel himself a part (31, p. 119). Second, the development of major inventions that have grown out of the discoveries of science moves beyond the development of social, political, and economic organizations. This condition can be termed "social lag" (31, p. 128). Third, new discoveries and inventions improve upon and replace old ones both in the physical and mechanical world and the world of human relations and organization. This is the principle of obsolescence. The atomic age can be used to illustrate these principles of continuing industrial revolution, social lag and obsolescence (31, p. 120). In the light of these principles, future changes can be managed only "by extending our knowledge, by keeping the whole process of learning free to study, explore, and examine things and ideas of all sorts" (31, p. 123).
From a wider historical context Noble traces the twin forces, scientific technology and corporate industrialism, which have shaped America. These two forces converge in the common medium of modern engineering (34, p. XVII). Modern engineering uses a technology that is for Noble always much more than information, logic, and things. He explains that technology is an essentially human phenomenon.

Technology is thus a social process; it does not simply stimulate social development from the outside but, rather, constitutes fundamental social development of people for new types of productive activity, the reorientation of the pattern of social investment, the restructuring of social institutions, and, potentially, the redefinition of social relationships (34, p. XXII).

Lasch interprets Noble's view of technology as "social production" and that "the professional engineer is an expert not only in applied science but in management of social relations" (29, p. XII).

Noble probes two types of education in the context of scientific technology and corporate industrialism: industrial education, which he calls the "new apprenticeship," and higher education, especially engineering education. In educational discussion, the rhetoric is that of progressive education utilizing such phrases as "education for life." However, one type of education, Noble contends, was "to prepare people for a life of labor; the other to prepare people for a life of managing people" (34, p. 168).

One clue for understanding the impact of technology on education may be found in Weber's notion of "rationalization,
which, for him, explained the transformation of the West from traditional to modern society. Weber perceived western society as having a rational technology, rational accounting, rational economic ethic, and rationalization of the conduct of life (43, p. 354). In another place Weber states that "the progress of rationalization in technology and economic organization determines an important part of the ideals of life in the modern society" (44, p. 75). Bell interprets Weber's concept of rationalization as the "axial principle" (4, p. 10) and "master key" (4, p. 67) of modern society. It is in this sense that inquiry may be made into the impact of technology in the structure of education.

The Role of Organizations

Structure is an "internal differentiation and patterning of relationships" (40, p. 51). It attempts to provide boundaries whereby efficiency may be expected. Structure is the fundamental vehicle to achieve "bounded rationality" (40, p. 54). Structure, in other words, may be defined as "any set of relations among parts of a living system which, on empirical grounds, can be assumed or shown to be stable over a time period and under a set of conditions relevant to a particular cognitive enterprise" (35, p. 68). In the consideration of structure, both human and nonhuman resources are included. Thus, a study of structure is in reality a sociotechnical system (40, p. 51).
The configuration of "bounded rationality" is recognized in the modern world as an organization. Arnold Gehlen, in his theory of institutions, proposed that man is characterized by great instability, because of his instinct deprivation. Therefore, he had to construct stable structures which are known as social institutions. Modernity, however, has "deinstitutionalized" society, resulting in modern society having a built-in instability factor. Since modern society does not provide the proper institutions, man must supply his own. The individual in the modern world must adapt his social functions from living within traditional institutions to performance based on qualification within new relationships (23, p. 50). Modern man performs in structural substitutes for institutions, namely organizations (19, p. 189).

Drucker has called attention to the newness of the society of organizations in the twentieth century. He designates this new situation as "a new pluralism" (19, p. 175). The scaling up in size of all organizations to giant size is also an important change, and "the large organization is the environment of man in modern society" (19, p. 186). Drucker's counsel is that modern man understand clearly the structure of the society of organizations. Moreover, he must realize that "every single major task has become institutionalized and that we will have to deal with the problems this creates as generic problems of our society and as its norm" (19, p. 178). Furthermore,
Drucker submits that it is through this society of organizations that work of today is organized. Since Drucker thinks that technology is not about things, process or product, but about work and how man does or makes (20, p. 44), he concluded that the organization is in itself "an important tool of man" (20, p. 48). For the knowledge worker, "the organization man" [not of the popular myth kind], or, above all, the effective executive, "the organization must be his tool, while at the same time it produces the results that are needed by society and the community" (19, p. 199).

Levy defines an organization as "membership units characteristic of society" (30, p. 20). He categorizes and discusses five major types of organizations: kinship and family organizations, governments and associated organizations, predominantly economically-oriented organizations, and miscellaneous organizations (30, pp. 25-26). Levy defined schools as educationally-oriented organizations. This in no way implies that economics, politics, and other social action are irrelevant to the school (30, p. 24). In fact, this overlapping is characteristic of organizations. As Drucker shows, it is never possible to give a final answer to the question as to the task of an organization (19, p. 191). For example, is a firm that makes shoes primarily concerned with the conversion of leather into the goods that consumers will want to pay for? Or is it primarily concerned with mass distribution?
Or is it in the fashion business (19, p. 190)? Drucker believes that any answer to the question, "What is our business?" becomes obsolete within a short period. The question has to be thought through again and again (19, p. 191). When an organization does decide where to invest its efforts and seek its rewards, that is, define its objectives, then the organization can do its work. "Concentration," Drucker declares, "on the specific task emerges as the key to strength, performance, and legitimacy of organization in the pluralist society" (19, p. 211).

The relationship of structure, technology, and organization is an open issue. Hickson, Pugh, and Pheysey tested "the broad hypothesis that technology and structure are strongly related" (27, p. 379). Their study by-passed materials technology and knowledge technology to concentrate for purposes of the study on operations technology. Subconcepts of operations technology include sequence of operations, workflow rigidity, and specificity of evaluation of operations. According to this research, "all three subconcepts of operations technology can apply to all work organization, whether manufacturing or service (27, p. 381). After a study of 52 diverse work organizations, they concluded that the general "technology-causes-structure" hypothesis could not be supported, but could be sustained only under restricted conditions. Their revised hypothesis states that "variables of operations technology will be
related only to those structural variables that are centered on the workflow" (27, p. 395).

In Perrow's view, organizational structures are related to technology. His models are structured with routine and nonroutine technologies. Perrow, in further analysis of these models, divided them into small and large variability. If the technology can be designed to be efficient to make large productions possible, that is, routinized, then a high degree of structure is demanded. Nonroutine technology, however, must forego high volume production and consequently the structure will be less elaborate (37, p. 90). Thus, by utilizing complex models based upon analytic concepts such as raw materials and types of technology, Perrow concluded that "we are in a position to define more carefully the nature of any organization and to see just what kind of management practices are likely to work and what kind are likely to fail" (37, p. 91).

For Presthus, technology falls under the umbrella of the psychological factors of complex organizations and organization behavior. He recognizes four discrete systems that represent the "structured field" of an organization—authority, status, small groups, and technologies (38, p. 113). The technology system is vital to the structure of the work group. Presthus points out that "the design of its authority relations, the degree of control over the individual work process, the nature of supervision, among other factors, seem to be greatly influenced by the technical
nature of the group work" (38, p. 135). Moreover, he thinks the technical context of an organization is so "inherent and infinitely varied" that it may be treated as a "given" (38, p. 114). Presthus illustrates the givenness and imperative of technology in organizational structure by the following:

Consider the operating room in a hospital where a group of specialists is about to perform an operation. Factors of authority, status, and small groups are obviously at work, but they are augmented by technical imperatives, the "laws of the situation," which govern perhaps even more imperiously the behavior of doctors, anesthesiologists, and nurses. Similar task assignments provide the framework for most interpersonal concepts in modern organizations (38, p. 113).

The technology/structure/organization configuration has been variously modeled. Gillespie uses what he labels "the technostructure model." In this scheme, organization is composed of three broad areas. First, organizational technology is composed of activity, equipment, materials, and knowledge. Second, organization technostructure involved both the horizontal and vertical differentiation in the model. Third, organization structure is the nontechnical aspect. "The technostructure model," states Gillespie, "focuses on various configurational arrangements through interrelationships of variables" (24, p. 10). This arrangement is similar to Thompson's three levels of responsibility and control in organizations. Relating the model to education, one can say that the technical aspect is the effective performance of teaching a class or conducting
classroom activity by a teacher. The managerial phase includes service and controls such as the decision on broad technical tasks to be performed. Thompson designates the third area as the institutional level which is the visible part of the wider social system that gives meaning, legitimation, and articulation of the school organization (40, p. 10). To Thompson, different technical functions cause significant differences in organization, and thus, make a difference in management and institutional levels. Therefore, he concludes that the three levels are interdependent (40, p. 12).

In his theory of organization Thompson adds another variable—the environment in which the institutional structure is situated. The environmental structure of the organization will make a difference in the three levels of organization. Therefore, the technologies within and the environment without vary with the way the organization proceeds (40, p. 14).

The Updrift of Influence

The Russian launching of Sputnik in 1957 had a dramatic effect on Americans. The event found most of the nation "psychologically vulnerable and technically surprised" (28, p. 2). Killian reports a crisis in confidence in the land: "As it beeped in the sky, Sputnik I created a crisis of confidence that swept the country like a windblown fire . . . . Confidence in American science, technology, and
education suddenly evaporated" (28, p. 7). Because of the impact of changing social forces, existing educational structures were under fire. However, after Sputnik, the traditionalists' attack on progressive education, evidenced by their books, study reports, and mimeograph machines, became intense (7, p. 126). New dimensions in the criticism became natural security and political concerns. Education came to be expressed in terms of national interest. The works of nationally-known individuals, such as Admiral Rickover and James T. Conant, major private foundations such as Ford and Carnegie, and national associations such as the National Education Association, American Council on Education, and Council for Basic Education were evidence of the growing concern for education in behalf of national interests and of the trend to make education a political issue (8, pp. 226-227).

Decentralized control has long been a tenet of education in the United States. Local schools and colleges were thought to be concerns of the local community and separate states. But as national interest came to be at stake, a vital change was wrought (8, p. 228). As a result of the debate aroused by Sputnik, there took place an updrift and a shift upward in educational authority and decision-making from the local level to the state level and from the state level to national level (8, p. 229). The change in the technological environment brought about by the Russian space
achievement produced a new situation which led to structural changes in American education.

Although there was not established a hierarchical pattern of national-state-local line of educational authority, the shift upward in control and influence was more indirect and subtle. The voluntary relationship between public agencies and private groups established patterns to influence the grass-roots level of educational operations (8, pp. 228-229).

Clark points out a classical example of the movement from the top in the work of the Physical Science Study Committee led by Professor Zarharias of MIT (8, p. 229-232). This project, concerning instruction of high school physics, was financed by a federal agency, the National Science Foundation. The materials were developed, actively promoted, and made widely available through normal commercial channels. Clark summarizes the pattern of influence which was set in motion from the top by a federal agency and a national private committee:

The object was to affect general educational practice, which was seen as a national weakness. The flow of influence was downward, through a chain of independent groups and organizations who found it to their interest to enter the alliance or compact . . . . In this pattern, decision-making was strongly influenced by the prestige of expertise (8, pp. 231-232).

The federal government has long played an auxiliary role in education through the Merrill Act of 1862, the Smith-Hughes Act of 1917, and the G. I. Bill of Right for veterans
following World War II. However, in the National Defense Education Act of 1958, the federal government participated directly in education through billions of dollars in student aid for scholarships and loans, aid to schools and colleges to create certain kinds of programs, and broad support for sciences, mathematics and foreign languages, and to aid in certain kinds of research (22, p. 249). In 1965, the Higher Education Act provided for institutional aid to private and public colleges as well as individual students, education facilities, developing colleges, community colleges, improvement of undergraduate programs and student aid, loans, grants, and work-study assistance.

The federal government's role in the structure of education arises from an array of interests. The Office of Education, the Department of Labor, the Department of Defense, together with the Atomic Energy Commission and the National Aeronautics and Space Agency, have a critical interest in the role of education in training men for work, with a particular focus in areas of science and research and development (8, p. 227). The Manhattan Project to a large extent provided a model for the federal government's venture into education. Rather than build centers for research and development, it used the structure of the university for the "double feature" of mission orientation and project grants. The concentrating on a specific mission and allocating large resources for such tasks has been a very successful approach (4, p. 245). Bell reports that from the end of World War II
and over the next two decades, R & D expenditures in America multiplied by fifteen times, whereas the GNP had only tripled. Most of these R & D expenditures were supplied by the federal government (4, p. 250). In 1940, the R & D portion of the federal budget was less than one percent; by 1956 it was about five percent, and it reached a peak of 12.6 percent in 1965. By 1971, however, it had declined to about eight percent. During the R & D growth period, chief funding of all federal R & D monies was in areas of defense, space, and atomic energy. These agencies spent 91 percent in 1960 and 82 percent in 1971 (4, p. 259). Of the $20.5 billion spent on R & D in 1965, the federal government financed 64 percent of that figure. Of the three million spent on basic research in 1965, 58 percent was used by universities, (4, p. 252).

Bell cites financial dependence on the federal government, in that three-fourths of all research funds came from federal sources, as influencing the structure of education (4, p. 243). Of the 2500 colleges and universities in the United States, one hundred carried out 93 percent of the research. Within this group, 25 universities carried out 54 percent of all university research and 10 universities carried out 38 percent. It is Bell's opinion that this concentration in higher education did, in fact, constitute on an elite level a "national system of education and university research" (4, p. 245). It was DeGrazia who pointed out that nearly forty years after the Manhattan Project 90 percent of
all federal R & D funds issued from three basic sources—the Atomic Energy Commission, National Aeronautics and Space Administration, and the Department of Defence—recalls a Russian proverb: "He who rides on my cart, sings my song" (16, p. 550).

Governance

The suggestion is sometimes made that modern man could control technology by modifying educational systems. The plan would humanize the scientists and bring the humanists to a better understanding of science. Passmore, however, brings forward the argument which questions the success of such an idea by recalling who it is that runs the educational system.

They are certainly not the humanists. They are run by men claiming to be experts, applying psychology, economics, sociology, and administrative theory. To expect an improvement in understanding from institutions which themselves are dedicated to turning out expertly trained experts is to display . . . a monstrously limited conception of technology's range and power (36, p. 42).

Who will control education has been a long-standing problem. In the 1890's, Rice called upon the public to reform education by "creating a new class of professionals who would manage education according to scientific principles" (13, p. 346). By the 1950's, Bestor was calling on the public "to undo the damage of the professionals by returning the schools to the arts and sciences professors" (13, p. 346). In Cubberley's opinion, the guiding influence should come from successful men of business and the professions as they serve on
school boards. "Men," he states, "who are successful in handling large business undertakings—manufacturers, merchants, bankers, contractors, and professional men of large practices would come first" as candidates for school board members (15, p. 124).

In his study of educational administrative practices during 1900-1939, Callahan found that, due to the lack of professional autonomy and the capitulation by the school leaders, the technological ideology of business and industry was adopted by educational administrators. "The wholesale adoption of the basic values, as well as the techniques of the business-industrial world," he wrote, "was a serious mistake in an institution whose primary purpose was the education of children" (6, p. 244). The tragedy as Callahan saw it was that educational questions were subordinate to business considerations, new administrators were not in the real sense educators, method and practices were labeled scientific when they were not, and the anti-intellectual climate was strengthened (6, p. 246). Models for school administrators became not the "thinkers such as the Deweys, the Beards, or the Veblens, but the men of action—the Fords and the Carnegies" (6, p. 248). Callahan lists among the causes of the application of business and industrial values to education the adoption of scientific management, the influence of businessmen serving on school boards, and the development of the professional school administrator (6, p. 245).
Another development in the first half of the twentieth century was the professionalization of engineering and the establishment of engineering as a recognized branch of higher education. This development created a link between the university and the corporation that has remained until the present. The corporation thus shifted to the university, an institution supported by state, secondary cost of production such as personnel training and basic research (29, p. XII). Military spending and war provided another unique opportunity for bringing the corporation, the university, and the state into closer cooperation (29, p. XIII).

Following World War II, as the new prestige and new wealth began to pour in on the university, the new managerial mind became a vital phenomenon in the university world. Nisbet recorded this observation:

Men were now being chosen for chairmanships, deanships, and presidencies not because they were necessarily among the light and leading of the academic community, but because they had something called "administrative" ability. And the ability turned out to be not so much a skill or sensitivity to curricular problems but rather to problems of finance, production, marketing, and especially salesmanship (33, pp. 76-77).

