Chapter 2

A Review of Literature Related to Construction as an Organizer for Technology Education

The Importance of Construction

According to Maslow's hierarchy of needs, food, clothing, and shelter are essential to human survival and must be secured before humans can advance and improve the quality of their lives (1970, p. 37). Technological systems in general, and more particularly, construction technology in its fundamental form, are direct results of our attempt to meet those needs (Hale & Snyder, 1981, p.6). Today, however, the role that construction plays is much more dynamic than rudimentary protection from the elements. We have developed a wide array of materials and techniques that allow for innumerable design alternatives through which we are able to respond to our primordial prerequisites while simultaneously creating sculptures that satisfy our desire for creative self-expression.

Humans have created and accumulated vast stores of technological knowledge in an unending search for new materials, techniques, processes, and systems with the result that "technology forced change in [our] institutions" (DeVore (1964, p.7). So, in addition to any positive or negative impacts felt by the individual, technology has been and is symbiotically linked with the alteration of organized human activities. With regard to construction technology, the variety and quantity of site built structures has grown dramatically as societies have transitioned from nomadic tribes of hunters and gatherers, to agriculturally centered communities, to factory cities in industrialized nations. The trend in construction technology is away from lean-tos and thatched huts and toward massive and mass produced structures as humans attempt to better address the wants and needs of more people, more efficiently, and with longer lasting results.

As the world population has grown so has the demand for construction. Kornblum (1988) (citing Matras, 1973; and Vining, 1985) stated that there is an "increasing tendency of people throughout the world to live in cities". He called this phenomenon the *"urban revolution*" (p. 540). To support this claim he pointed out, "in 1800, only 3 percent of the world's people lived in cities with populations over 5,000, and of this proportion, a mere 2.4 percent lived in populations over 20,000. . . . But by 1970, fully one-third of the world's population lived in cities" (p. 540). This movement toward urbanization and the resulting increased need for site built structures has not ceased. Quite the opposite, it has been projected to continue into the future. The United Nations Population Division of the Department for Economic and Social Information and Policy Analysis (PDDESIPA) (1994) estimated that in 1994 "45% of the world population [were] urban dwellers" and by 2025 that will increase to 61.1% (p.1). In addition, the 1994 mean percentage of the population living in urban settings in the "more developed regions" was 74.7% and was projected to reach 84% by 2025 (p. 2). To comprehend the significance of the change that these figures represents it was important to consider the increase in total population. It took thousands of years, until 1804, for the human population to reach 1 billion. Yet, in the last two hundred years it has increased five-fold (see Figure 1).