In 1968 Drucker observed that during the last twenty years the government, the military, the hospitals, and education "have begun to apply to themselves the concepts and methods of business management. And this is indeed new. This is indeed startling" (19, pp. 188-189). Drucker cites
an example of this reflection which occurred in 1968. During that year, amid social and curriculum debates, the 9,000 secondary school principals meeting in convention, chose for the theme of their keynote address "The Effective Executive," and they invited an expert in business management to deliver it (19, p. 189).

Ashby realistically recognized the managerial function of the university administrator in the area of science and technology. It is through the administrator that the interaction occurs between science and technology and society. It is also through him that a medium is provided between the two cultures, the humanities and science and technology. The administrator, depending upon how he responds, can be a bottleneck or a pump. Ashby illustrates his point by picturing the university president at budget time.

He is under pressure from all sides to include items in his budget. There will not be money enough for all of them. He is wise enough to surround himself with a committee; but the combined expertise of his committee and himself cannot cover all the decisions which have to be taken: an electron microscope for Bio-physics or a bore hole for the geologists? A new wing to the Organic Chemistry Department, or a block of flats for the married graduate students? He has to consider the prestige of his university; the relative merits of Professor A's memorandum (which dawdles on for thirty pages) and Professor B's (which puts the matter bluntly in a page and a half); the claims of Professor "C", whose work is perhaps the most distinguished of any in the faculty but who never gets around to submitting a memorandum at all; the state of public relations with governments (which may favor Professor A's project, even though he is an insufferable bore about it); the alumni, who want an Olympic swimming pool rather than more laboratories; the claims for practical subjects (like production engineering) as against subjects
of vaguer worth (like sculpture and music).  
Upon the administrator's decision depend the future of Professor B's research on biology, the prospect that married graduate students will come to the university (by virtue of its residential amenities) to work with Professor C, and a host of other consequences, utterly unpredictable. No wonder an American university president once described administration as a strain on the character rather than the intellect! (2, p. 267).

Ashby recommends that preparation for the administrator's work should include a sympathy with the way the scientist thinks and works. He should know probability and statistics, because administrative decisions are "exercises in probability theory." Finally, the administrator should understand the organization of science and technology, the financing, and the policy decision-making structure (2, pp. 275-276). Ridgeway provides a concrete illustration of this kind of administrator in reference to Franklin D. Murphy, who until 1968 was chancellor of the University of California, Los Angeles. Murphy was known not only as an educator, but as a businessman as well. He held membership on several boards of large corporations, even while serving in the chancellorship. He is reported to have made this comment: "The facts are that the best university professors from the best universities in the United States are usually involved in industry: as consultants, in the economic field, in data-processing-systems analysis field--this is growing rather than decreasing" (39, p. 23).

The new prestige and new wealth for the university brought forth and formed a new breed of academic man. Nisbet uses terms like "higher capitalism," "a new capitalism," and
"academic capitalism" to describe the new situation in the American university. It was a "force that arose within the university and had as its most eager supporters the members of the professoriat" (33, p. 73). The new wealth brought new institutes, centers, bureaus, and an "entrepreneurial atmosphere" on the campus which developed a new class on the American campus—"a new bourgeoisie" (33, p. 102). Nisbet, using a perspective borrowed from Veblen, referred to work of the new academic bourgeoisie as "conspicuous research." He puts it in these words: "Ordinary research was not enough. It must be significant, bulky even to bring exemption from ordinary academic activities. One must obtain, if possible, the title of Director of Research or Research Professor" (33, p. 109).

The federal government's involvement with the university and the new breed of academic man had a "distinctly utilitarian bent, tied for the most part to industrial or military ends" (39, p. 6). Increasingly the university came to look more like "a center for industrial activity than a community of scholars" (39, p. 3). Ridgeway details some of the activities in the following way.

The first controlled chain reaction which led to the development of the atomic bomb was achieved in the laboratories at the University of Chicago. John Hopkins ran the Applied Physics Laboratory which developed the self-deteriorating proximity fuse. The radiation laboratory at MIT was the main center for radar research ... Many of the studies which led to the development of the hydrogen bomb were made by university scientists who spent their summers at Los Alamos; the father of the bomb, Edward Teller, of course, is from the University of California. The Lincoln Labs at MIT
carried forward work on radar defense warning systems, as well as missile guidance systems. The Jason Division of the Institute for Defense Analysis, a think tank run for the Defense Department by twelve universities, made studies for the military on missile reentry problems, counter-insurgency and technical uses of nuclear warfare in Southeast Asia. Professors at Harvard and MIT worked on building clever communication systems for the military, and others worked secretly during the summers on breaking codes (39, p. 6).

Given the above as an accurate description, it is little wonder that censorious students during the years of campus unrest dubbed the university as a "knowledge industry" and "knowledge factory" and that a discerning professor described his colleagues in the faculty meetings to be more like stud farmers or market analysts than men seeking the truth (16, p. 552).

Operation

The technological influence on educational operation was felt in the early decades of the twentieth century through the great preacher of the gospel of efficiency, Frederick W. Taylor, and his disciples. Though his influence was chiefly upon administration, the administrator, and professional administrative training programs, Taylor's ideas were adopted, interpreted, and applied to American education from the elementary schools to the universities (6, p. 41). The principal rated teacher efficiency and teacher rated the principal efficiency. Pupils, even the janitors, were rated as to their efficiency (6, p. 103). Callahan states that "American society was saturated with business-industrial
ideas . . . . American public education did little but respond to the dominant forces" (6, p. 120).

One outgrowth of these dominant forces was the "factory system" in education. The Gary Plan and its near relative, the Platoon School, were examples of "the application of scientific management to education" (6, p. 130). It was William C. Bagley in 1918 who named this administrative arrangement the "Factory System." The problem was that the division between administration and supervision was drawn too sharply, and this tended toward the factory system in school organization. The hierarchy established moved downward from school board or board of directors, superintendent as general managers, vice-superintendent as foremen, principal as boss, to the teachers as hands or routine workers (3, pp. 379-80).

Cubberley also saw the schools as a factory, but in a different sense:

Our schools are, in a sense, factories in which the raw products (children) are to be shaped and fashioned into products to meet the various demands of life. The specifications for manufacturing come from the demands of the twentieth century civilization, and it is the business of the school to build its pupils according to the specifications laid down. This demands measurement of production to see if it is according to specifications, the elimination of waste in manufacturing, and a large variety in the output (15, p. 57).

Cubberley believed that not only was the school a factory, but that the manufactured product is citizenship. "The public schools," he wrote, "are the chief factories of American citizenship, and the citizenship manufactured
represents the machinery with which our national life is carried on" (14, pp. 41-41).

The factory model continues to be the rule in the American organizational operation. In 1962 Clark observed that this pattern was still the way the school was organized for getting its work done—primarily a system of delegation. The controlling board delegated to officers who then delegated to subordinates.

The organization becomes a web of work jurisdictions, offices, and assigned responsibilities. There is a splitting of purpose from the most general at the top to the most specific at the bottom; purpose as the lowest level may amount to two turns of a bolt by a worker on the assembly line, or a daily lesson by the teacher. Coordination becomes a central task of officers, and internal communication one of their basic problems" (7, p. 171-172).

Two refinements in the structure of educational personnel of the factory model are differentiated staffing and team teaching. Nation's Schools describes the differentiated staffing concept in the following way:

There is no precise definition, but it implies a restructuring and redeployment of teaching personnel in a way that makes optimum use of their talents, interests, and commitments, and affords them greater autonomy in determining their own professional development. A fully differentiated staff includes classroom teachers, at various responsibility levels and pay—assigned on the basis of training, competence, educational goals, and difficulty of task—subject specialists, special service personnel, administrative and/or curriculum development personnel... and a greater number of subprofessionals and nonprofessionals, such as teaching interns and teacher aids 19, p. 43).
Trump offers a definition of team teaching:

The "team teaching" applies to an arrangement in which two or more teachers and their assistants, taking advantage of their respective competencies, plan, instruct, and evaluate in one or more subject areas a group of elementary or secondary students equivalent in size to two or more conventional classes, using a variety of technical aids to teaching and learning through large group instruction, small group discussions, and independent study (41. p. 318).

These two organizational arrangements viewed from the technological perspective can be said to be operational technologies, because they involve putting educational personnel in position of specialization for which they are best qualified (1, p. 17).

Another innovation in school structure related to technology is flexible scheduling. Flexible scheduling based on the assumption that students do not all learn at the same rate, that curiosity and interest provide ample motivation, and that the student can be trusted to handle his own schedule. As Allen in 1974 pointed out, this plan would have been all but impossible twenty years ago, but with the computer control systems available, flexible scheduling can be clean and organized. The computer can know all the combinations and keep up with programs set up for students. It can tell what is known and what needs to be known, not only about scheduling, but also "about the students, the administration, the teachers, and mounds of other related data needed to keep a school running" (1, p. 17).

This technique is part of the cybernetic and associated communications technology which tend to consolidate and concentrate power. Cybernetic technology includes computers
and all their associated hardware and social indicators, monitoring systems, and advanced communications technology (42, p. 5). Data acquisition and management systems provide a systems management capability of substantial complexity and power that is revolutionizing modern man's ability to control physical and social organizations (42, p. 2). The prospects for this type of technology are staggering.

These give man the ability to acquire and manage instantaneously huge quantities of data, a controlled capacity so great it must be regarded as a different kind, not merely in degree from previous human capabilities. The new ability permits previously impractical degrees of centralization of control of complex social operations, and has transformed both the industrial community and the government in the time since its introduction. The simplest examples suggest the power of this change. In the private sector, sophisticated communications technology has made possible the growth of the multi-national conglomerate. In the public sector, we need only contemplate the president's ability to act as a virtual battlefield commander in portions of the Vietnamese War, a battlefield commander half the world away from the action (42, p. 5).

A distinctive characteristic of technology is scale and its corollaries. Multiplicity and the options opened because of technology may be referred to as the "carpet of measured choice." For example, the size of the steam shovel of a few cubic yards capacity is almost microscopic when compared to "Big Muskie" used in strip mining. Or the scale of the small home-owned entrepreneur is minute when compared to the multi-national corporation. The size of social organization, transportation, and communication networks are a creature of modern technology (26, p. 33).
Drucker directs attention to the growth of modern universities and research centers. He reports that no university in the western world had more than 5,000 students before 1914. Today universities of 20,000 students are "medium sized." And the research laboratory has grown just as fast (19, p. 173). This technological concept of scale is evident in the examination of the American comprehensive high school by James Conant. Conant affirmed the concept of the comprehensive approach with its emphasis on general education, elective system and college-bound program. Conant was so enamored with the approach that he states, "I should like to record at this point my conviction that in many states the number one problem is the elimination of the small high school by district reorganization" (9, p. 40). Conant's reasons were financial considerations, low standards, limited scope of programs, and teacher shortages. His study led him to this conclusion:

The prevalence of such high schools—those with graduating classes of less than one hundred students—constitute one of the serious obstacles to good secondary education throughout most of the United States. I believe such schools are not in a position to provide a satisfactory education for any group of their students—the academically talented, the vocationally oriented, or the slow reader (9, p. 77).

Conant was concerned about all types of students, but his emphasis was on the academically talented. He was convinced that these students were not being sufficiently challenged, that they were not as a rule working hard enough, and that their program of academic subjects was not of sufficient
range (9, p. 40). Conant's study for the reorganization of the school district shows the technological temper. He suggested that specialists in school transportation, school construction, and school finance be asked to assist in the reorganization. "The states that do not join but remain with small schools," he warned, "cannot make their proper contribution to the national effort" (9, p. 84).

The scale, multiplicity, complexity syndrome is related to a principle of technology that Ellul designates as self-augmentation (21, p. 86). Once a new system is found and initiators give direction, the augmentation principle is set in motion and thousands of contributors are used to improve the technique. The automatic growth and self-generating process is tied to the natural growth of organizations. Two laws, that technology is irreversible and that technology involves geometric proportion, become operative when the self-augmentation principle is in motion. It retreats only when the civilization collapses (21, p. 86).

Ellul's notion of self-augmentation and Thompson's concept of organizational domain expansion interlace at the point of size and complexity. In his theory of organization Thompson's focus is on the behavior of organizations. He argues that "organizations do some of the basic things they do because they must--or else! Because they are expected to produce results, their actions are expected to be reasonable and rational" (40, p. 1). Through technical rationality
organizations they produce desired outcomes (40, p. 14). The core technology is that which produces and the organization must and does try to protect it from environmental influences (40, p. 20-23). Organizational action, however, does not rest on one single technology, but rather upon a technological matrix (40, p. 26). That matrix, that province, that domain, the organization identifies, protects, defends, and expands through consensus, power, strategy or competition, through a larger core technology, combination of core technologies, and multiple-component organization (40, p. 44). The university, for example, extends its domain by vertical integration, that is, in one direction through student recruitment and public relations, while the other direction through student placement and alumni support (40, p. 40). The university also may extend its domain by increasing the population served by attempts to increase the student body. It may offer Saturday classes, night classes, off-campus classes, conduct seminars and institutes (40, p. 42). Again, the university may extend its domain through increasing its objectives. Instead of being limited to the teaching and learning process, the university may seek to impose discipline and constraints in other matters such as health care, athletics, and student services (40, p. 43). Thompson shows how the university's domain in core technology is extended.

American universities in the last half century have proliferated with a great variety of new departments, institutes and schools. In some
cases these simply reflect the intensification of knowledge which results in new disciplines, and are structural reactions to unwieldy categories of knowledge. This type of splitting springs from . . . university technology (40, p. 47-48).

In order to reduce the possibility of contamination of the client by outside factors which might reduce or negate the effectiveness of the organization effort, Thompson mentions the university's attempt to be the "total institution." In this case, boundaries are placed around the client, and the university becomes "a place of residence and work where a large number of like-situation individuals, cut off from a wider society for an appreciable period of time, together lead an enclosed, formally administered round of life" (40, p. 43).

The scale and complexity of the upward drift, the control and operation within the structure of education, draw attention to the individual involved in the structure. Maley observes that "the trend toward bigness, whether it be in education, cities, group organizations, industry, business, labor, or government, frequently brings with it a tendency to diminish concern for the individual and his or her development" (32, p. 10). The larger and more complex educational systems become, the more techniques for mass handling to expedite the educational production and routinizing procedure for processing students in batches must be utilized. This approach, according to Clark, "discouraged serious concern with ideas on the part of most students. As
an anonymous student in the large class has long known, the class work that becomes routinized can be completed without serious thought—'copy it down and feed it back'" (7, p. 228).

A reader of English literature knows that the problem of routinizing is confined not to the contemporary world. Dickens recognized the difficulty with the approach in *Hard Times* in his satirizing of Mr. M'Choakumchild who along with "one hundred-forty other school masters had been lately turned out at the same time, in the same factory, on the same principle, like so many piano legs" (17, p. 6). As the "impersonality in education is extended, and fixed by the technical investment" (7, p. 285), it is doubtful that the psychological and social conditions can be established in which students can develop "broader understanding necessary for civilized man in a complicated society" (7, p. 283). Clark contrasts the mass processing operation with the simpler, smaller method: "Independent judgment, human sensivity, an understanding and appreciation of subtle human affairs have long been taught, if at all, by the close interaction of a teacher and a smaller group of students and disciples" (7, p. 283).

Berger puts the question of the individual in large, complex structures in the context of his discussion of modernization. "Modernization," he states, "brings about a novel dichotomization of social life" (5, p. 133). The dichotomy of social life is between the megastructures, the huge and immensely powerful institutions of the public sphere
such as the state, the corporation, labor unions, education, and the organized professions and the private life which is a result of, in Gehlen's word, "under institutionalization" (5, p. 133). Berger recommends what he terms mediating institutions of family, church, voluntary association, neighborhood, and subculture. Mediating structure, says Berger, is essential to both private life in order to provide individual meaning and identity and the megastructure to provide foundations and stability of social contract in the modern world (5, pp. 134-135).

In summary, Chapter IV has recorded research on the impact of technology on one of the basic elements of education—its structure. It was pointed out that social institutions, including education, are influenced by technology. Technology has had an impact on education most obviously through its inventions and products. In a broader context, however, technology has impacted education through organizational structure, technologically oriented leadership, technical methods of operation, and historical events related to technology that have determined education's function.

Chapter V will investigate another basic element of education, its purpose, as seen in the nature and needs of the student.
CHAPTER BIBLIOGRAPHY


CHAPTER V
TECHNOLOGY AND THE NATURE AND NEEDS OF THE STUDENT

Educational aims provide direction for education because they embody psychologically desired and ethically desirable values (6, p. 219). Traditionally, educational aims have been put forth from various values such as the ultimate end of human life, self-realization, cultivation of the intellect, social context, and growth. Those ultimate purposes are broken down into manageable intermediate aims or objectives like the Cardinal Principles of Education, for example (6, pp. 106-110). Brubacher is persuaded that there are no unalterably or eternally fixed educational aims, but they are constantly being refashioned. "Aims," he states, "arise out of concrete situations in which people are involved. Aims, therefore, must be tailor-made for the occasion . . . . We do not know our aims till a situation arises . . . ." (6, p. 111).

Each national crisis such as the Great Depression, World War II, the Cold War, the Russian launching of Sputnik, has caused debates as to what is appropriate education for American youth (31, p. 168). Few people would argue that modern technology, though not a crisis limited to a
particular event or specific time frame, is of such nature that it has not only affected man's life, but also his educational needs. George S. Counts in 1929 perceived this fact and called on educators to build a new American society Counts believed that the times were revolutionary in nature. "Today we are witnessing," he wrote, "the rise of a civilization quite without precedent in human history—a civilization founded on science, technology, and machinery, possessing the most extraordinary power, and rapidly making of the entire world a single great society" (10, p. 31). This truth was brought to the American consciousness by the unexpected technological ability of the USSR to place a satellite in outer space. The event caused a deep concern in the United States. The result was a vigorous reappraisal of American schools and colleges.

A Transformation of American Education

The United States following World War II experienced a crisis in popular education. Public sentiment for progressive education had begun to shift by the early 1940's and its popular form, the life adjustment movement, came under particular criticism. However, life adjustment education was merely a part of the larger crisis in American education which involved buildings, budgets, enrollments, teachers, inflation, communist expansionism, and the demands of industrial economy for trained and intelligent manpower.
Cremin viewed the situation as "the deepest educational crisis in the nation's history" (11, p. 339).

Life adjustment education was the root of W. H. Kilpatrick's impatience with formal learning and disciplines books, classics, history, and foreign languages. These traditional forms were replaced in the life adjustment scheme of things with projects, units, enrichment experiences, and new growth. This form of education was not formal learning but dealt with citizenship, family life, conservation, consumer education, leisure time activities and health (29, p. 144). "The appearance within professional education of an influential anti-intellectualist movement," observed Richard Hofstadter, "is one of the striking feature of American thought" (19, p. 323).

The writings of Arthur Bestor, according to Cremin, "constituted by far the most serious, searching, and influential criticism of progressive education to appear during the 1950's" (11, p. 345). He represented the growing dissatisfaction among the intelligentsia who believe that the ultimate purpose of education was intellectual training. Intellectual training, Bestor argued, is given through the academic disciplines. Cremin sums up Bestor's argument by stating, "True education, then, is the deliberate cultivation of the ability to think through training in the basic academic discipline: history, English, science, mathematics, and foreign language" (11, p. 345).
In the aftermath of Sputnik, professional educators did not "cut a very heroic figure." Broudy suggested that it was because school people derived the values of a good life uncritically from the social milieu rather than the emerging needs and values in a prospective understanding of social reality (4, pp. 133-134). Even though educational remedies for social problems were vigorously, reflectively, and critically discussed and there was a willingness to make accommodation to the cultural necessities, Broudy contends that these leaders of progressive education misconstrued these necessities. "The educational demands to science-based technology," states Broudy, "differ fundamentally from those generated by a social matrix based on private enterprise in the hands of small farmers, businessmen, artisans, and professional workers" (4, p. 136). Broudy argues that their fundamental assumption was no longer viable because massive collectivization had "radically changed the conditions and ground rules for achieving the qualities of life that were envisioned as essential to the individual rational man" (4, p. 138).

The warning had been sounded to the progressive educators years before by Bode in his Progressive Education at the Crossroad. The issue, according to Bode, was democracy. If progressive education could be successful in translating itself into the democratic philosophy and procedure, it would prosper. If it persisted in the one-sided absorption of the individual, then it would be left
behind (1, pp. 43-44). The dismal end came for progressive education because the conditions of the contemporary society were very much different from that which gave rise to it, and because it had failed to keep pace with the transformation of American society. "Had the Russian Sputnik never illuminated the Western pedagogical skies," concluded Cremin, "the movement would have died of its own internal contradictions. Sputnik may well have dramatized the end; but even so, there were few mourners at the funeral" (11, p. 185).

The Changing Nature of Work

The explosive rate of technological change has resulted in a growing range of complexity in contemporary life. Modern man has thus become more conscious of the strategic importance of education in such a society (27, pp. 6-7).

Drucker points out that the modern concept of work has been altered. "The substitution of knowledge for manual effort as the productive resource in work is the greatest change in the history of work," he states (13, p. 81). The modern worker has become a knowledge worker. The modern type of work and the modern worker requires education in mental training and skills rather than physical ones. Education has moved from being an ornament and luxury to the central economic resource of the technological society. As such, it replaces money as the index of status and opportunity (13, p. 82).
The United States has created the world's first service economy. As Harrison Brown has shown, at the end of World War II 55 percent of all workers worked in goods-producing industries. By 1974 two-thirds of all job holders were in the service sector. By the year 2000, the figure will approach 90 percent with ten percent producing foods and goods required to meet human wants (5, p. 62). A key element in the service economy is education. Jobs in health care, education, government services, research and development, entertainment, science-based industries, and jobs in the leading edge of economic growth such as computers, communications systems, information retrieval, electronics, teaching and health require educated personnel (5, p. 26).

Another aspect of the effects of the changing nature of work on educational needs is specialization. Boulding calls attention to the fact that there is now "specialization within specialization within specialization" and that reminds him of the old joke about the specialist who ends up knowing everything about nothing and the generalist who ends up knowing nothing about everything (2, p. 10). Clark, in his book *Educating the Expert Society*, looked at technology's effect on the role of education.

Our age demands army upon army of skilled technicians and professional experts, and to the task of preparing these men the educational system is increasingly dedicated. The ideal of the expert ascends over the ideals of the cultivated man, in the general society, and in education itself. . . . The expert versus the cultivated man, the specialist versus the generalist, the scientist versus the humanist, these are themes running
through the modern debate over education and intellectual life. The effect of technological advance is to increase the pre-eminence and power of the expert, and with this, to increase the commitment of education to technical and professional preparation (9, p. 3).

As evidence of the "expert" trend in the technological society, Clark points to the fact that General Electric, Union Carbide and other large corporations hire more Ph.D.s than does Harvard (9, p. 49).

The Triumph of Vocationalism

Among the forces behind vocationalism are professionalism, occupationalism, and technicalism. Not only do these forces mutually reinforce one another; they also have an impact on educational institutions. According to Clark, a change has occurred in higher educational institutions from the making of cultivated men to the training of employees. Colleges and universities have become the pre-employment training arm of industry and government (9, p. 50). He believes that education has become so fused with vocations that "it may be seen as a part of the economic foundations of society" (9, p. 46). Halsey follows this view as he comments that in every industrial society higher education is "the training institution for the skilled manpower required by a complex technology" (18, p. 120). Whyte also observed this fusion of campus and corporation from his perspective in 1957 of The Organizational Man, which was different from his own personal experience in 1939.
The union between the world of organization and the college has been so cemented that today's seniors can see a continuity between college and the life thereafter that we never did. Come graduation, they do not go outside to a hostile world; they transfer . . . . The two have been so molded that it's difficult to tell where one leaves off and the other begins (33, p. 69).

Whyte augments this view by drawing attention to the descent of recruiters from corporations that has become a built-in regular feature of campus life every spring. He contends that United States education is preparing the youth for the organization system (33, p. 86).

The tendency to vocationalize and promote a vocational subculture is due to the technological ideology of the modern world. As schools, colleges, and universities compete in student recruitment and for financial support, reputation and image in relation to the contemporary ideology is critical. Large, technologically-produced educational enterprises, therefore, are tooled to handle and to train efficiently large numbers in diverse fields for a technological society (9, p. 216, 228).

One area that demonstrates the ascendancy of the vocational thrust in education is in the field of guidance and counselling. According to Broudy, the influence of life-adjustment was felt more in the guidance and counselling services than in the instructional program (4, p. 135). One Rockefeller report in 1958 projected an accelerated increase in skill and training that would be needed by America's
labor force because of the impact of automation, specialization, research and development, and the military threat of technological inferiority. This situation demands goals to identify and guide students to develop their full capacities (27, pp. 9, 28). Fisher and Thomas agree that the world has become so fantastically complex and that occupational categories have become such a bewilderment of labels and sublabels that vocation guidance is almost an absolute necessity (15, pp. 92-93). The educational historian, H. G. Good, also supports the notion that "the growth and specialization of industry and the rise of new skilled and technical occupations have increased the need for guidance" (17, p. 446). The key concept relating to guidance activities for Rudolph was concentration. Curriculum guidance, aptitude testing, and career counseling were natural outgrowths of concentration, the elective system, experimental psychology, and vocationalism. "Any pretense," wrote Rudolph, "that these services were peripheral to the educational experience rested on professional ignorance and arrogance" (28, p. 251).

Since guidance is strongly emphasized as essential to the success of the technological system, as many teachers as possible should be trained to take part in it. It is also suggested that when possible to have a special guidance officer to supplement the teacher where technical expertise is required (27, p. 30). According to Clark, the guidance counselor is the most significant role emerging in the
educational organization. Because of the nature of his job, the counselor stands equal with the teaching in the progress and destiny of the student (9, p. 179). Rudolph notes that guidance and testing services were strongest on the college and university level in the state institutions where vocationalism had its greatest impact, whereas organized guidance lacked support in the liberal arts institutions where graduates could assume membership in the "establishment" in the power centers of America (28, pp. 251-252).

The purpose of guidance is to stimulate the individual to develop his potentialities. Those who are in need of the most help are the retarded, the delinquent, and the able student (27, p. 30). The process involves both advice concerning the young person's educational problems and the most appropriate course of study (27, p. 30) and also assisting the student in alignment of talent to career choice (9, p. 179). In this way, the educational system serves to match person and occupation in order to reap the greatest reward (15, p. 93) without prodigious waste of time and effort to the individual and society (9, p. 179). Seen from this perspective, the education system selects, sorts, and chooses those who are to be trained and distributed in the various occupations by sorting and defining life changes (9, p. 44).

It is acknowledged that any educational system is a great sorting out process (27, p. 28; 30). The close
relation of advanced technological societies and education causes concern that education becomes a "talent farm" and a "massive people processing" enterprise (8, p. 513). Abuse and distortion of education's power of its role in the economy and the system of stratification as an agent of selection, training, and occupation placement of individuals is problematic (9, p. 38; 18, pp. 118-127). The Rockefeller report recommended that the process of guidance must be carried out "mercifully and generously" (27, p. 29). The admonition of Fischer and Thomas was that it must be done in the "spirit of inquiry" (15, p. 93). A case in point is the attempt to identify talent through large scale testing programs. Basic considerations in testing are that they are effective but limited, no single test is conclusive, and they are to be used along with other data. The Rockefeller Report words are: "We cannot measure the rare qualities of character that are a necessary ingredient of great performance. We cannot measure aspiration or purpose. We cannot measure courage, vitality or determination" (27, p. 29).

Guidance and counseling by no means have universal support. Karl Popper's criticism of a selection process in education that begins with Plato's assumption that a task of education is to select future leaders and train them for leadership, is an assumption, according to Popper, still taken for granted. Selection is an impossible task and it
should never be the task of an educational institution. In Popper's words:

This tendency transforms our educational system into a race-course, and turns a course of study into a hurdle race. Instead of encouraging the student to devote himself to his studies for the sake of studying, instead of encouraging in him a real love for his subject and for inquiry, he is encouraged to study for the sake of his personal career; he is led to acquire only such knowledge as is serviceable in getting him over the hurdles which he must clear for the sake of his advancement ... . This impossible behavior for an institutional selection of intellectual leaders endangers the very life not only in science, but of intelligence (26, pp. 135-136).

Broudy's criticism of the stratification of technological society is a bit more subtle. It rests on the creation of an elitism who understands technology and the rest who are merely users. "A scientifically literate public is not necessary in a mature technological society, albeit a competent scientific elite is indispensible," he states (3, p. 25). "Technological maturity puts a premium on the elite: a governing elite, an industrial, military, taste-making elite. The many," argues Broudy, "will live--presumably quite well--on the brains of a few" (3, p. 26). Broudy contrasts a person's function in life in an agricultural era with that of one living in the technological society. Then, everyone knew all there was to know about making a livelihood by farming. In the technological society, with its diversity of occupations, specialization, and fragmentation, people are dependent upon others for
livelhood. It is not necessary to know all about technologies as it was in farming (3, p. 26).

Ellul's comment about vocational guidance is founded on the spurious claims it makes for itself which are not in correspondence with technical reality. There are no natural aptitudes, and therefore vocational guidance could not possibly find them. Vocational guidance is merely a technique in a complex of other techniques (14, p. 359). Human potentiality is flexible. Vocational guidance simply modifies those potentialities "in accordance with the suggestions of other techniques" (14, p. 360). This theme is picked up by Violas: "Changes in career patterns indicate not merely flexibility of human potential, but also the influence of guidance techniques" (32, p. 196). Vocational guidance has to work through the individual's adaptability. Since education must respond to needs, forecast must be made to determine occupational structure. "The individual," states Ellul, "must be educated and adapted in advance to his future job as a function of the anticipated technical progress" (14, p. 34). This results in what Ellul calls an "intrusion into the life of the individual" through "rigorous adaptation of the individual to the world of technique" (14, p. 361). "So," contends Ellul, "in isolation from other techniques, vocational guidance is useless" (14, p. 362). From this context, then, vocational guidance becomes "a means for subordinating men to the requirements of economic technique" (14, p. 362).
Specialization and General Education

By mid-twentieth century, general education was an idea that was in distress (7, p. 164). Rudolph is convinced that "general education was not an expression of the dominant culture. It spoke for a counter culture that acted as if it were the culture, it was an expression of the 'establishment'" (28, p. 261). Therein Fischer and Thomas see education faced with a paradox. "On the one hand, we live in an age of increasing specialization, but on the other, our analysis leads us to recommend a vigorous general education for all" (15, p. 160). Levine argues the same point: "With an increasing technological need for greater specialization, general education is increasingly important to provide a basis for common humanity among people" (21, p. 50). The Rockefeller Report affirmed that the trend toward specialization demanded individuals whose education and experience included both depth and breadth. People who, though specialists, did not allow themselves to become captives of their speciality. The report defined these people as "gifted generalists: men with enough intellectual and technical competence to deal with the specialists and enough breadth to play more versatile roles—whether as managers, teachers, interpreters or critics" (27, p. 11).

The Harvard Red Book distinguished general education which looks to the student's life as a responsible human being and citizen, from special education, which looks at the student's competencies in some occupation (16, p. 51). The
paradox is again evident. General education seeks to unite men, while specialization divides men according to their individual competencies (28, p. 256). Levine agrees with the point that specialization isolates people, underlines their difference, and is, in this sense, divisive, while general education is a commonality sufficient to surmount the difference in vocation (21, p. 50).

Hutchins addressed the question of what kind of education is needed in the technological society. Science and mathematics are essential to the education that the world needs for they are the basis of technology and thus have a claim on every citizen. Mathematics is an intellectual technique and in many subjects to think at all is to think like a mathematician. However vital an ingredient this is in the proper education today, Hutchins argues for a liberal or liberating education that produces a certain detachment in order to develop critical standards that can apply to one's own person and society. There is need for a "certain critical distance" to comprehend a society (20, pp. 102-103). Fischer and Thomas specify that one of the areas where critical powers come into use is careful and systematic consumer education. The school needs to develop in students a "general critical ability" against clever slogans, shapely girls, and status symbols (15, p. 159). Margaritis questions whether or not education in industrial societies can solve the problem it confronts in trying to detach itself "in judgmental ways from contemporary massive pressures" (22, p. 95).
Mounier thinks technical education is the worst possible education for our culture. He considers the machine to be a most powerful force making for depersonalization. He sees faith, hope, and charity no longer existing but as having been replaced by security, economics, ambition, and social mobility. Mounier would have men become men of dialogue, to raise questions, to challenge comfortable assumptions, and to act as catalysts (23, p. 94).