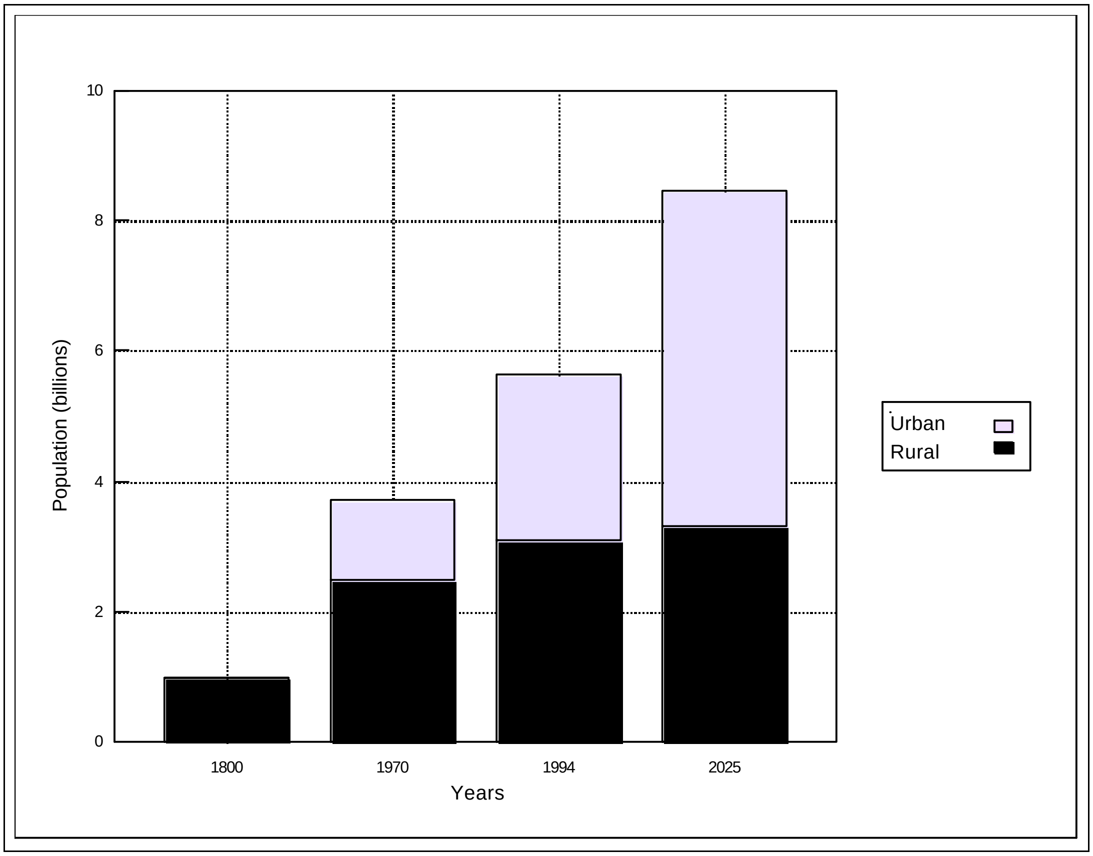

Figure 1. Urban Population Growth as Compared to Total Population Growth

By 2025 the world population is expected to grow to 8.3 billion. (PDDESIPA, June 7, 1994, p.1). Further, if we compare the percent of the population living in cities with 20,000 or more in 1804 to the percentage of the population that is expected to be residing in urban areas in 2025, we find that the population in urban areas has increased by a factor of 848.6 while the total population will only have increased 8.3 times. Combined, these figures represent an increase in the urban population by a factor of roughly 7043, or an estimated urban population increase of close to 5.1 billion in a period of 221 years. This dramatic transition from rural to urban life obviously could not have occurred in the past, and will not occur in the future without constructing the urban environment.

The fact that billions of people continue to live in rural settings does not mean they are unaffected by advances in construction. Although some nomadic tribes may survive without housing, most human beings want and need protection from the natural elements. Besides people, plants, animals and equipment need to be protected. Henak (1994) noted that, “barns provide shelter for livestock; greenhouses protect tender plants, . . . and water tanks keep water clean and available” (pp. 1-2). In addition, essential components of transportation systems are site built and connect urban and rural communities. Airports, docks, canals, railways, and roads provide access, making it possible to commute between work and home, and to transport products from one setting to another. Finally, both rural and urban residents enjoy the benefits and suffer the consequences of such constructed facilities as dams, power plants, power lines, military installations, factories, disposal sites and recreational areas. In fact, even when we attempt to “get away from it all” we utilize various components of our constructed world to accomplish that objective.

Technology, Technological Literacy, and Construction

That construction did, does, and likely will exert a strong influence on humanity, although important, did not constitute sufficient basis in this study for determining its relevance as a technology education curriculum organizer. Developing understanding about the relationship between construction and technology, and the role construction plays with respect to technology literacy were considered to be essential. Therefore, a literature review was undertaken in order to establish operational definitions of these terms.

Defining Technology

Subsequent to William E. Warner unveiling *A Curriculum to Reflect Technology* in 1947, various members of the industrial arts and technology education community have at different times contributed to our understanding of the term technology. Householder (1989) credited DeVore with being “one of the first to suggest that technology should be called a discipline” (p. 12). During the mid 1960’s he published works that outlined and advocated a rationale and an organizational structure for the study of technology. Even though he did not attempt a comprehensive definition of the term, he highlighted some important features. He determined that “technology incorporates both cultural-social elements and technical elements” (DeVore, 1968, p. 12), and it is essentially a human endeavor, “because it deals with man and man created it” (DeVore, 1964, p. 7).

Outside the realm of American industrial arts, others were also contemplating the implications of technology. Jacques Ellul (1964/1954) a French scholar, discussed technology in relation to *technique* which he felt more capably described the larger “sociological phenomenon” (p. xxvi). He wrote, “the term *technique, as* I use it, does not mean machines, technology, or this or that procedure for attaining an end . . . [and it] is not an isolated fact in society (as the term *technology* would lead us to believe)” (p. xxv-xxvi). Elull did not directly define technology; instead, he implied an industrial constraint by connecting it to machines and procedures. He believed, however, that “technique is applied outside industrial life” (p. 4).

Although Elull concentrated on the implications of technique, his reflections on the meaning of that term were compatible with the less restricted definition of technology offered by some other authors, and therefore, were instructive for this study. To derive an appropriate definition, Elull, determined that rather than focusing on “different individual techniques” it was important to identify “points in common, [and] certain tendencies and principles shared by them all” ; the totality of which he called, “the technical phenomenon” (p. 19). However, he also studied the *means* or the conscious effort to find the most efficient way to accomplish a given task. This, he defined as, “the technical operation” (p. 19). He considered *the technical operation* to be a component of *the technical phenomenon*. Elull believed that the drive to optimize or identify “ the best means in an absolute sense” resulted in “a science of techniques” (p. 21). Ultimately, he felt that this science created the need for experts who became the decision makers. Related to the goal of optimizing means, Elull recognized five "subdivisions of modern technique" which were, mechanical, intellectual, economic, organization, and human (p. 22). He didn't think it necessary to explain mechanical technique because "it is so well known" (p. 22). Intellectual technique was related to information systems; "(card indices, libraries, and so on)" (p. 22). He said that "economic technique is almost entirely subordinated to production and ranges from the organization of labor to economic planning" (p. 22). "The technique of organization" applied to "not only commercial or industrial affairs of magnitude . . . but also to states and to administration of police power" (p. 22). Finally, "human technique" included a range from "medicine and genetics to propaganda" (p. 22). To comprehend all of these aspects, he defined technique as, "the *totality of methods rationally arrived at and having absolute efficiency* (for a given state of development) in *every* field of human activity" (p. xxv).

When Towers, Lux, Ray, and Stern (1966) contemplated the definition of technology, they expressed concern about the general lack of a clear understanding and the potential for inappropriate usage of the term in relation to other concepts. Specifically, they stated that, "the loose usage of the terms 'technology' and 'industry' is at the root of the terminological problem" (p. 30). They also expressed discomfort regarding the numerous ways that technology was commonly used and the potential number of ways it could be interpreted. They concluded "it means too many things to too many people" (p. 32). In addition, they were concerned that significant aspects were typically overlooked. They reviewed a definition from Webster's dictionary and determined that too much emphasis had been focused on "the means employed by people to provide itself with objects of material culture"; while too little consideration had been given to technology as "the science of the application of knowledge to practical purposes" (p. 33).

Interestingly, given their concern about terminology, they introduced another word *praxiology*, which they suggested should be used in place of technology. Although they believed that praxiology could be applied with less ambiguity than technology, they acknowledged that most people were not familiar with that term. Therefore they decided to use technology instead but restricted the meaning to: "the science of the application of knowledge to practical purposes" (p. 38). However, they also wrote, "Praxiology (Technology) is the product of the organized, disciplined study of the practices of man. It has to do with all of the practices which ultimately affect individual and social behavior" (p. 39).

While the Industrial Arts Curriculum Project publications were primarily focused on the industrial aspects of technology, Olson (1973) considered it from a broader perspective; as a significant social influence . Similar to the sentiments expressed by DeVore he wrote, "technology is man-made and is the environment he makes for himself" (p. 4.). In a more expanded discussion of the topic he described technology as a "many faceted phenomenon" (p. 2) wherein he delineated the individual aspects or facets. He determined that technology is "the total of what man knows and does with materials" (p. 2) and such knowledge is used in “gaining advantage over nature” (p. 2). Further, by using the advantages gained, humans engage in “creating [their] own environment" (p. 2), and therefore, are able to “live where [they] will” (p. 2); or more specifically, “technology is the man-made environment” (p. 2). Undoubtedly, site-built structures or our constructed environment are consistent with these criteria. In addition, Olson quite succinctly pointed out that various aspects of our society are influenced by technology when he wrote, “As technology advances culture changes” (p. 2). He also noted that human involvement with technology is a creative act of expression, whether at work or for leisure purposes; and through this involvement even the creator is changed.

Layton (1973) like Olson and DeVore, considered technology to be “a social process conducted and directed by men” (p. 2). Consequently he considered Elull and others like him to be “pessimists” and disagreed with their perception of technology as a “mysterious force that cannot be controlled” (p. 2). Layton viewed technology as knowledge, but not “simply knowledge in the abstract” (p. 3). He wrote, “It is knowledge at work --the knowledge that gives men the ability to do things. Technology, therefore, is knowledge operating in a social context and finding expression in machines and tools” (p. 3). He believed that “technology is imbedded in work. . . [but] technology need not involve machines at all -- the creation and dissemination of useful knowledge is as much a part of technology as are tools” (p. 3).

In 1981, the authors of *Jackson’s Mill Industrial Arts Curriculum Theory* forwarded their interpretation of technology which included many of the same elements that Olson included. They defined it as “the knowledge and study of human endeavors in creating and using tools, techniques, resources, and systems to manage the man-made and natural environment for the purpose of extending human potential and the relationship of these to individuals, society, and the civilization process” (Snyder & Hales, p. 2). Unique to this definition was the inclusion of systems. By looking at the evolution of “socio-technological organizations “ plus the advancement of technological artifacts, the authors determined that “technology was a total system composed of many elements and subsystems” (p. 3). As such, it represented one of three fundamental adaptive systems used by humans. Subsystems within the technological component of the “human adaptive systems” were identified as “universal technical systems” (p. 16). Construction was specified along with manufacturing, communication and transportation as one of these universal technical systems because it was considered to be “basic to every society” (p. 16).

Volti (1988) also considered systems to be essential to technology, but more fundamental than that was “group effort” (p. 4) or, organization. He suggested that, “even a relatively simple technology, such as one centering on the use of earthen ware pots, requires a complex network of material suppliers” (p. 4). While Volti did acknowledge that one person might be able to perform all of the functions related to the pottery example, he was certain that such an approach would not be very efficient or productive. Furthermore, he explained that this would be impossible if we were to consider something more sophisticated such as a “computerized manufacturing system” (p.4). Therefore, he defined technology as, “a system based on the application of knowledge, manifested in physical objects and organizational forms, for the attainment of specific goals” (p. 6). Curiously, after offering this definition he noted a short-coming related to “specific goals”, which was “the possibility that technology does not always respond to existing needs; a new technology may in fact create its own needs” (p. 6). Had this issue been addressed prior to composing the definition a qualifier might have been included, for example; *in attempting to attain specific goals* would be one alternative that could have addressed this concern.

The authors of A Conceptual Framework for Technology Education skillfully allowed for the unintended consequences or results of technology when they defined technology as *“* a body of knowledge and the systematic application of resources to produce outcomes *in response* to human needs and wants” (1990, p 7) [italics added]. As Volti (1988) acknowledged “the attainment of specific goals” (p. 6), is not always the result of a technological endeavor. This pitfall was avoided by writing “in response to human needs and wants” (Savage, E. & Sterry, L.,1990, p 7) because it doesn’t attempt to address the outcome; it simply cites the motivation.