The technological age raises the question of how to grow cultivated experts. "To train men technically, we now know, is relatively simple," states Clark. "The difficulty lies in finding the inclination, the time and the ways to combine the technical training, simultaneously or in sequence, with an education in the basic sciences, the humanities, and the social sciences" (9, p. 290). Attempts have been made to bring broad understandings into technical programs of study and to place specialized training in a liberal arts setting. "Yet," remarks Clark, "the underlying trend is for marked specialization and separation of fields of knowledge, making it even more difficult to attain an adequate combination of depth and breadth, of 'education' and training" (9, p. 290).

Hutchins recalled the words of Sir Richard Livingstone:

"The Greeks could not broadcast the Aeschylean trilogy, but they could write it. We can broadcast it--if we can get the sponsor--but can we write it? If we cannot, it may be because science and technology have shifted our attention away from the issues with which the trilogy is concerned" (20, p. 80).
Knowledge and Learning

Drucker recommends that education in modern society should have a knowledge foundation. Education in the craft skills of yesterday must be replaced by the education of technologists. In other words, people need to be "technologists" rather than "skilled craftsmen." The way, according to Drucker, to teach a skill today is by putting it on a knowledge foundation through a course of studies. Drucker is not particularly concerned about the number of people who are purely theoretical, because we need only a small number of them. "But we need an infinite number of people capable of using theory," he states, "as the basis of skill for practical applications in work . . . . The ablest of the young, the most gifted intellectually, the most brilliant ones need, even more the dimwits, the ability of the 'technologist' to apply knowledge to work through a knowledge-based skill" (12, p. 318).

Drucker has more in mind than just new subjects. Rather, it is an approach to design education on different assumptions (12, p. 319). Seeking new assumptions for education today, he asks what school age youngsters need to know.

"We know that the most important thing they will have to learn is not this or that subject matter. The most important thing they will learn is how to learn. The most important thing, in other words, is not specific skills, but a universal skill—that of using knowledge and its systematic acquisition as the foundation for performance, skill, and achievement" (12, p. 320.)
From this position Drucker argues for continuing education, not mere extended education, as the proper way to proceed. Today's educational assumption must be that students go from one level of education to the next higher one, and that as adults they will return more than once (12, p. 320).

Another important component in Drucker's theory of education is his concept of the structure of knowledge. He contends that since knowledge has become central to our society, this fact changes the position, meaning, and the structure of knowledge. Traditional dividing lines between disciplines no longer hold firm and are, in fact, increasingly meaningless (12, p. 349). Drucker thinks that there has been a shift away from disciplines as the center of teaching and learning. He explains this shift in the following way:

The most probable assumption is that every single one of the old demarcations, disciplines, and faculties is going to become obsolete and a barrier to learning as well as to understanding. The fact that we are shifting rapidly from a Cartesian view of the universe, in which the accent has been on parts and elements, to a configuration view, with the emphasis on wholes and patterns, challenges every single dividing line between areas of study and knowledge (12, p. 350).

An additional facet of the new structure of knowledge is that knowledge and the search of it are organized around areas of application. Formerly, knowledge was organized around a discipline with its faculty and departments. Increasing within the last several years interdisciplinary work brings men from all disciplines, ranging from economics
and from agronomy to art history. Interdisciplinary work organizes educational institutions toward areas of effectiveness and determines its direction (12, pp. 351-352). In other words, Drucker means that a shift has taken place in the meaning of knowledge from being an end in itself to becoming a means:

What used to be knowledge is becoming information. What used to be technology is becoming knowledge. Knowledge as the central energy of a modern society exists altogether in application and when it is put to work. Work, however, cannot be defined in terms of disciplines. End results are interdisciplinary of necessity (12, p. 352).

This is not to indicate the complete demise of the disciplines. The disciplines are tools, resources, and specialities. They become in the new structure of knowledge what in organizational theory is known as "staff services," which provide information service and advice (12, pp. 352-353). Drucker allows room for men in a specialized discipline, but not for many:

The greatest need is for the man who can develop and teach the application to end results of knowledge and information drawn from diverse disciplines.

We need further the man who can, in his own work, bring together knowledge and skills from a great many disciplines and integrate them into effective application outside the university. He is today not officially recognized—but he is the real "star" in today's university (12, p. 355).

The Cognitive Need

The change in the structure of knowledge is related to the knowledge base in society. Drucker deplores the
mediocrity of much of American education as it was before Sputnik. In his opinion, this was a weakness of America's knowledge base. Conversely, he would encourage everyone to become knowledgeable—both the "great man" who creates new knowledge and the "journeyman" who converts new knowledge into everyday action.

For its knowledge base, a modern society needs both scientific and technical people and people in the humanist, political, economic and behavioral disciplines. Above all, it needs people capable of understanding technology while not themselves scientists or engineers. And it needs people capable of understanding the humanities, the economic and political discipline, while not themselves humanists. It needs people who can put knowledge to work rather than people who are the prisoners of discipline or method (12, p. 358).

The question of freedom of modern man is raised by Hutchins. "Can the mind of modern man be set free if he does not understand the age in which he lives? Can the dream of controlling technology be realized if modern man does not understand technology" (20, p. 95)? Toward an answer to his question, Hutchins offers a two-part answer: the society is becoming more technological in character, and the more technological it becomes, the less ad hoc education there can be. The more rapid changes produced in society because of technology, the less value ad hoc education has. "It now seems to be safe to say," asserts Hutchins, "that the most practical education is the most theoretical one" (20, p. 8). Again, he observes, the incursion of new methods of communications and information service into education is
having an impact on libraries, encyclopedias, and instruction. As a result, training and transmission of information increasingly receive less attention from education. The collection, storage, retrieval, and distribution of information by electronic means, for all practical purposes, removes from education the task of transmission of knowledge. Hutchins admits to avoiding as "too dreadful to contemplate" discussion of the prophecies frequently made that information will be accumulated in electronic banks and transmitted to the human nervous system by means of coded electronic messages" (20, p. 76). If training and transmission of information are no longer the primary concern in educational systems, Hutchins asserts that understanding is left for the primary mission of education (20, p. 76). Peters concurs that, in today's artificial world produced by science and technology, knowledge and understanding of the human condition should be one of the aims of education.

It goes without saying that, in an industrial society, an individual is severely handicapped if he lacks the basic skills of literacy and numeracy, for these are necessary for being at all at home in all three types of worlds [natural, interpersonal, and socio-political]. Urbanization, however, has created a shield between modern man and many of the features of the natural world with which his less literate forefathers had to come to terms. But science and technology, which have been largely instrumental in creating this artificial environment, have brought in their training a host of new things to understand. So modern man, in confronting the natural world, has to understand something of gas, electricity, and pollution, as well as more enduring phenomena such as fire, snow, the seasons, and the properties
of the soil. He must also develop a modicum of practical knowledge in dealing with them. Further countless contingencies in an industrial society range from repairs to the water system to first aid to the injured, to deal with that for which help is not readily available. Under our present system of schooling it tends to be only the nonacademic child who gets any systematic training in such practical skills. There has been too little thought about the role of practical knowledge in education that is not part of training for a particular job (24, pp 475-576).

The Affective Need

The educational purposes in a technological age incorporates the affective domain. Boulding believes that "the greatest and most fundamental purpose of education of children and young people is to increase their chances of living useful, happy, and creative lives in the next fifty or sixty years" (2, p. 8). This is accomplished not by preparing them to live in this present world but rather the world of the future. He declares that the great task of education is to transmit the "neosphere" that includes not only the cognitive but also valuational structure of all human nervous systems from one generation to the next (2, p. 8). Whyte recognizes that "the organization man" needs an education in "the intellectual armor of the fundamental disciplines." In an age of group action and specialization, however, what the student needs is "some kind of foundation, some sense of where we come from, so that he can judge where he is, and where he is going and why" (33, p. 86).
It is proposed by Popper that a worthy aim for education would be to give students what they so urgently need in order to be free, independent, and capable of choosing for themselves—a sober combination of individualism and altruism (25. p. 275). The whole problem, according to Popper, is that the educational system has rested on the romantic combination of egoism and collectivism. The result has been a system whose ultimate basis is power (25, p. 275). It is also the opinion of Hutchins that the object of education the world over is to gain riches and power. Educational aims reflect cultural aims. If a society uses technology to gain prosperity and power and to accelerate technological change without thought of the social, moral, and ethical consequence, then this nation will be mirrored by education. Hutchins suggests this situation recalls the words of Ellul (20, p. 25).

Instruction must be useful to life. Today's life is technique. It follows, then, that instruction must above all else be technical . . . . Education . . . is becoming oriented toward the specialized end of producing technicians; and, as a consequence, toward the creation of individuals useful only as members of a technical group, on the basis of the current criteria of utility—individuals who conform to the structure and the needs of the technical group. The intelligentsia will no longer be a model, a conscience, or an animating intellectual spirit of the group, even in the sense of performing a critical function. They will be the servants, the most conformist imaginable, of the instruments of technique . . . . An education will no longer be an unpredictable and exciting adventure in human enlightenment, but an exercise in conformity and an apprenticeship to whatever gadgetry is useful in a technical world (14, p. 349).
What is needed, asserts Popper, is an "ethics which defines success and rewards." We are beginning to realize that sacrifice may mean just as much, or even more," writes Popper, "when it is made anonymously. Our ethical education must follow suit. We must be taught to do our work, to make our sacrifice for the sake of this work, and not for praise or the avoidance of blame" (25, p. 275). There is certainly something like a romantic aesthetic element in education (25, p. 276).

In summary, Chapter V has recorded research on the impact of technology on one of the basic elements of education—its purposes as they are seen in the nature and needs of the student. It was pointed out that dramatic technological advance by a rival nation spurred the United States to educate its people to meet the challenge of survival in the technological world. Moreover, the technological world has changed the nature of work and wrought a new concept of knowledge. These conditions have produced a need for specialization in education. Specialization, in turn, has required the support of counselling and guidance. Also, it was indicated in this chapter that educational needs of students demand not only the cognitive but the affective domain in learning.

Chapter VI will focus on another basic element on which technology has had an impact—the curriculum.
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CHAPTER VI

TECHNOLOGY AND CURRICULUM

Boulding compares human knowledge to concentric circles with the most basic and fundamental thing in the middle. The critical question for curriculum is "What is the essential core? What should be the prerequisites of the core? (4, p. 10). In the Durkheimian thesis education is a reflective and active process. For him it is impossible to understand curriculum and pedagogy without analyzing the broader social movements that generate it. Changes in educational ideals and practices originate from the larger society and the social structure in which the school is located (25, p. 89). According to Durkheim:

Educational transformations are always the result and symptom of the social transformations in terms of which they are to be explained. For a people to feel at any given moment the need to change its education system, it is necessary that new ideas and needs have emerged for which the old system is no longer adequate (15, p. 92).

What was the societal condition that has given shape to American education? It is Brzezinski's opinion that, prompted by technology, particularly electronics technology, a third revolution is changing the basic institutions and values of American society. Three Americas are being created. First, there is the industrial America of security and leisure. Second, there is the first America which
traditionally has fallen behind but is now attempting to find a new social position. Third, there is the technetronic America symbolized by the new complexes of learning, research, and development. The technetronic America links education to society and creates new unprecedented opportunities in experimentation, innovation, fine arts, and culture (7, p. 200). Brzezinski refers to Bell's discussion regarding the social transformation coming to pass through technology. Key elements in this theory are material goods and living standards, a new social class composed of engineers and technicians, a new mode of thought of functional relations and quantity, a new interdependence and social relationship made possible through improved transportation and communication, and a new ethical perception that considers by time and space (7, p. 203).

In addition to the societal conditions at large, there was an internal stirring within education itself. Harold Benjamin surveyed the problem in terms of a changing social order. His book, The Saber-tooth Curriculum, spoke of a curriculum for a particular society, which was good for its time. However, the conditions of society had changed, but the curriculum continued (2). Heath records that curriculum reform had its origin soon after World War II by critics of the status quo in schools, augmented by academic schools who were troubled by the decline in standards and outmoded curriculum, and given impetus by international threats and
by the launching of Sputnik I and the debate which followed (39, p. 1). The Sputnik event aroused the American public's interest in curriculum, especially in the areas of better science instruction and better preparation of teachers (9, p. 30. Woodring gives the curriculum reform movement no designation or name, but describes it as

... including a new emphasis on greater rigor and high standards and a move away from such goals as "life adjustment" and toward broader goals that will make possible the survival of the nation and the expansion and further development of culture. It made use of new technological developments such as educational television and teaching machines and programmed learning that goes into them. It includes programs for the reallocation of the variables of time, space, and personnel in the schools and provides for team teaching and regrouping of children to facilitate learning. It places less emphasis on social and recreational activities and more emphasis on intellectual development (39 pp. 1-2).

Heath further comments that the curriculum revision involved the preparation of new and improved educational materials such as textbooks, supplementary reading, visual aids, laboratory equipment, and examination for use in the classroom. This concept of curriculum reform is a departure from the 1920s, 1930s, and the 1940s when curriculum was thought to be the total experience of the child (39, p. 5).

A New Curriculum Focus

The debate over curriculum, between professors of academic disciplines and professors of education, often centered around "subject centered" curriculum versus "child centered" curriculum. Critics of existing education received
their greatest support from the launching of Sputnik. Americans believed that they had lost world leadership and the blame fell on the public schools, especially child-centered education. Many critics compared the United States to Russian education and found United States education wanting. The Russian youth had a more rigorous diet, thus resulting in their superiority. Hyman Rickover charged that the lack of science, mathematics, and other related subjects weakened the American system. Rickover charged that professional educational leaders, not the teachers, were the voice of education, and that the philosophy of the whole country placed a higher value on material possessions than on the intellectual life and the life of the mind (29, pp. 182-183).

It is Bernal's judgment that "the Sputnik's effect on stimulating American scientific education was perhaps its most remarkable by-product" (3, p. 815). The Rockefeller Report reminded Americans that the crisis in science was not an invention of the newspapers, or scientists, or the Pentagon, but was indeed a real crisis. Again, the report emphasized that the USSR was not the "cause" of the crisis. The cause of the crisis was the breath-taking movement into a new technological era. The USSR had served only as a rude stimulus to awaken Americans to that reality (30, pp. 27-28).

The heart of the matter is that we are moving with headlong speed into a new phase in man's long struggle to control his environment, a
phase beside which the industrial revolution may appear a modest alteration of human affairs. Nuclear energy, exploration of outer space, revolutionary studies of brain functioning, important new work on the living cell—all point to changes in our lives so startling as to test to the utmost our adaptive capacities, our stability, and our wisdom (30, p. 28).

The immediate implications for education were evident, the report concluded. America needed an ample supply of high-calibre scientists, mathematicians, and engineers (30, p. 28). A National Education Association report, Contemporary Challenge to American Education, recommended the short range goal of an emphasis on higher education, particularly at the graduate level, for mathematics, science, and technology, the intermediate range goal of secondary and higher education level recruitment, training, and retraining of teachers in mathematics, science, and language, and the long range goal of infusion of public and private support on a massive scale (16, p. 16).

The period of the late 1950's and 1960's was one of curriculum innovation. An example is a project of the Physical Science Study Committee under the leadership of Professor Zacharias of MIT. The project proposed changes in the instruction of high school physics. The committee, in two years time, 1956-1958, provided textbooks, homework assignments, laboratory guides, films, teachers' guides, laboratory apparatus, and classroom and college entrance tests. The committee gave its materials to a publisher, its equipment to a manufacturer of scientific apparatus, and its
films to a film distributor for production and distribution. The National Science Foundation initiated and supported a program of summer institutes, teaching teachers how to use the new materials. Although the materials became available only in the year 1958, it was reported that by 1963-64 and 1964-65, forty to fifty percent of students taking high school physics were studying the new materials (10, pp. 229-232).