Critical to the understanding of Savage and Sterry’s (1990) definition was the meaning ascribed to resources. Resources were defined as “people, tools/machines, information, materials, energy, capital and time” (p. 16). Several questions or concerns arose as this definition was analyzed. First, the authors indicated that technology is “a body of knowledge,” but the wording did not clearly connect knowledge and application. This left the reader wondering if and how such knowledge might be used. Second, as written, the definition seemed to imply that as resources, people were to be systematically applied. If read in this manner, one possible interpretation was that technology managed people rather than the other way around. Third, this definition failed to mention any kind of reciprocity between society and technology; instead, technology almost seemed to be an independent entity.

While the definition itself was ambiguous or imprecise, other portions of this document did address and elucidate the three points of concern identified above. With respect to the socio-cultural aspect of technology, the authors wrote that, “technology is an integral part of our society and culture” (p. 7). In terms of the human/technology relationship, it was considered to be reciprocal. This was demonstrated by the following points: 1) “People create technology," 2) “Technology responds to human wants and needs," 3) “People use technology," 4) “Technology affects and is affected by people, society and culture," 5) “Technology shapes and is shaped by values” (p 11). Regarding knowledge, it was expected to “give people an understanding of what it was, is, and can be” (p. 10). In addition, the authors wrote that technological knowledge can be applied “in a social/cultural context through technical processes and systems to produce outcomes in response to human wants and needs” (p. 10). Nevertheless, after investigating beyond the stated definition, new insights remained limited to certain aspects of resources, specifically, the need to incorporate energy, capital, and time.

Wenk (1995) supported his contention that “every technology has a core of science and engineering” (p. 21) by defining what he considered to be the significant related terms. He defined technology as, “a set of organizations and resources synchronized to produce specific goods or services” (p. 21). He described natural science as “a highly differentiated body of knowledge used to predict natural phenomena and ultimately control them” (p. 21) and, engineering was defined as “problem solving, applying factual information to the arts of design” (p. 22). Wenk perceived technology, science, and engineering as connected through research and development which are engaged “to generate new basic knowledge, and . . . to prove new applications” (p. 23). Although he recognized the necessity of knowledge for the development of technology, it did not appear to be an integral component; he seems to have credited science and engineering as the originators and defenders of that knowledge.

Finally, the definition, “technology is human innovation in action” (1996, p. 16.) offered by the Technology for All Americans project provided the most limited explanation of the concept of those reviewed. The authors elaborated on it somewhat and wrote, “[technology] involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities” (p. 16). While these statements to some degree confirmed attributes previously identified in the reviewed works, such as knowledge, systems, and solving problems to enhance the quality of human life, they did not enrich or expanded our understanding.

The one unique aspect of this definition worthy of careful deliberation was an apparent limitation implied by the use of the words innovation and generation. According to Webster's New World Dictionary of the American Language (1986), *innovate* was derived from the Latin word innovare which meant "to renew or alter" (p. 726). However, the more current meaning was "to introduce new methods, devices, etc." (p. 726). The follow up sentence which seemingly was intended to clarify the scope and meaning of "human innovation in action," discussed the "generation of knowledge". This addition was neither expansive or edifying, in that *generation* was found to mean "the act or process of bringing into being; origination; production" (p. 581). Conceptually this phrase was synonymous with innovation. Indeed, innovation has been and is a valued component of technology as evidenced by the frequent use of the various conjugations of the verb *create* which were encountered in most of the documents examined during the investigation of this topic. Even so, the preceding review of definitions has demonstrated that the whole of technology was not embodied in creativity or innovation. Further, the fact that knowledge of existing or previously discovered technologies was not recognized in this definition was indicative of a significant flaw since, "the acquisition of these technical means has been cumulative over the years with each new element adding to the existing inventory of knowledge" (Savage & Sterry, 1990, p. 7).

Technology - An Operational Definition

After reviewing the work of the preceding authors, it became evident that technology was more than the basic dictionary definition: "the science or study of the practical or industrial arts, [or] applied sciences" (Guralnik, 1984, p. 1460). Because no single definition incorporated all of the attributes identified, it was necessary to synthesize a definition by drawing on the contributions of the various works that were reviewed. Therefore, the following operational definition was composed for the purpose of establishing a base of understanding related to this research. *Technology is knowledge applied and created in response to perceived wants and needs, which alters the human and non-human environments through the use of tools or devices, methods, and systems in processes that convert and/or consume resources*.

To enhance the likelihood that readers of this definition will understand it as the author intended, the following explanations were offered.

- *Knowledge applied* - assumes the existence of knowledge whereas *knowledge created* assumes the addition of new knowledge to the existing body of knowledge.
- *In response to perceived desires and needs* - recognizes that people perceive individual and societal requirements, dreams, and goals. In addition, humans also perceive or believe they perceive the needs (and in some cases desires) of non-human entities. Given the value laden nature of perception and the subsequent selection of a response, perceptions

may or may not be accurate and responses may or may not be efficient, effective, or appropriate.