Curriculum was examined by Jerome Bruner in his book *The Process of Education*. For Bruner structure was considered important in learning. Primary stress was placed upon developing concepts and principles. Schools were asked to provide the structure for such learning. This way of learning would be helpful in the future in specific application to tasks that are highly similar to those originally learned and in transfer of principles. Coupled with these is an attitude of a sense of excitement about discovery of similar ideas and a sense of self-confidence in one's ability to see these relationships (6, pp. 17-20). Bruner was persuaded that structure for learning could best be provided when curricula were devised by scholars who are people of vision, competence, and understanding.

The experience of the past several years has taught us at least one important lesson about the design of curriculum that is true to the underlying structure of its subject matter. It is that the best minds in any particular discipline must be put to work on the task . . . . Only the use of our best minds in devising curricula will bring the fruits of scholarship and wisdom to the student just beginning his studies (6, p. 19).
The reliance upon experts in each discipline as designers of curricula was looked upon with disdain by Broudy. The idea of the educational crisis being solved by other than professional educators was distasteful to him. He encouraged educators to regain educational initiative. Broudy's advice to educators was that "we must examine what vocation, citizenship, and self-development mean in the mass democratic society, and what these new meanings call for in the way of curriculum" (5, p. 138). The threat to professional educators' leadership is seen in other literature. Drucker thinks that education is too expensive to be accepted without questioning and that it has become too powerful to go unchallenged. He reasoned that education must become a public issue because "education has become too important to be left to the educators" (12, p. 313).

Curriculum and the Two Cultures

It was C. P. Snow in his "two culture" thesis that popularized the dichotomy of science and the humanities (32). Others have made it a trichotomy by making technology a separate entity (31, p. 6). If, however, one connects science and technology either by taking technology as "applied science," or by looking at science as based on technology, or seeing a reciprocal relation between the two (35, pp. 372-373), there can be profitable discussion.

Levi sees a difference between the humanities and science to be the objects to which they address themselves,
the faculty of mind which they engage, and the language in which they are expressed (27, p. 56). From Whyte's standpoint, the conflict is not so much between science and the liberal arts as it is between the fundamental and applied disciplines. He prefers the fundamental, basic, and general educational approach as opposed to the narrow specialization and vocation approach as illustrated by business education (38, pp. 89-101). Drucker, however, sees a close relation between technology and the humanities. He believes that, although technology is a major element in our lives, questions regarding technology are not simply technological problems. They are human problems (14, p. 89). Hook agrees that there are no important human problems that are purely technical problems, but all of them pose choices. Thus, values and value judgments are at the heart of the great decisions that man makes. Hook's conclusion is that a liberal arts education must undergird and accompany any other type of education (22, p. Xll). Knowledge of history and evaluation of technology, for example, are essential to an understanding of human history. "We must understand the history, the development, and the dynamics of technology in order to master our contemporary technological civilization," states Drucker (14, p. 89). It is important to know what technology does "to man as well as for him" (14, p. 89).

Various approaches have been suggested to handle the two-culture question. Some scholars emphasize the general
education or liberal arts approach as the dominant factor, while others stress the science point of view with the humanities playing an ancillary role. A third group would take the approach of synthesis and convergence in which science and the humanities are seemingly one.

Hook sketches the areas of study that he thinks constitute the correct curriculum substance. He classifies them under six categories:

--To communicate clearly and effectively with others, to comprehend and to express.
--To know about the body and the mind, and man's place in the universe.
--To know how the society functions, its history, economics, and social forces shaping the past and the future.
--To be informed of the values and ideas of the times, the cause, consequences, costs, and differences in value judgments.
--To acquire a sense for evidence, relevance, and canons of validity, a defense against gullibility.
--To be inducted into the cultural legacies of civilization, to develop and discipline the sensitivities to bring delight and enjoyment through art, literature, and music (21, pp. 32-33).

Conant defines a liberal education as a process and an aspiration. The process begins in childhood, is carried on through years of schooling, and is tested by the momentum it sustains in adult life. It aspires to that which is beyond, rather than what it embraces. This education aims to enlarge understanding, to develop a respect for data, and to strengthen the ability to think and to act rationally. It seeks to produce an informed, inquiring and judicious habit of mind rather than particular abilities (11, p. 92).
Conant names five areas to be studies on the college level: philosophy, sociology and anthropology, economics, political science, and psychology (11, p. 97).

Lord James of Rusholme (Eric John Francis James), in his article "Liberal Education in the Age of Specialization," acknowledges the necessity in the modern world for specialization. Today's demands are for hard thinking and depth of concentration in one field. Outside of this hard core of specialization, James recommends a diversity of courses for purposes of support, stimulus, and leisure. Support studies are certain preliminary skills necessary to the pursuit of specialization. They are utilitarian in nature, like driving a car. Stimulus studies are designed to introduce the student to the great ideas and great books to help him to see the relevance of Plato, or Homer, or Matthew Arnold, or Conrad, for himself as a citizen or person. This level is quite superficial. It cannot be a "bundle of general education" and it must not be below the dignity of the "prof." Leisure studies allow for time to think, read, and talk about what is learned. It should not fill all the time available with requirements of busy work, and it should not be overtaught (24, pp. 176-177).

"There is only one subject-matter for education," wrote Alfred North Whitehead in his Aims of Education, "and that is life in all its manifestations" (37, p. 18). The study of life, in Whitehead's view, occurs in a rhythm or cycle. The first stage of romance is found in the vividness of novelty.
Stage two is precision or the exactness of formulation. The third stage is generalization, that is, a synthesis similar to the Hegalian one. Education, according to Whitehead, should consist of a continual repetition of this rhythm (37, pp. 29-30).

John Platt thinks that we need nothing less than the application of full intelligence if the society is to solve pressing problems. He recommends fully interdisciplinary, research teams to put together technical methods, organization designs, and social inventions that can be widely enough accepted to be effective. Platt argues for the constructive use of science in the present, crucial situation. In the past, science has been used for intellectual pleasure, control of nature, and war. Now, he admonishes, "The task is clear, the task is huge. The time is horribly short . . . . The whole human experiment may hang on the question of how fast we now press the development of science for survival" (28, p. 178).

The importance of modern science in the solution of philosophic problems is a theme given prominent consideration in the work of Werner Heisenberg. Heisenberg develops a thesis put forward by Carl J. Burckhardt, that in an age when the great watchwords and ideals of the past have so lost their ordering power, science and technology may take on the role of bringing order into thought. He shows broad connections that represent the unity of life on earth. Heisenberg argues that sober and careful use of science and
technology can point to the ordering forces of the present age. Although it may appear to the superficial observer that science and technology are increasingly fragmented into special disciplines in which the individual no longer can see an overall connection, Heisenberg contends that on closer examination the movement is in the opposite direction. "Through the ever-increasing abstraction, which is taking place before our eyes in the exact sciences and is also gradually invading wider regions of intellectual inquiry," states Heisenberg, "very broad connections, hitherto closed to human consciousness, are becoming visible not only within a given science but between different sciences" (20, pp. 66-67).

Using modern mathematics, modern atomic physics, and modern biology as examples, Heisenberg shows how larger connections of these phenomena are made by way of law through pressing forward past the regions of nature that are directly experienced by the senses to those observed by the most elaborate resources of technology to a degree of abstraction previously unknown in science. Heisenberg's comments of conclusion border on the visionary, even mystical, as he describes the unity of mind and spirit to which science and technology reveal.

It seems, therefore, that developments in many different fields of science and technology are running in the same direction: away from the immediate sensory present into an at first uncanny emptiness and distance, whence the great connections of the world become discernible. . . . From the cosmic distances to which man can penetrate by means of modern technology, we see
perhaps more clearly than from earth itself the unitary laws whereby all life on our planet is ordered. That at this point the chance arises of penetrating into that initially uncanny emptiness and distance which technology and science have led us to, not only with the mind but also with the heart, is shown delightfully in the tale by the French aviator Antoine de Saint-Exupery. His little prince, who looks after his small planet, cleans out the volcanos and waters a rose, lives in that distance, but yet learns that "On ne voit bien qu'avec le coeur, l'essentiel est invisible pour les yeux." [One sees well only with the heart, the essential is invisible to the eyes.] (20, pp. 68-69).

There is yet an important place for the "over-specialized," or "conscientious specialist," but according to Heisenberg, he can no longer play a leading role. "For whether it be in physics, chemistry, biology, or medicine," he states, "we are compelled to look out across the frontiers into neighboring territory, and often beyond this territory into philosophy itself..." (20, p. 209).

The close relation of science and the humanities is seen in the concept of the point Omega in the works of Pierre Teilhard de Chardin. Omega is a point of "supreme synthesis" in the Noosphere, the sphere of the mind which results from the process of convergence. This "universal center" is the climax and final condition of the Universe resulting from "the gradual concentration of its physico-chemical elements in nuclei of increasing complexity, each succeeding stage of material concentration and differentiation being accompanied by a more advanced form of spontaneity and spiritual energy" (33, p. 81). The two factors which drive toward the Omega point are increase of knowledge about the universe and
the unification and intensity of the system of human thought; in short, science and mankind. "Taken in the full modern sense of the word," states Teilhard, "science is the twin sister of mankind" (34, p. 248).

Teilhard distinguished three principal lines of advance toward the Noosphere and thus the point Omega. Two are relevant for this study. There are: the organization of research and the concentration of research upon the subject of man (34, p. 278). As a child of the transition period, man is clinging to outworn habit and is unconscious of his new power. Thus, man has "put Pegasus between the traces . . . . But the moment will come," prophecies Teilhard, "when man will be forced by disparity of the equipage to admit that science is not an accessory occupation for him but an essential activity, a natural derivative of the overspill of energy constantly liberated by mechanization" (34, p. 279).

The concentration of research upon the subject of man speaks of an era of human science. Teilhard predicts that "Man, the knowing subject, will perceive at last that man, 'the object of knowledge,' is the key to the whole science of nature" (34, p. 281). The rationale for this theory is that man "represents, individually and socially, the most synthesized state under which the stuff of the universe is available to us. He is at present the most mobile point of the stuff in course of transformation" (34, pp. 281-282). The third line of advance toward the point
**Omega** is the conjunction of reason and mysticism, which, though important, is not particularly relevant to this study. Teilhard's view is visionary. But it is, as Julian Huxley has pointed out, "speculation with great intellectual boldness . . . extrapolated from a massive array of fact, and is disciplined by logic. It is, if you like, visionary, but it is the product of a comprehensive and coherent vision" (23, p. 16).

**A Knowledge Base**

All of the new industries of the twentieth century are based on knowledge. "The new industries," states Drucker, "represent a qualitative rather than a merely quantitative shift. They are different in their structure, in their knowledge foundations, and in their sociology" (12, p. 41). Their foundations are the modern physics of radiation and quantum, the new science of matter and structure, and the physical chemistry of molecular and atomic bombs. Moreover, there are areas outside the traditional sciences that are also based on knowledge. The computer, for example, is based on the symbolic logic of modern mathematics.

A new perception of the systems concept is crucial to the information industry. These things add up to be what Drucker considers to represent the new technologies of the twentieth century which "embraces and feeds off the array of human knowledges, the physical sciences as well as the humanities" (12, p. 38). "The fact that the new technologies are not based on science alone but on new knowledge in its entirety
also means that technology is no longer separate and outside of culture, but an integral part thereof" (12, p. 39). This, according to Drucker, represents one of the discontinuities in the modern world.

Knowledge is defined by Drucker as "systematic, purposeful, organized information" (12, p. 40) or "systematic organization of information and concepts" (12, p. 268). When information is applied to doing something, it becomes knowledge. Knowledge is, then, a form of energy which exists in doing work. This reasoning leads Drucker to imply that knowledge is a tool, a tool of modern technology (12, p. 269).

Since the new emerging industries of the twentieth century are based on knowledge rather than experience, the manpower for these industries demands an education which is based on knowledge. To use Drucker's words, "the systematic acquisition of knowledge, that is, organized formal education, has replaced experience--acquired traditionally through apprenticeship--as the foundation for productive capacity and performance" (12, p. 40). Drucker explains the implications of knowledge-based industries for education. The new workers are knowledge workers rather than manual workers. The jobs, skilled or unskilled, are knowledge-based. The preparation for these jobs is a course of study. "The way to teach a skill today," asserts Drucker, "is by putting it on a knowledge foundation and teaching it through a systematic course of studies, that is, through a 'program'" (12, p. 318).
The productivity of the worker depends on his ability to put to work the concepts, ideas, and theories which he learns in school (12, p. 41). The knowledge worker uses theory and concept rather than physical force and manual skill. The manual worker does things right, efficiently, while the knowledge worker does right things, effectively (13, pp. 2-4). It was the Sputnik event that established prominent place for knowledge. That event made it quite clear that the right knowledge base was essential to national survival. It taught Americans that knowledge was no longer a private but a public concern (12, p. 356).

Bell concurs with this importance of knowledge. A distinctive mark of the post-industrial society, according to Bell, is the change in the character of knowledge.

What has now become decisive for society is the new centrality of theoretical knowledge, the primacy of theory over empiricism, and the codification of knowledge into abstract systems of symbols that can be translated into many different and varied circumstances. Every society now lives by innovation and growth, and it is theoretical knowledge that has become the matrix of innovation (1, p. 343).

Because of the centrality of theoretical knowledge, according to Bell, there is a new role emerging for the educational organization. "Just as the business firm was the key institution of the past hundred years because of its role in organizing production for the mass creation of products," writes Bell, "the university—or some other form of a knowledge institute—will become the central institution
for the next hundred years because of its role as a new source of innovation" (1, p. 344).

Systems Concept

Technology during the twentieth century has changed in its structure, methods and scope. It is characterized by professionalism, specialization, and institutionalization. Its methods are based on research, and its scope is all-encompassing. Modern man needs desperately an understanding, a theory, and a model of technology. To realize this, according to Drucker, "technology must be considered as a system—a collection of interrelated and intercommunicating units and activities" (14, p. 53).

A system is defined as "a grouping of parts that operate together for a common purpose" (18, p. 1-1). Bell views a system as a set of reciprocal relationships in which variation in one element has consequences for all other parts of the system (1, p. 31). Kaufman thinks a system to be "a process for effectively and efficiently achieving a required outcome based on documented needs for "the sum total of parts working independently and together to achieve a required outcome" (26, p. 125). A system may incorporate both people and physical parts (18, p. 1) and in its complex form is counter intuitive (1, p. 32). The number and complexity of variables in a system along with the extreme difficulty in sorting and holding them simultaneously, necessitates the use of algorithmic rather than intuitive
judgment in making decisions. Bell refers to this as "the end of ideology" when technical decision making is calculating and instrumental rather than emotional and expressive (1, p. 34).

The systems context involves complex sociotechnical support systems which are part of more complex sociotechnical systems. Hannay and McGin draw attention to the complexity of purchasing a common article: "To buy a car, in a real sense, is to buy into a complex road, energy supply, parts distribution, maintenance, registration, insurance, police, and legal system" (19, p. 28). The systemic character of modern culture is increasingly becoming a complex web of interlocking, individually complex sociotechnical system to the degree that one may speak of the progressive "systematization" of modern western culture (19, p. 28).

The systemic "embeddedness" caused Jack Burnham to project a social ontology, "We are now in transition from an object-oriented to a system-oriented culture" (8, p. 16). In pre-industrial times man depended on nature and the threats were storms, flood, earthquakes, and so on. Man in the artificial environments of the technological world has a major threat of technological breakdown (14, p. 87). Failure in technological systems may come not only through breakdowns, but strikes and sabotage. Hannay and McGin think the situation may be compared to playground stilts: "Modern technological society is perched, seemingly precariously, on
multi-level stilts, able to reach higher and higher and see further, but vulnerable to being tripped up and thrown off balance by recalcitrant forces" (19, p. 29).

A systems approach in education is the application of formal problem-solving tools and techniques to the identification and solution of educational needs and problems and for effectively and efficiently achieving desired outcome. The historical roots of the systems approach are empiricism, physical and applied sciences, engineering, management and weapon systems during World War II (26, p. 126). Kaufman lists the major contributors to the development of systems in education: Charters, in 1954, related educational endeavors and educational engineering; Haben, in 1956, proposed adapting systems to audio-visual communication; Carpenter in 1960 suggested a general strategy for man-machine systems; individuals such as Finn, Bern, VanderMear, Silvern, Ofiesh and Meierhenry, Mager, Banathy, and Corrigan; and organizations, commissions and funded groups, and some universities and colleges. In addition to these, education has received contributions from applied scientists, philosophers, behavioral scientists, and general systems theorists (26, pp. 131-132). Systems approach to education, according to Kaufman, is a six-step problem-solving procedure; problem identification, specification of main and sub-goals, design and implementation evaluation, and required revision (26, pp. 137-138). He also thinks that systems approach in education offers quantitative improvement
of educational outcomes in the shift "from an intuitive approach and toward an empirical and even an evaluative framework for the systematic and measurable improvement of education" (26, p. 162). The most common ones Kaufman names are needs assessment, system analysis, behavioral objectives, planning and programming, budget systems (PPBS), method-means selection, network-based management tools, and refined testing and assessment methods (26, pp. 162-163).