- Alteration of *the human and non-human environments* - implies technologically induced change which includes: intended and unintended physical, affective, and cognitive impacts on individuals and societies; any and all impacts on animals, plants, or ecosystems; redistribution, reformation, or reconstitution of living and non-living materials. Also included are any changes to technology resulting from the changing context in which it exists and operates.
- Other authors suggested that one of the requirements of technology was organized or systematized knowledge or actions (Enull, 1954; Towers et. al, 1966; Volti, 1988; Savage & Sterry, 1990). However, this author's definition makes no such assumption. When technological knowledge is being created and initially applied, no organization or system may exist. Continued use, refinement, and expansion of such knowledge would constitute the criteria for organization or systemization. Therefore, while all technological means *(tools or devices, methods)* have the potential for altering existing systems or developing into new systems, an organized system is not considered essential for technology to exist.
- Whether the outcome of a technological activity is physically measurable, or cognitively registered, resources such as energy, capital, labor, materials, or time are converted and/or consumed in the process.

A Review of Selected Definitions of Literacy

According to Webster's New World Dictionary, literacy was, "the state or quality of being literate; ability to read and write" (Guralnik, 1982, p. 825). Literate was defined as, "1. able to read and write 2. well educated; having or showing extensive knowledge, learning, or culture 3. [Now Rare] versed in literature" (p. 826). Related to the varied skills or abilities required when reading or writing, Hatch (1985) concluded that literacy is a "mulitdimensional concept that assumes a functional level of ability on each of its dimensions" (p. 23).Dyrenfurth (1991) in citing Miller stated that, "the most popular sense in which the term is taken is the ability to read and write at a level that allows an individual to function - at least minimally" (p. 139). He did, however, point out that other interpretations or extensions of this term have emerged; with such examples as, "agricultural, computer, economic, [and] . . . cultural literacy" (p. 139). DeVore, (1992) strengthened the argument that new species of literacy are evolving or are being recognized when he wrote, "technological literacy is a form of literacy never before provided by schools and formal education" (p. 60). If literacy can be modified or subdivided by descriptors representing different fields of study or knowledge, then it also seems logical that each of those fields would contain unique dimensions. Therefore, whether *technological* or some other descriptor, the use of adjectives to modify the term literacy was consistent with Hatch's viewpoint and, at the same time, supported the concept of "extensive knowledge" as it relates to specific fields of study.

Acceptance of a definition of literacy which encompasses more than the ability to read and write doesn't necessarily diminish the importance of these skills. In a multiple dimension conception of disciplinary specific forms of literacy, reading and writing would comprise important dimensions. Reading and writing, after all, are vital means of obtaining and sharing knowledge. The transmission of knowledge is, however, not limited to these activities. Furthermore, these skills do not represent the totality of our potential means for creating and accessing knowledge. Different disciplines not only focus on unique bodies of knowledge, they also incorporate diverse methods of inquiry. Therefore, certain combinations of particular categories of knowledge and skills constitute functional literacy within specific domains. And, as Hayden (1989) noted, knowledge and the ability to function are inseparable (p. 32).

Referring back to the dictionary definition of literacy, it indicated that literacy describes a certain "state or quality of being". When the meanings of *state* and *quality* were investigated, another aspect of literacy was revealed. The first meaning assigned to *state* was, "1. a set of circumstances or attributes characterizing a person or thing at a given time; way or form of being; condition" (Guralnik, 1982, p. 1390). Quality was, in part, defined as, "1. any of the features that make something what it is; characteristic element or attribute 2. basic nature; character; kind 3. the degree of excellence which a thing possesses" (p. 1161). Both state and quality were similar in that they point to the existence of attributes or characteristics. Further, both definitions implied that these attributes were fluid; they allowed for a range of reactions. The definition of state included the element of time. The "*degree* of excellence" found in the definition of quality suggested the existence of levels of variance. Therefore, the dimensions of literacy can be expressed along a continuum from total absence of knowledge and ability to possessing all knowledge and ability.

Considering that literacy is typically discussed in relationship to illiteracy; some level of knowledge, ability, or competence is assumed. The dictionary used "extensive' to describe the level of require knowledge to be considered literate. Good (1973) interpreted it as having the "ability to read and write at the level of the average fourth grade pupil" (cited in Hatch, 1985, p. 22). To resolve this apparent incongruity would require considerable effort. To begin with, it is essential to recognize that the label *literate* is applied according to standards formally or informally established within diverse contexts or domains. To formalize or clarify such standards it would be necessary to determine and make meaningful comparisons of measurable characteristics to be used in identifying the terms *extensive* and *functional* in relationship to the knowledge base of any domains or contexts of interest. Because the goal of this research was to carefully consider the qualities assigned to the construct literacy, it was essential to point out its variable nature, which may be consciously acknowledged or unconsciously assumed. However, defining specific characteristics related to levels of attainment was left for future research.

An Operational Definition of Literacy

As a result of the prior analysis, literacy was operationally defined as *the combination of domain specific knowledge and ability that constitutes functional competency; wherein such domain specific knowledge and ability can be subdivided into measurable dimensions of a multidimensional construct*.

For purposes of clarity, the following dictionary definitions have been included.

- Competent - “1. well qualified; capable; fit [a *competent* doctor] 2. sufficient; adequate [a *competent* understanding of law]” (Guralnik, 1982, p. 289).
- Functional - the ability to perform “a special duty or performance required in the course of work or activity” (p. 565).