Modern culture is increasingly systemic in character. To be able to view modern life through the conceptual lens of systems makes for better comprehension of the nature, operation, strengths, and weaknesses of human activities and institutions such as the factory, the hospital, communication and transportation (19, p. 28). Forrester is convinced that when systems which he terms "system dynamics" is applied to education the flood of information can be pulled together and knowledge reintegrated for a foundation of universal understanding that is applicable to technology, politics, management, economics, psychology, religion, values, and the transactions between them all (17, p. 168). Wallin supports system dynamics in education. He believes that it represents a liberal study "because it integrates rather than compartmentalizes knowledge, because it transcends disciplines and professions, because it is common to many fields of inquiry, and because it is useful for citizens of an interdependent globe" (36, p. 137).
Forrester recommends the principle of system dynamics for American higher education as it moves into the 21st century. The general objectives of higher education of creating a whole man, unifying knowledge, and providing a perspective for social change remain valid. However, according to Forrester, "For education to regain relevance, the general objectives of higher education need to be reinterpreted into a form of education more suitable for the newly-emerging socio-economic modes of behavior" (17, p. 158). Forrester illustrates the need for reinterpretation by pointing to education as a creature of the growth mode that has taken place during the past two years in population, industrialization, and standard of living that has shaped educational tradition, attitudes, values, and objectives. As growth slows, stabilizes, and/or declines, education will have to adjust to the new socio-economic reality (17, p. 160).

The challenge of two-hundred years ago was to create a social and economic system consistent with a period of exploration, exploitation of nature, immigration, and growth. That period has run its course. The new challenge is to frame a society for the next one-hundred years of deceleration in growth. The challenge is even greater than two-hundred years ago. It is easier to frame a growth society that can offer life, liberty, and the pursuit of happiness than it is to frame an environmentally restrained society capable of preserving the same values (17, p. 167).

Forrester furnishes a neat, concise statement of the essentials of systems dynamics.
Systems dynamics builds on personal experience, measured data, observed structure, and knowledge of the process of control and decision-making. It accepts the feedback control-loop structure within which all processes of change occur. As such, it deals with growth, goal-seeking, equilibrium, stagnation, and decline. It deals with the structures, policies, and processes that produce change through time (17, p. 170).

A system dynamics offers a philosophy and methodology for unifying different disciplines and providing the time dimension to understand social systems. System dynamics provides a common language in which different disciplines can be put into a single framework. It serves as a communicative medium that interrelates descriptive information, history, measured numerical values, and previously unrecorded human observation and experience of different specializations. The structure provided by system dynamics unifies separate bits of knowledge into a whole. Not only does system dynamics provide a structure for unifying knowledge, but it provides the time dimension that shows how these structures behave dynamically in history, and reveals how present structures and policies affect the future (17, pp. 168-169).

Forrester believes that "systems dynamics can preserve the strength of a liberal education while compensating for its inherent weaknesses" (17, p. 170). Liberal education is rich in information available. It has gathered a wealth of descriptive data on many facets of the nature of man and nature. The difficulty arises, however, in dealing with the
information. Herein lies a weakness of liberal education. Although the amount of information is massive, there are few criteria for choosing between the relevant and useless information, and there is no basis for precise assumptions, no guiding principle for structuring information, and no ability to deduce dynamic consequences of the information. Forrester argues that "system dynamics adds two significant background threads to those already present in a liberal education--concepts of structure drawn from the field of feedback systems and computer simulation . . ." (17, p. 170). Forrester illustrates the powerful effect that comes from the approach of unifying disciplines and the time dimension by referring to the book The Limits to Growth. The implication of this book for education is not that growth is limited, as important as that is. Far more relevant for education is that knowledge can be unified--assumptions, disciplines, time behavior, and public perceptions and concerns (17, pp. 172-173). This approach, according to Forrester, is in line with the approach of system dynamics.

System dynamics is much more than mere modeling. It is a way to cast disparate fields into a common framework. It relates the past to the present, and the present to the future. It allows one to anticipate future implications of present assumptions. It shows what futures are consistent with present realities. It assists in sorting out feasible futures from impossible utopias. It helps in re-establishing goals for the future toward which present human effort can be constructively harnessed. System dynamics can provide a time perspective to integrate history, present and future, into one continuum (17, p. 173).
The system dynamics form of analysis can be adapted to simple conceptual models. This method is being applied to physical systems and developed by Science Curriculum Improvement at Berkeley for fifth grade level (36, p. 136). Forrester reports that the structural concepts of feedback loops have been successfully taught at the fifth and sixth grade levels as a part of an inverted concept of the theory of educational progression that puts synthesis first and uses holism and dynamics as motivation for coming later to the stages of acquisition of knowledge, comprehension, application and analysis (17, p. 173). Many graduate and professional schools have developed curricula around this method under such names as "operational research" and "policy analysis" (36, p. 137). Wallin suggests that "developing undergraduate curricula using system dynamics methods as a tool may be the basis for a problem-solving, vibrant, general education (36, p. 137).

In summary, Chapter VI has recorded research of the impact of technology on one of the basic elements of education—the curriculum. It was pointed out in the chapter that curriculum is governed by the social fabric into which it is set. Technology has produced a new curriculum focus that stresses science and mathematics. Also, it was stated that technology involves not only technical problems but also human problems. Therefore, humanities have become an important part of education in the technological world.

The last basic element of education to be discussed in this study on which technology has had an impact is instruction.
CHAPTER BIBLIOGRAPHY


The fourth revolution in education, according to Ashby, is now in process. It is the explicit application of technology to education (1, p. 34). The fourth revolution may be described as technology in the service of education. It is the intent of this section of the present chapter to discuss the historical background, the underlying theory, and the practical application of this fourth revolution.

Historical Background

Educational technology has become both a fashionable term and a professional specialty in recent years. Unwin and McAleese state that it is "emerging as an interdisciplinary conglomerate concerned with virtually all aspects of education" (25, p. 307). Although educational technology has become prominent only in recent years, its historical roots reach far back into antiquity.

Paul Saettler, who has written a most comprehensive and exhaustive history of educational technology, names the Sophists of the Fifth Century B.C. in Athens as probably the first instructional technologists. He traces further development through the concepts of Comenius, Pestalozzi, Froebel, and Herbert. During the science and technology
period since 1900, he discovers instructional technology in the teachings of Thorndike, Dewey, Montessori, and Skinner (18).

Unwin and McAleese list and discuss five streams of historical roots that are central in the broader concept of educational technology: audio-visual instruction, programmed instruction, curriculum development, systems analysis, and educational planning (25, p. 312). The task force on definition and terminology for the Association of Educational Communication and Technology cites a similar development of educational technology. This group recognizes the movement beginning in the 1920's through visual instruction, audio-visuals, communications, early systems concepts, audio-visual communications (a synthesis of communications and systems concepts), systems approach and instruction technology. The current definition of educational technology given by this task force seeks to synthesize all of these concepts (2, pp. 27-53).

Recent impetus for educational technology originated with Sidney L. Pressey around 1925. He saw education as a major activity that was still in the crude handicraft stage of development. Pressey thought that, as a large scale industry, education should use quantity production methods as other major industries. He predicted an "industrial revolution" in education in which machines would revolutionize education as they did industry to facilitate manufacturing (17).
Educational technology got a boost in the 1950's and 1960's in the work of B. H. Skinner. In Skinner's psychological theory of operant conditioning, the important stimulus is the one immediately following a response, not the one preceding it. When this stimulus is reinforced, the general tendency to make this response is strengthened. For Skinner the science of instruction is based on operant reinforcement in which acts of learning are reinforced or strengthened so as to increase their probability in the future. Skinner's teaching machines are a direct application of his concept. He believes that teaching machines must do more than present information. They must relate to student behavior. This relationship includes a response by the student, controlled sequence, frequent and immediate reinforcement, and individual learning rate. These things, according to Skinner, will manage the contingencies of reinforcement and thereby ensure learning. This concept is in contrast to the traditional audio-visual instruction which places heavy emphasis on stimuli or messages to the learner. Skinner's notion of the science of behavior reverses this emphasis. He believes that the learner's behavior and the consequences or reinforcement of that behavior are the key elements in learning (4, pp. 39-41). In his Technology of Teaching, Skinner states his concept of teaching.

Three variables compose so-called contingencies of reinforcement under which learning takes place: (1) an occasion under which the behavior occurs; (2) the behavior itself; and (3) the consequences of the behavior . . . . Teaching is
simply the arrangement of contingencies of reinforcement (21, pp. 3-4).

One other person who deserves to be mentioned in the historical development of educational technology is Robert M. Gagne. It was he who led the way, with his volume *The Condition of Learning*, toward linking learning theory and the technology of instruction (20, p. 65). Gagne's only assumption for education is "the existence of a student who is capable of learning" (10). This is the starting point. He argues that a variety of ways that the student learns can be identified with each requiring a different set of conditions for their occurrence (10, p. 19). Implications derived from specification of conditions of learning concern a learning structure, management of learning and the learning situation, instructing functions, and the selection of media for instruction. In brief, the following is Gagne's point of view of the process.

There are many varieties of learning as there are distinguishable conditions for learning. These varieties may be differentiated by means of descriptions of the factors that comprise the learning conditions in each case. In searching for and identifying these, one must look, first, at the capabilities internal to the learner, and second, at the stimulus situation outside the learner. Each type of learning starts from a different "point" of internal capability, and is likely also to demand a different external situation in order to take place effectively (10, p. 23).

With Gagne, along with the work of his associates, educational technology has reached a synthesis. "Media" is considered in a broad and inclusive sense. It includes both traditional instructional media as oral and printed forms as
well as the new electrical technology (10, pp. 28-29). Other scholars, however, have made significant contributions, among them Melton, Lumsdaine, Hawkridge, Glaser and others, particularly those from the experimental or behavioristic persuasion. One Carnegie Commission report draws attention to the historical contribution to educational technology of these behavioral scientists.

Behavioral scientists have joined the fourth revolution and have served usefully in pointing out the importance of defining learning objectives and suggesting ways in which natural learning processes can be utilized in the presentation of subject matter. Part of their contribution has been to take the machinery of the fourth revolution out of the spotlight and to assign such novel media as computers and television a place in the ranks alongside the slide projector, the textbook, and the teacher as useful participants. This integration of new media, long-familiar technology, planning of instructional space, learning theory, and the professor into a total effort is sometimes called the "systems approach" or the "learning environment approach" to instruction. This view now has international acceptance (4, p.7).

Undergirding Theory

The problem of definition has been a hindrance to educational technology. It is not clear to many people just what the term means. Does it mean technology in, of, or for education? Chadwick thinks that the concept of educational technology is so ambiguous that "almost anything reasonably intelligent and well organized seems to become a 'systemic application of knowledge to the solution of educational problems' educational technology" (5, p. 7).
In the historical development of educational technology two concepts have emerged, the physical science view and the behavioral science view. The physical science view defines itself largely in terms of apparatus and devices such as radios, film, projectors, textbooks, teaching machines, computers and so on. "The assumption underlying this view," according to Saettler, "is that the perennial villain in the teaching-learning process is 'verbalism'" (18, pp. 2-3).

In addition to these two major concepts, there are other sets of conceptual frameworks that maintain firm support in the literature of educational technology. Among the more familiar concepts are audio-visual instruction, educational media, learning resources, and educational communications. Probably the most popular and inclusive concept that rivals educational technology is instructional technology. In many cases educational technology and instructional technology are used synonymously and as equivalents.

Educational technology as defined by Unwin and McAleese embraces a five-fold mosaic of concepts relating technology to education, psychology, information and communications, management, systems, and planning. Their definition is as follows:

Educational technology is an area of study and practice (within education) concerned with all aspects of the organization of educational systems and procedures whereby resources are allocated to achieve specific potentially replicable outcomes (25, p. 325).

An Association for Educational Communications and Technology task force also uses broad concepts in its
definition. The three ideas used in this definition are: theoretical construct, the showing of how ideas and principles are synthesized into a cohesive whole; a field, the applications in and implications for the real world; and a profession, the identifying of the criteria for a special group within the field (2, p. 19).

Others, however, define educational technology in a more limited sense. A HEW Commision report, for example, offers a definition that emphasizes the role of a learning theory. It defines educational technology as:

A systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of special objectives, based on research in human learning and communications, and employing a combination of human resources to bring about more effective instruction (Tickton, p. 22).

Instructional technology is the application of science to practice of human learning. Lumsdaine refers to this as "psychotechnology" (13, p. 373). Four distinct components are found in instructional technology. First, there is the theoretical basis that provides the rationale for using instructional technology, that is, a learning theory. Second, there are prescriptive rules which govern the content and form of an instructional episode. The third component is the content of the instruction and information to be given to the student. The last component is the form that the instruction takes, that is, the instructional product (9, pp. 44-45).
Advocates of instructional technology sometimes overemphasize the potentials of media and systems. One Carnegie Commission report guards against this tendency. In its definition of instructional technology it seeks to ensure that technology will be regarded as secondary to teaching and learning and not become an end in itself. This report defines instructional technology as the "enrichment and improvement of the conditions in which human beings learn and teach achieved through the creative and systematic organization of resources, physical arrangements, media, and methods" (4, p. 89).

Application to Learning

Theories of learning that have been proposed include association, trial and error, conditioning, and insight. Gayne's definition of learning as "a change in human disposition or capability which can be retained and which is not simply ascribable to the process of growth" (10, p. 5). He argues that learning occurs in events.

A learning event, then, takes place when the stimulus situation affects the learner in such way that his performance changes from a time before being in that situation to a time after being in it. The change in performance is what leads to the conclusion that learning has occurred (10, p. 6).

Education is for learning. Educational technology proposes to assist and/or have some responsibility in this task. It is, therefore, necessary to analyze the learning task and related concepts. A variety of learning typologies
have been suggested. Bloom and his colleagues produced a famous one of the cognitive domain. The main headings of his scheme are knowledge, comprehension, application, analysis, synthesis and evaluation (3), Krathwohl has done a similar effort in the affective domain (12). The development psychologists like Piaget (16) and Erikson (7), the personality psychologists like Maslow (14) have produced taxonomies according to their respective approaches. It is, however, the experimental or training psychologists who have produced "the most usable taxonomic bridges between theory and practice" (20, p. 65).

Gagne and Briggs outlined five large categories of learning outcomes. The major areas are intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes. Intellectual skills are those capabilities that make a person competent and enables him to respond to conceptualizations of his environment. These skills make up the basic structure in formal education. Cognitive strategies are capabilities that govern the person's own learning experiences such as remembering and thinking behaviors. Verbal information is that verbal knowledge commonly needed in life. Motor skills are capabilities expected from most people. Attitudes are those capabilities in the affective domain that determine reactions to things, people and situations (11, pp. 19-34).
Gagne thinks that there are varieties of situations in which people learn, and not just one or two. He identifies and distinguishes eight kinds of learning.

Type 1: **Signal Learning** - The individual learns to make a general, diffuse response to a signal. This is the classical conditioned response of Pavlov (1927).

Type 2: **Stimulus-Response Learning** - The learner acquires a precise response to a discriminated stimulus. What is learned is a connection (Thorndike, 1898) or a discriminated operant (Skinner, 1939), sometimes called an instrumental response (Kimble, 1961).

Type 3: **Chaining** - What is acquired is a chain of two or more stimulus-response connections. The conditions for such learning have been described by Skinner (1938) and others, notably Gilbert (1962).

Type 4: **Verbal Association** - Verbal association is the learning of chains that are verbal. Basically, the conditions resemble those for other (motor) chains. However, the presence of language in the human being makes this a special type because internal links may be selected from the individual's previously learned repertoire of language (cf. Underwood, 1964).