Technological Literacy

The benefits of technological literacy have been extolled for some time now. In 1605 Francis Bacon wrote,

> Historie Mechanical, is of all others the most radicall, and fundamentall towards Natural Philosophie, such Natural Philosophie, as shall not vanish in the fume of subtile, sublime or delectable speculation, but shall bee operative to the endowment, and benefit of Mans life . . . . Many ingenious practizes in all trades, by a connexion and transferring of the observations of one Arte, to the use of another, when the experiences of

> severall misteries shall fall under the consideration of one man's mind. (pp. 6, 10)

In more recent times, DeVore (1964) suggested the need for technological literacy when he wrote, "today the solution of the problems of our society requires an educated citizenry - people knowledgeable about technology" (p. 15). In 1968 he called for it specifically, and stated that, "there is a greater need than ever before for technological literacy" (p. 1). Almost thirty years later virtually the same position was argued by the Technology for All Americans project. The author's wrote,

> Because of today's technological processes, society and individuals need to decide what, how, and when to develop or use various technological systems . . . . Such decision making depends upon all citizens acquiring a basic level of technological literacy — the ability to use, manage, and understand technology (1996, p. 6).

In addition to these examples, other authors (Olson, 1973; Hale & Snyder, 1981; Lauda, 1982; Erekson, 1986; Gilberti, 1986; Jones, 1986; Maley, 1986; Technology Education Advisory Council, 1988; Project 2061, 1989; Savage & Sterry, 1990; Dyrenfurth, 1991; DeVore, 1992), to mention a few, have pointed out the need for educational programs that would afford students the opportunity to become technological literate. In fact, within the field of technology education, the importance of this goal has been such that, "literature citations alone that verify this would fill many, many pages" (Jones, 1986, p. 35).

Even though there has been strong support for this clarion call, a consensus has never been reached as to what technological literacy is or exactly how it might be achieved. Erekson concluded that, “technological literacy has been difficult to define in precise terms — it means different things to different people/groups” (1986, p.12). Gilberti (1986) felt the need to “bring about some consensus” but after reviewing the definitions of several different authors determined that “more work is needed” (p. 22). In a similar vein, Dyrenfurth (1991) wrote, “Given the plethora of informed and uninformed material written about technology and technological literacy, it is a genuine challenge to assemble anything resembling a cogent synthesis” (p. 138).

Difficulties notwithstanding, it seemed logical that failure to clearly delineate the essential components of technological literacy would result in an inability to determine appropriate curriculum and course content for technology education. Consistent with this line of thinking, Towers et. al. (1966) wrote, “to provide for the most effective and efficient transmission of knowledge, the educator must codify and structure disciplined bodies of knowledge” (p. 3). In support of developing a taxonomy for the field of technology, DeVore (1968) argued that a structure is necessary in order to comprehend the totality of a field of knowledge, and identify “the component elements and their interrelationships” (p. 10) . He further noted that the organization of disciplinary knowledge precedes curriculum development. Savage and Sterry (1990) expressed similar sentiments when they wrote, “curriculum development follows a process which begins with the development of a program philosophy, generates program goals and objectives, creates subject objectives, and places this information into a scope and sequence” (p. 27). To illustrate how one might apply this approach they provided samples of a “program philosophy” and “program goals” (p. 27). Upon inspection, those samples were found to be closely aligned with their “mission” statement and closely aligned technological literacy “goals” (p. 20).

An analysis of selected definitions of technological literacy was, therefore, imperative for determining essential themes and attributes which could contribute to an operational definition. After an initial review of several definitions, it became apparent that some issues required a discussion of fundamental considerations related to writing a definition .

Considerations Related to Writing a Definition

The editors of the *Britannica World Language Edition of Funk and Wagnall’s Standard Dictionary* in keeping with their stated purpose “to present the fundamental facts and characteristics of the language accurately, faithfully, and interestingly” (1965, p. iv)) pointed out that a primary tenet for establishing the meaning of a word is, “to formulate a definition that can substitute for the word itself in the context in which the user reads or hears it” (p. iv). For the editors of a dictionary this is accomplished through considerable research and by following certain prescribed methods or rules. One generally known and accepted rule related to dictionaries is that “main entries follow one another in alphabetical order” (Mish, 1984, p. 10). On the surface, mentioning a practice so fundamental seemed unnecessary. However, with respect to clarifying a the meaning of a word and its derivatives, this simple method has proved to be quite beneficial. Another commonly accepted rule related to writing a definition is, avoid using the word being defined in the definition. A few exceptions to this rule do exist though and have been cited. In the case of a word having multiple senses or multiple meanings associated with the word, the word or a form of the word might be used to differentiate one sense from another. Guralnik (1984) described the use of “illustrative examples of entry words in context” and stated, “these brief illustrative examples are helpful in clarifying meaning, discriminating a large stock of senses for a basic word, showing level of usage or special connotation, and supplying added information” (p. xiii). In the case of “internal entry words," they may “occur within definitions . . . [wherein] the meaning of the inserted entry word is made clear in the definition” (p. xiii). In addition, a main entry may have cross-references which utilize the root or a derivative of the main entry. Besides reviewing the initial explanatory sections of several dictionaries, I spoke with Mr. Andrew Sparks, an editor of Webster’s New World Dictionaries and discussed the appropriateness of using the word one is defining within the definition. He commented that, other than the case of expanding on one or more of the senses of a multiple sense word, it was simply a matter of common sense and/or logic that such an approach was flawed and unlikely to enlighten the reader. A review of the definitions of technological literacy incorporated in Table 1. demonstrates the reason that this issue was raised. All of the definitions of technological literacy included in this table, to some degree, violated this basic rule, and therefore, weren’t readily understandable or comparable.