Type 5: **Multiple Discrimination** - The individual learns to make different identifying responses to as many different stimuli, which may resemble each other in physical appearance to a greater or lesser degree. Although the learning of each stimulus-response connection is a simple type 2 occurrence, the connections tend to interfere with each other's retention (cf. Postman, 1961).

Type 6: **Concept Learning** - The learner acquires a capability of making a common response to a class of stimuli that may differ from each other widely in physical appearance. He is able to make a response that identifies an entire class of objects or events (cf. Kendler, 1964).

Type 7: **Principle Learning** - In simplest terms, a principle is a chain of two or more concepts. It functions to control behavior in the manner suggested by a verbalized rule of the form "If A,
then B," where A and B are concepts. However, it must be carefully distinguished from the mere verbal sequence "If A, then B," which, of course, may also be learned as type 4.

Type 8: Problem Solving - Problem solving is a kind of learning that requires the internal events usually called thinking. Two or more previously acquired principles are somehow combined to produce a new capability that can be shown to depend on a "higher-order" principle (10, pp. 58-59).

Both the large categories of learning and the types of learning in Gagne's scheme are hierarchial in nature, that is, one step is taken successfully before another one, and the simpler types of learning are subsumed under the more complex. The progress from simple to complex learning in the major categories of learning are from motor skills to verbal information, to intellectual skills, to attitudes, to cognitive strategies (11, pp. 99-120). The hierarchial steps in these types of learning are signal, stimulus-response, chaining, verbal association, multiple discrimination, concept, and principle learning (10, pp. 59-61).

Another set of activities in the taxonomy of learning is designated by Gagne and Briggs as the events of instruction. The authors' list and discussion are summarized conveniently by Schramm.

1. Gaining attention. A stimulus is presented to appeal to the learner's interest or his curiosity. It may be a question, a challenge, a demonstration, a short change in the visual scene, or the like.

2. Informing the learner of the objective. The learner has to know how he will know when he has learned what is expected of him in the lesson.
3. Stimulating recall of prerequisite learned capabilities. For any except the most fundamental learning, the learner must have at hand certain knowledge and skills he has previously learned so that he can use them in the new task. The problem is to remind him of this necessary background.

4. Presenting the stimulus material. When the learner is ready, he or she must be shown the material to be learned or to be worked with.

5. Providing "learning guidance." The learner will need to be directed by prompts or hints or questions toward the objective.

6. Electing the performance. Having arrived at the objective the learner must now be challenged to show that he can "do it," perhaps by use of an example or a problem.

7. Providing feedback. The learner must be informed of the correctness of his performance—by words, by a smile or a nod, or by some other means.

8. Assessing performance. The teacher wants to make sure that the learner has indeed learned to accomplish the objective. One of the commonest ways to make sure of this is to ask for one or more repetitions.

9. Enhancing retention and transfer. This calls for practice, especially with varied tasks requiring the same skill that has been the objective of the lesson (20, pp. 74-75).

These events of instruction do not always come in the exact order given; nor do they necessarily occur in every lesson. However, most of them will occur and this is the most probable order.

The next logical stop in the learning process is the choice of media for instruction. What is needed, in the words of Schramm, is an "algorithm for translating instructional event (backed up by the analysis of learning tasks and learning hierarchies) into the choice of media for
instruction" (20, pp. 75-76). But, concludes Schramm, "this is where the theoretical literature begins to break down" (20, p. 76). There is a lack of solid research in this area. Only certain aids are available. Dale's "Cone of Experience," for example, is helpful. He attempts to begin with the basic, direct experiences and proceed to the more complex and abstract experiences. Dale's experiences from simple to complex are direct, contrived, dramatized demonstrations, study trips, exhibits, educational television, motion pictures, still pictures, radio and recordings, visual symbols, and verbal symbols (6, pp. 42-43). The standard text by Wittich and Schuller suggests that selection should be on the basis of the conceptual level of the learner, suited to reach the student, and provide concrete or quasi-concrete experience (26, p. 46).

Other aids for media selection are available, but they, too, are a bit vague and do not fully prepare the teacher for deciding what media experiences best fit any given learning needs. At bottom, it becomes a matter of intuitive decision. Dale's rule, following his scheme, is to "go as low on the scale as you need to in order to insure learning, but go as high as you can for the most efficient learning" (6, p. 45). Saloman offers this rule for media selection, "The better a symbol system conveys the critical features of an idea or event, the more appropriate it is" (19, p. 392). Gagne and Briggs have this rule in media selection, "Good judgment must
be used in planning just how to accomplish such instructional event for the lesson plan" (11, Prin., p. 152).

Resources in educational technology are coming to bulk larger and larger as the field continues to expand and technical capability grows. The practical application of this ever enlarging bulk of educational technology will be determined by the definition and concept of educational technology by the user. For example, the text by Wittich and Schuller is entitled Instructional Technology, but basically the authors take an audio-visual approach. Gayne, on the other hand, maintains that the oral or lecture method is valid in educational technology.

Schramm uses the title for his book Big Media, Little Media. For him the big media are the more complex and expensive apparatus such as sound films, television, and computers. Little media are the simpler ones such as the slide, radio, transparency, programmed text and the like. The "Little Media" are well known and established in aid to education. The "Big Media," however, are still in the experimental and formative stage if development. After reviewing the literature on the educational value of television instruction, Schramm finds that "there is no basis in the research for saying that students learn more or less from television than from classroom teaching" (20, p. 28). In computer instruction Schramm finds interactive drill and time-saving noteworthy, especially in language study (20, p. 30). Wittich and Schuller classify media into twelve
groups and one area which they call instructional systems. The divisions are picture and graphs, community study, maps and globes, audio-recordings and playback, still projection, motion pictures, television, computers, and individualized instructional technology (26). One Carnegie review of educational technology includes the printed word, film, self-instruction units, radio, television, and computers (4).

Extrapolation of current experimentation will bring surprising revelations into educational technology. The future may bring increasing emphasis on the bodily processes into educational technology. Since the computer memory can store facts, information may not be the main concern. Man's understanding of himself and self-fulfillment will have emphasis through the new domain of psychical expansion under such terms as "self-consciousness," "upsurge of unused powers," "super life," "increased action for being," etc. (23). Meditation will be a part of educational technology. Brain research may prove to be an aid in education (8). Self-concept, mental states, learning curves, cycles, perceptual and cognitive styles will all play a part in education in the technical age. "Perhaps the most important application of biofeedback training," according to Sullivan, "is in the area of education" (22, p. 55).

Educational technology is bringing about the fourth revolution in education. The fundamental change produced by the new technology will move instruction "from the historical
requirement-met-through-teaching approach to a resources-available-for-learning approach" (4, p. 2). But as in all revolutions, there is resistance and reaction. Resistance to change and fear of job security on the part of teaching personnel, too high expectation by advocates of educational technology, dehumanization by machines, and cost factors are major obstacles for educational technology. The main failure of educational technology in the opinion of Chadwick is that it has failed to articulate a new model for education. It has merely been a supplement to the old model (5, p. 18).

Moldstad's quote from Hannon may summarize the position of educational technology today:

A plain bar of iron is worth $5.00. Made into horseshoes it is worth $10.50; into needles, $4,285; into balance wheels for watches it is worth $250,000. The same might be said of the new technology in education--its values will be determined by what you make of it (15, p. 3).

The golden age of education promised by educational technology may arrive, but it has not yet come. The golden age may depend on what is made of educational technology.

The second part of this study, Chapters IV-VII, has sought to investigate the impact of technology on four basic elements of education--structure, purpose, curriculum, and instruction. It was the intention of this investigation to analyze the data presented and, from the findings, to assess technology's impact on education in order to arrive at some conclusions. The findings and conclusions from parts one and two are to be found in Chapter VIII.
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CHAPTER VIII

SUMMARY, FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND IMPLICATIONS FOR INDUSTRIAL ARTS

Summary

The problem of this study was to define the role of technology as a significant factor for developing education which, with particular reference to industrial arts education, will contribute to the general education of the student. This study was conducted for the following purposes:

1. To assess technology as significant for education,
2. To assess concepts of education which postulate technology as a significant factor,
3. To assess the impact of technology on education,
4. To discuss critically the implications of the above assessments for industrial arts education.

The problems raised by the statements of purpose and the research questions derived from them were investigated in the literature of reputable and respected scholars who have spoken to the interrelatedness of technology and education. Four categories of sources were chosen from which relevant data were collected—the history and philosophy of technology, the social sciences, the work of generalists, and education. Selection of data included both common and
divergent viewpoints of facts and judgments in order to provide balanced understanding and perspective. The data, although collected from various disciplines, were assembled in such a way as to form a composite structure of ideas which have implication for education and to the subject of inquiry presented in this study.

The study focused on the period of time from 1957-1980. Its implications were developed in relation to the American society. A fully developed philosophy of education in the technological age was beyond the scope of this study, and one was not developed.

The study was presented as critical, philosophic research. The inquiry into the areas defined by the statements of purpose and the related research questions constituted the substance of the study. Each statement of purpose and its related questions were developed as a separate chapter.

Findings

Chapter II presented data which were related to purpose number one regarding technology as significant for education. Based on the data cited in answer to the research questions, the following findings were apparent.

Regarding the significance of technology for education as seen in the concept of culture, it was found that:

1. Culture is a way of behavior. It is to be treated as a living and functioning whole which exhibits distinctive
qualities and definable characteristics. A people's dominant concern is referred to as a cultural focus. The focus of modern American culture is technology.

2. Technology is a key to the understanding of the growth and development of culture because it undergirds all human life and signifies the means of articulation between man and the cosmos. The knowledge, attitudes, and customs of technology are as much a part of the culture of man as is his political or religious behavior.

3. Environment as a unit of culture is characterized by technology. Man's experience has been transformed from a natural environment to that of the general framework of technology, that is, the technosphere, to that of self-experience with machines, and to that of field-experience which is experience among machines. The technological environment creates a change in customs and in institutions which will in turn result in the need for adjustment of other customs and institutions. Man's experience inside the machine and, thus, being artificially related to the world, has been criticized as alienating him from the deepest layers of his fundamental self. Such a perspective would view the world of the future to reflect the inexorable, vital needs, urges, and limitations of biological man rather than the imperative of technology.

4. Because he is born into it, the individual uncritically and unconsciously accepts his culture and is consequently molded by it. The deliberate part of the
molding process in culture that influences and induces the individual is education. It is from culture that education is created and derives and identifies its content. Education, therefore, imparts the ideology, the system of beliefs, and sentiments and values of the culture. To be cultured is to be educated. Since the focus of American culture is the configuration of technology, the same may be said for American education. The higher the level of technology achieved within the culture, the higher become the educational demands because of the increasing differentiated and stratified nature of the technology.

Regarding the significance of technology for education as seen in the concept of consciousness, it was found that:

1. The insights gained from phenomenology are helpful in the analysis of the technology/education matrix. The notion of consciousness in phenomenology is always a "consciousness of," that is, consciousness is always intentional and it is always directed toward an object. This implies a shift in emphasis from the question of reality of the world to the meaning of that which appears to consciousness. Through the notion perception man establishes primordial contact with the world. Perception gives meaning to the pre-conscious, pre-personal, and anonymous world as a generalized existence. The world finds its way to existence and existence perceives the world. Not only is there a physical world of earth, air, and water, but there is also a cultural world of roads, villages, stores, churches, and
implements such as a bell, a spoon, a pipe, and other technological products. Each of these objects is molded to human action. Through perception, things and truths and values are both constituted by man and are constituted for him. Applied to education, phenomenology presents a method of getting to reality as it appears to consciousness. The child is given a situation, yet he takes positions within it. He chooses and is chosen. He is molded by the world of his upbringing, yet he recreates and reconstitutes that world.

2. Technology may be viewed not so much as doing, but rather thinking, contemplating, and perceiving. As such, modern man is unconscious of his technological ambience. He simply takes it for granted. Man's perceptual values are constantly changed by technology. The relationship between technology and perception in terms of the developing child is experienced through the medium of toys. The toys for the child today become the tools of the adult tomorrow. The combination of modern technology and child-centered values which dominate the mid-twentieth century has created a shift in the perceptual world from a stable and static world of dolls, wooden toys, and fairy tales for young and old, to an unstable, ever-changing universe of electrical toys and science fiction with vastly extended perceptions of time and space.

3. Sociology of knowledge is concerned with the analysis of the social construction of reality. It seeks to understand the relationship between human thought and the
social context within which it arises and the way knowledge is socially established as reality. From this analysis it is learned that those who shaped modern Western thought and values were men of the heroic attitude which is characterized by vital drive, brute force, and rationality. The modern legacy of the heroic attitude is expressed in technology as a will to control and to direct various realms of existence. To be and to act in a world defined by a technological body of knowledge is thus apprehended as reality. Education is an expression of this consciousness. With its emphasis on technical training, education aims at developing the technological body of knowledge with its will to control, thereby producing human fuel for society's technological and bureaucratic machinery because it is apprehended as reality.

4. An analysis of institutions and institutional processes provides the social base for not only the structure of consciousness, but also the carriers of consciousness. One key phenomenon for modern consciousness is technological production. The processes and institutions that are directly related to technological production are primary carriers of modern consciousness. Because the carry-over of technological production is so enormous, it is not necessary to be engaged in technical work in order to think technological. Secondary carriers are processes and institutions that are not themselves concerned with technological production, but serve as transmitting agencies for the consciousness derived
from this source. Mass education, along with mass communication, are two important secondary carriers of modern consciousness. Through school curricula, movies, and television the population is continuously bombarded with ideas, imagery, and models of conduct that are intrinsically connected with technological production.

5. Technology is an extension of man's physical and nervous systems to increase power and speed. Man is rapidly approaching the final stage of extension—the technological simulation of consciousness, when creative processes of knowing will be collectively and corporately extented to the whole of human society. Technological simulation of consciousness is risky. It may result in a numbing effect on man's judgment and perception. Hopefully, man will develop the necessary understanding to bring the new forms into orderly service in order that the new consciousness will produce ultimate harmony of all being.

Regarding the significance of technology for education as seen in a theory of knowledge, it was found that:

1. Technology affects man's patterns of thought and valuation and habits of life. From this perspective, technology may be considered as a philosophical theory of knowledge and value.

2. The American mind was shaped in part by pragmatism. The experimental temper and the instrumental purposes of pragmatism led to the establishment of a philosophy of technology. At the heart of the American philosophy of
technology is the pragmatic notion of the instrumental theory of knowledge wherein knowledge resides in concrete human acts where it becomes functionalized.

3. The instrumental theory of knowledge was made possible through a change of attitude toward the relationship of knowledge and action. For historical, philosophical, and sociological reasons, these two were traditionally separated. With the coming of the scientific revolution, however, there was a change in attitude in man's understanding of natural occurrences and their interactions. The traditional relationship of knowledge and action was transformed into constant and effective interaction.

4. The new interactive relationship of knowledge and action is seen in experimental inquiry. In this method ideas are put to work in a situation which involves overt doing. The ideas become acts performed, deeds done, actual operations to guide, direct, and control the inquiry. The resultant is a new situation in which things are differently related to one another such that the consequences have the property of being known. The application of the experimental method to tools has given rise to the evolution of industry. Its application to technical action creates a technological world that is ever dynamic.

5. The quest for certainty ends in the perfecting of methods of inquiry, that is, the unity of theory and practice and linking knowledge and action, by which secure values can be realized. The instrumental theory, therefore, becomes a
technological theory both of knowledge and value. Technological theory not only makes possible a technological civilization, but it also means that man participates in his own destiny. The educational significance of the technological theory of knowledge and value is manifest in the fact that, while students are developing a problem-solving attitude or mind, they are developing a technological attitude that leads to technological action.

Regarding the significance of technology for education as seen in the concept of identity, it was found that:

1. One major problem in the technological society is the identity crisis. Value conflicts in the technological society produce in individuals conditions that may be described by such terms as loneliness, alienation, cognitive dissonance, social friction, and so on. These may be subsumed under this major problem of technological trauma—identity crisis.

2. The processes by which identity is shaped are determined by social relations and social structure. It is a process located in the core of the individual and the core of his communal culture. The school is in contact with the student during the critical process of identity formation from the technology of toys in younger childhood to actual participation in technology in adult life. The student's budding sense of identity is in danger of identity confusion arising from unresolved conflict, lack of a good model, lack
of the opportunity to learn, lack of success, and a premature fixing of identity.