	Components of Selected Definitions of Technological Literacy	Dyrenfurth (1991, p. 179)	Technology for All Americans (1996, pp. 1 & 6)
1	Extent to which an individual understands and is capable of using technology	✵	8, 10
2	Basic functional skills - competency	✵	
3	Critical thinking - competency	✵	9, 12?
4	Constructive work habits - competency	✵	
5	Generalized procedures for working with technology - competency	✵	10
6	Interpersonal & teamwork skills - competency	✵	
7	Ability to learn independently - competency	✵	12
8	Citizens have a degree of knowledge about nature, behavior, power and consequences of technology from a broad perspective	1	✵
9	Critical thinking related to designing and developing products, systems, and environments to solve practical problems	3	✵
10	The ability to use technology involves the successful operation of key systems of the time. This includes knowing the components and behavior of systems	1, 5	✵
11	The ability to manage technology to insure efficient and appropriate activities		✵
12	Understanding technology involves more than facts and information, but also the ability to synthesize the information into new insights	3, 7?	✵
13	A functional understanding of technology in making decisions related to the major technological problems confronting society	1	8
14	The ability to use tools (i.e. technology) along with the know-how to solve practical problems	1	10
15	Understanding and appreciation of the contributions of technology, its evolution and associated problems	1?	8
16	Utilize technology to solve problems or meet opportunities to satisfy human wants and needs	1, 2?	9
17	Recognizing that problems and opportunities exist that relate to and often can be addressed by technology	1?	9
18	Identifying, selecting, and using resources to create technology for human purposes		10
19	Identifying, selecting, and efficiently using appropriate technological knowledge to satisfy human wants and needs.	1	10, 11
20	Evaluating technological ventures according to their various consequences	3?	8, 11
21	Knowledge about the history, evolution, nature, and development of technical means, including the people, places, cultures, and environmental contexts in which the means were invented and developed.		8
22	Knowledge and understanding of the processes of invention and innovation, including experience in the process.	1	9, 12
23	Knowledge and understanding of the behavior of adaptive systems and the tools, machines, materials, and techniques & associated biological and physical transformations and energy conservation processes.	1, 2, 5	8, 10
24	Knowledge and understanding of the behavior of technical element and adaptive systems and the assessment of their impact in relation to humans, societies, & the natural environment within agreed upon ethical contexts.	1	8, 11
25	Multidimensional comprehension of technique and applied science, which are used to offer explanations and/or solutions [to] the problems in the natural and human-made environment.	1, 2, 3	8, 9, 10, 12

Table 2. A Comparison of the Components of Selected Definitions of Technological Literacy

	Hatch (1985, pp. 26-27)	Savage & Sterry (1990, p. 20)	DeVore (1992, pp. 62 - 63)	Gilberti (1986, p. 21)
1	14	16, 19	22, 23. 24	25
2	14	16	23	
3	14	16,17,18,19, 20	22	25
4				
5			23	25
6				
7				
8	13	20	21, 23, 24	25
9	14	19	22	25
10	14	18, 19	23	25
11	13	19, 20	24	
12			22	25
13	✷	17, 20	24	25
14	✷	16, 17, 18, 19	22, 23	25
15	✷	17?	21	25
16	14	✷	22	25
17	13	✷	22, 23	25
18		✷	23	25
19	14, 15	✷	23, 24	25
20	13	✷	24	25
21	15		✷	25
22	14?	16, 17	✷	25
23	14?	18, 19, 20	✷	25
24	13	20	✷	25
25	13, 14, 15	16, 17, 18, 19, 20	21, 22, 23, 24	✷

✷ = Author's work.

The numbers listed in each column represent potential linkages between the concepts or characteristics which comprise the definitions offered by the various authors. Each concept corresponds to a number in the left hand column. The numbers within the columns represents this author's attempt to cross-reference the various concepts. Linkages were established by identifying the same or similar wording, or by identifying phrases with related meanings. In those cases where it was challenging but possible to identify a relationship between two concepts, the texts were reread to clarify the original authors' intentions. The most abstract relationships are denoted by a number followed by a question mark. In performing this analysis, subjective judgment was used, therefore, other readers may reach different conclusions.

Note: Although most of the definitions were directly quoted a few have been paraphrased.

To complicate matters further, the definitions included in Table 1. were written without some of the operational benefits available in a dictionary. To illustrate these points the dictionary definitions of technological and its affiliates were reviewed.

First, with respect to the relative location of the word technological in the dictionary, it was preceded alphabetically by the related terms technic, technical, and technique; and followed immediately by technology (Guralnik, 1986, p 1460). Technological was defined as, "1. of or having to do with technology 2. due to developments in technology; resulting from technical progress in the use of machinery and automation in industry, agriculture, etc. " (p. 1460). Clearly, without an understanding of the word, technology, the first sense wouldn't have been very informative. The second sense was somewhat more expansive and identified certain characteristics, but it also utilized technology and the related term, technical. Based on these observations, it was determined that technological was not a root word.