Regarding the significance of technology as seen in the concept of education as a technology, it was found that:

1. The tone-giving dominance of technology governs the detail lines of educational policy, the range of instruction offered, and the character of the personnel, governing boards, and administration. Education as a sociocultural invention is not only influenced by technology, but it may be also considered as a technology. Education as a technology is operative within the syndrome of the whole technological society. Behavior modification, career education, and competency-based education are three recent examples of technological ideology that appear in education policy.

2. The crucial issue confronting education in the technological age is the relationship between sociocultural literacy and freedom. Knowledge of sociocultural alternatives makes freedom from sociocultural determinism possible, and that education must provide.

Chapter III presented data which were related to purpose number two regarding the concepts of education that postulate technology as a significant factor. Based on the data cited in answer to research questions, the following findings were apparent.

Regarding the research question concerning the concepts of education that postulate technology as a significant factor suggested by individuals, it was found that:
1. Modern trends suggest that the world is a world of technological imperative. One hope for this kind of world that will assure man's survival is a kind of education which is oriented around and characterized by the spirit of science as a method of thinking. Education in the world of technological imperative will include among its fundamental studies a study of the history of science and technology and an understanding of the technological processes through a working knowledge of the technical arts. Moreover, most important in this scheme of education are the inclination, ability, and willingness to relate continuously one study or one specialization to another.

2. Education in the technological age is comprehensivist in nature. It is characterized by wholeness. Knowledge is structured in assimilable wholes in comprehensivist education and imparted even at the elementary levels in terms of whole systems. Comprehensivist education is primarily concerned with exploring and discovering more about the universe, its history, and its future. Furthermore, it is concerned about why human beings are part of the universe and how they may best function in universal evolution. Comprehensivist education does not aim at how to get a job, earn a living and survive, or any particular specialization. It intends, however, to produce the comprehensive generalist, the philosopher-scientist-artist rather than only the deluxe-quality technician-mechanic.
Comprehensivist education for the technological age utilizes the comprehensivity curriculum. The comprehensivity curriculum integrates the whole range of specialized disciplines in sciences and humanities to provide information that produces technical advantage for world society living systems.

The location of comprehensivist education is in the home, in one-pupil schools, as well as in the school. Learning aids for the home and campus are educational machine technologies such as two-way TV, video-tape documentaries, and computers with linkages via libraries and control centers. Schools are equipped with generalized experimental equipment for maximum flexibility after the circus model. At home or campus, comprehensivist education is basically a process of individual learnings through personal inquiring, experimenting, and self-disciplining.

3. Education in the technological age is to proceed from the critical value-questions such as "who are we" and "where are we going." This approach will prepare citizens in how to think, and would provide individuals a means to find order in a complex universe and to attain knowledge, skills, tools, attitudes, and values required to participate successfully in deciding the future. Knowledge, moreover, is restructured into areas which more adequately reflect contemporary experience—science, technology and humanities.

Technology is a valid, intellectual discipline that, when studied, three things may be achieved: there is
emancipation from technology's domination of society and of individuals who are trained simply to fulfill a role in the technological society; there is access to the tools of technology in order to know and to understand about the production, communication, and transportation which affects the lives of people; and there is participatory technology which refers to people developing, implementing, and regulating technology. A study of technology does not imply that everyone must be a technologist, but it does mean that all citizens are to be educated, as a part of their basic liberal education, about the interrelated behavior of technological, scientific, and humanistic systems. Because technology is a critical variable in the modern world, only in a disciplined study of its components, contexts, and complexities can man hope to gain control, freedom, and participation required to direct it to human purposes and social goals.

Regarding the research question concerning the concepts of education that postulate technology as a significant factor proposed by a professional industrial arts group, it was found that:

Since technology is a dominant feature of the culture, learners need valid concepts about it in order to cope adequately with it. Education in the technological age, therefore, should provide understanding of technological concepts and humane technological competencies that are directly useful in the lives and careers of people. Concepts
and competencies grow out of three interwoven domains of human capacity—doing, knowing, and feeling. Psychological and philosophical principles and an instructional model have been constructed whereon rests an educational system that involves the learner in transacting with the technological phenomenal world in all three domains.

Regarding the research question concerning the concepts of education that postulate technology as a significant factor as implemented by educational institutions, it was found that:

One of the significant developments in higher education during recent years is that of interdisciplinary studies which show the relation of science, technology, and society. Models used for these studies are often drawn from the various disciplinary backgrounds of the individuals or groups responsible for the programs. Topical approaches for these interdisciplinary studies may include the historical background, the contexts of public policy, and the focus on value questions. Although diversity exists in the programs, the various approaches are held together by the common recognition that technology is a sociocultural process. Interdisciplinary studies bring together the humanist and the technologist to find understanding of their complementary function in civilization and culture and to discover shared principles that could serve as a basis for community.
Chapter IV through VII presented data which were related to purpose number three regarding the impact of technology on education.

From the data presented in Chapter IV in answer to the research question regarding the impact of technology on the structure of education, it was found that:

1. Technology is a force in history, culture, and society, and is, therefore, an influence on education as an historical and sociocultural institution. The demands of modern technological society on education form an implicit question around which controversies about schools revolve. Technology's influence on education is most readily seen through inventions and discoveries and products of technology which bring about change in education. Salient examples of technology's direct intrusion into education are industrial education and engineering education.

2. One clue for understanding the transformation of the West from traditional to modern society is the notion of rationalization. The configuration of bounded rationality is recognized in the modern world as an organization. It is through the organizations that work of today is organized, and it is in organizations that modern man performs and functions. Organizations thus become tools of modern society. As an educationally-oriented organization, the school is in reality a tool, a technology of modern society. The educational organization, then, not only uses technology; it is a technology.
3. After the launching of the Russian Sputnik in 1957, education became a national concern and political issue because of the shaken confidence in American science and technology, prestige in world leadership, and national survival. The result was an updrift and a shift upward in educational authority and decision-making from the local level to the state level, and from the state level to the national level. The National Defense Act of 1958 and the 1965 Higher Education Act were responses to the national interest in education. Particular areas of concern were labor, defense, energy and space. With the Manhattan Project serving as a model, structures were established for mission orientation and project grants that were concentrated in higher education which constituted an elite, national system of education and university research.

4. Technology began to impinge on education during the early decades of the 20th Century through the influence of businessmen serving on school boards and the development of the professional school administrator. Other factors in the impingement process were the professionalization of engineering and the subsequent establishment of engineering as a recognized branch of higher education, the creation of a link between the university and the corporation through funds on the one hand, and personnel training and basic research, on the other, and military research and spending which brought the corporation, the university, and the state into close cooperation. The technological impact is also evident
in that the university administrators increasingly assumed
the managerial mode of operation, the best professors from
the best universities were progressively involved in industry
as consultants, and the emergence of a new breed of academic
man who had utilitarian connections with the federal
government which were tied for the most part to industrial or
military ends. The university laboratory, for example, has
served during recent years as the delivery room for many of
the most sophisticated technological advances. These
conditions created a new situation of academic capitalism—a
knowledge factory and a knowledge industry in the university
environment.

5. During the early decades of the twentieth century,
educational institutions began to adopt scientific management
practices. The factory model in the organizational structure
of education, which was identified as such during this
period, continues to be the operational structure for the
American school. New types of organizational structure such
as team teaching and differentiated staffing are techno-
logical refinements of this pattern. The operational
structure of education is characterized by such technological
principles as consolidation and concentration of authority
and power, multiplicity and complexity in scale, and
self-augmentation. The resultant educational megastructure
has social, psychological, and intellectual implications for
the nature of education and for the individual student.
From the data presented in Chapter V in answer to the research question regarding the impact of technology on the nature and needs of the student, it was found that:

1. A dramatic advance in technology like the launching of the Russian Sputnik puts into focus the crisis which technology imposes not only on the life of man, but on his educational needs. The Sputnik event dramatically signaled the need for a transformation of American education from the progressive life adjustment education to a more rigorous intellectual training through the academic disciplines in order to meet the new technological challenge.

2. The complexity of life in the technological age has led to important changes in the nature of work. Knowledge has superseded manual effort, service industries have surpassed production industries, and the expert is pre-eminent over the generalist. Each of these transformations requires education in mental training and skills rather than physical ones. Education has thus moved from being an ornament and luxury to the central economic resource of the technological society.

3. The drive for professionalism, occupationalism, and technicalism has produced a triumph of vocationalism in education. Schools and colleges are the pre-employment training arm of business, industry, and government. Vocationalism is supported by programs of guidance and counseling and by the most significant role emerging in the educational organization—the guidance counselor. Although
guidance and counseling do not enjoy universal support, they function as a sorting-out process for the diversity of occupations, specializations, and fragmentations of the technological age and are technologies working in concert with other technologies within the technological milieu.

4. The technological age increases the need for specialization. Yet, specialization increases the need for an education that provides a basis for a common humanity. Thus, education is faced with a paradox--how to learn the basic essentials of science and mathematics required for a knowledge of technology, and how, at the same time, to have a liberating education that produces a certain detachment in order to develop critical standards that can apply to the individual and society.

5. Education aims at the systematic acquisition of knowledge as the central energy of modern society for every student--the gifted as well as the slow learner. Educational needs for the technological age are best achieved when they are designed as a continuing education process, structured to emphasize the wholeness and patterns of knowledge, and organized around areas of application.

6. Education in the technological age is to equip people to be knowledgeable about technology while not themselves scientists or engineers, and people to be knowledgeable about the humanities while not themselves humanist. In a technological society the most practical
education is the most theoretical one which leads to a
knowledge and an understanding of the human condition.

7. The affective purposes in education for the
technological age incorporate social, moral, and ethical
dimensions in order to increase people's chances of living
useful, happy, and creative lives. This means an education
rested on a sober combination of individualism and altruism.

From the data presented in Chapter VI in answer to the
research question regarding the impact of technology on
curriculum, it was found that:

1. Educational ideas and practices originate from the
larger society and social structure in which the school is
located. Curriculum, then, is generated by broad social
movements and is a reflection of it. The social
transformation that has been triggered by technology is
reflected in the school curriculum.

2. The crisis of American education perpetrated by the
Sputnik event was a result from a shift into a new
technological era. Sputnik dramatized the necessity for
schools to turn from child-centered curriculum to a new
curriculum focus that emphasized the concepts and principles
of science, mathematics, and engineering.

3. As systematic, purposeful, organized information is
put to work, it becomes knowledge. Knowledge used for
practical application becomes technology. Knowledge, then,
is a tool, a tool of technology. The knowledge worker today
uses theoretical and conceptual knowledge rather than the
physical force and manual skill as was done in former days. The knowledge worker is educated in the technological age through a curriculum which provides a systematic acquisition of theoretical knowledge by means of an organized, formal course of study known as a program.

4. Modern culture is increasingly recognized as being systemic in character. A system, defined as a grouping of parts that operate together for a common purpose, facilitates better comprehension of the nature of phenomena. Technology, for example, can be seen as a system. When applied to curriculum, the systemic concept provides a philosophy and methodology for unifying different disciplines into one single framework, and floods of information can be drawn together and knowledge reintegrated.

5. Questions regarding technology are not simply technical problems, but they are also human problems. Technology, thus, poses value questions and requires value judgments. Liberal arts, therefore, has a substantial role in education for the technological age. There must be a crossing of the frontiers and a broad connection available between the two cultures--science and technology and the humanities. Various approaches are suggested to handle the two-culture question. Some scholars emphasize the general education or liberal arts approach as a dominant factor, while others stress the science and technology point of view with the humanities playing an ancillary role. A third group
would take the approach of synthesis and convergence in which science and the humanities are seemingly one.

From the data presented in Chapter VII in answer to the question regarding the impact of technology on instruction, it was found that:

1. Educational technology may be said to be technology in the service of education. It is the application of technology for quantitative production in education. Educational technology is a synthesis of many historical strands which includes audio-visual instruction, programmed instruction, curriculum development, system analysis, and educational planning.

2. Educational technology may employ any and everything from lecture method to computer instruction. Theoretical literature in the field of education technology provides only guidelines for the proper choice of media experiences that is best fit for any given learning needs. Practical application of education technology is usually a matter of intuitive decision. The user's definition and concept of educational technology will most often determine its practical application. The most promising education technologies for the future are in the bodily processes such as biofeedback training and brain research.

3. The fundamental change being brought about by educational technology is a shift in the model for instruction from the historical requirement-met-through-
teaching approach to a resources-available-for-learning approach.

Conclusions

Based on the findings of this research, the following conclusions from the study are presented:

1. The significance of technology for education is constituted by the common interrelatedness of technology and education with concepts of culture, consciousness, knowledge, and identity.

2. There are existing concepts of education that deal critically and crucially with the theory, practice, and values of technology that would sustain and affirm human purposes and social goals.

3. The impact of technology on the structure, purpose, curriculum, and instruction of education is both pervasive and inextricable.

Recommendations

The following recommendations are based on the findings and conclusions of this study. It is recommended that:

1. Educators incorporate technology as one of the major experiments of the human race along with other noble achievements of mankind to formulate a philosophy of education for the technological age.

2. Educators realign the categories of knowledge to provide for a discipline which can deal critically and crucially with the theory, practice, and values of technology
that would sustain and affirm human purposes and social goals.

3. Educators take cognizance of the pervasive and inextricable impact of technology on education, and consequently adjust their educational purposes and practices to accommodate it.

Implications for Industrial Arts Education

One of the purposes of this study was to discuss critically the implications of the subject of inquiry for industrial arts education. On the basis of the study, the following comments are made:

On the strength of the conclusions of this study, the definition of industrial arts education may be amended to read: those phases of general education that deal with technology—its evolution, organization, materials, processes, products and occupations—and the consequences of the technological nature of society.

The history of industrial arts has been a history of adjustment to social-economic conditions in the education environment. The program has moved from its origin as manual training to manual arts to industrial arts to a recent and popular, though not universally accepted, designation of industrial technology. Each name reflected a subtle difference in emphasis. A new emphasis is now needed in industrial arts. The paradigm shift from industrial arts or industrial technology to technology education is a reflection...
of the new emphasis, that is, to bring the content base of this program area in line with the new reality which is that education occurs in a technological society and in a culture whose focus is technology. The supreme task of technology education, then, is technological literacy. This does not imply, however, that other program areas have no responsibility and technology education has a monopoly and is the gatekeeper for technological understanding. But it does imply that one program area in education has major responsibility in the process.

The concept of technology education implies a move away from just woods, metals, and drawing, where tools, skills, and projects are central. It must not linger around manufacturing and construction with their stress on procurement, management, and processes. Technology education must press on to meaning. Meaning evolves from individual learning experiences. These occur through the student's own individual learning patterns of personal inquiry, experimenting, and self-disciplining via technology in the service of education. Group learning experiences foster meaning. These may be organized around a surgery model. To facilitate learning experiences, the technology laboratory is utilized. Rather than large, permanent, stationary equipment of the industrial arts laboratory, the technology laboratory will be located in a large multi-purpose area. The equipment will be versatile, movable, and the generalized experimental type for maximum flexibility after the circus model. Guidance in
learning is provided by individuals and teams who are themselves philosophers-scientists-artists.

This study suggests general guidelines for technology education as newly defined. First, technology education curriculum is understood to be both physical technology and social technology. The curriculum, then, would affirm materials, processes, and products, but it would also avow the social consequences, both primary and secondary, of technology. Second, technology education proceeds from the affective domain as well as from the psychomotor and cognitive domains. This implies that technology education is value-laden. Therefore, it must help answer questions of identity, purpose, and means. The implication is that the curriculum is formulated to approach technology critically and with a certain detachment in order to achieve understanding. The curriculum, then, is designed in technology education for knowing how to think and how to act. Third, technology education is conceived as multidisciplinary. Just as industrial arts sought to incorporate science and mathematics, technology education must draw, for example, upon the resources of the social sciences. As the systemic concept is applied to technology education curriculum, information is pulled together and knowledge reintegrated. Last, technology education is perceived as firmly attached in the education process in the context of general education. Although it will naturally lend itself to future occupational possibilities for students, it must guard
against progressive technicalism even as industrial arts had to be ever vigilant against progressive vocationalism. The aim, then, for technology education is to develop a comprehensive generalist, the philosopher-scientist-artist, rather than only the deluxe-quality technician-mechanic.
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