To develop a more complete understanding, the first alphabetically related listing, technic, was investigated. Initially, technical and technique were listed as cross-references for technic; and then the following definition was offered: "the study or principles of an art or of the arts, esp. the practical arts" (p. 1460). Because the first cross-referenced word, technical, was also used in the definition of technological, it seemed appropriate to follow up with that word. Therefore, related to the field of technology education, technical was defined as:

> 1. having to do with the practical, industrial, or mechanical arts or the applied sciences [a *technical* school] 2. of, used or skilled in, or peculiar to a specific science, art, profession, craft, etc.; specialized [*technical* vocabulary] 3. of, in, or showing technique [*technical* skill] 4. in terms of some science, art, etc.; according to principles or rules [a *technical* difference] (p. 1460).

The bracketed portions as seen in the paragraph above, provided excellent "illustrative examples" of the defined word being used in the intended context. It should also be noted that those examples were used to illuminate rather than to define.

In terms of history, Webster's Ninth New Collegiate Dictionary cited 1617 as "the date of earliest recorded use" (Guralnik, 1984, p. 17) of the word technical in the English language. Possible origins of the word were identified as the Greek word *tecnikos*, meaning art or skillful; *techn*é, French for art; or the Greek word *tekton* which meant builder or carpenter (p. 1211).

Technique, the second cross-reference found listed under technic was defined as:

> 1. the method of procedure (with reference to practical or formal details), or the way of using basic skills, in rendering an artistic work or carrying out a scientific or mechanical operation 2. the degree of expertness in following this [a pianist with good *technique* but poor expression] 3. any method or manner of accomplishing something (Guralnik, 1984, p. 1460)

Once again, the use of the main entry in the definition was limited to its use as a contextual illustrative example.

As was previously brought out, technology was incorporated into the first sense definition of technological. The dictionary delineated its attributes as follows:

> 1. the science or study of the practical or industrial arts, applied sciences, etc. 2. the terms used in a science, art, etc.; technical terminology 3. applied science 4. a method, process, etc. for handling a specific technical problem 5. the system by which a society provides its members with those things needed or desired.

Considering the above definition, several points were observable and noteworthy. 1) The first three senses of the definition were composed of unique descriptors; in other words, terms not derived from or related to the main entry. 2) Following those, technical was used for the purpose of illustration or clarification. 3) In the case of the fourth sense, while it was essential to be able to comprehend the word technical, a form of explanation was available in the second sense. Further, because these terms and their definitions were found in a dictionary, in alphabetical order, any confusion about the meanings was quickly resolved.

The purpose for this analysis was to expose some simple but essential considerations required to arrive at a meaningful definition, and to observe the advantages a dictionary offers which most manuscripts do not. Obviously, Dyrenfurth, Technology for All Americans, Hatch, Savage & Sterry, DeVore, and

Gilberti (See Table 1.) had different limitations, objectives, and responsibilities when composing their definitions of technological literacy than did the dictionary editors. Nevertheless, assuming that increased comprehension of this construct was a primary goal for these authors, then those conventions that were most likely to result in a precise and readily interpretable definition remained valid.

Given that the dictionary defined technological and literacy separately, a terminological comparison with the work cited in Table 1 was not possible. The dictionary did, however, provide a conceptual and procedural background against which other work could be appraised. With respect to the definitions of technological literacy found in Table 1, it was interesting to note that four of the six (Dyrenfurth, Technology for All Americans, Hatch, and Savage & Sterry) used the word technology in their definitions, and the remaining two (DeVore and Gilberti) used technical and techniques, or technique. In order for readers to confidently grasp the intended meanings of technological literacy with technology, technical, and technique serving as descriptors; the requirement for these terms to be precisely defined and easily located in the text seemed obvious. The fact that no two of the cited authors defined technology in the same way seemed indicative of a lack of consensus regarding this term. Further, no definitions of technical or technique were offered. Therefore, one would have to assume that the use of these descriptors in a definition of technological literacy would, at best, create an aura of ambiguity. Finally, although all of the cited authors included some form of definition for technology, none of them were located in close proximity to the definition of technological literacy, thereby reducing the readers efficiency in obtaining a clear understanding.

The documents reviewed related to this discussion of technological literacy primarily focused on defining technological literacy or defining the field of technology education. In either case, this author perceived the definitions of technology and technological literacy to be paramount to the successful communication of the themes forwarded. Other than in Hatch's dissertation, a glossary is not commonly expected in the type of documents cited. On the other hand the use of a derivative or the root word in a definition was surprising. Given that these terms have not easily or necessarily been successfully defined, as observed in the section of this paper titled A Review of Technology, and as presented in Table 1, it seems that careful if not extraordinary efforts are warranted in order to achieve understanding and consensus.

After considering these issues and attempting to cross-reference the definitions of technological literacy included in Table 1, DeVore's outlook on the assorted perceptions of technology struck a familiar chord. He wrote,

> The diverse and conflicting viewpoints about technology are of little help to those concerned with public policy, education, and technological literacy. With no common agreement on meaning, it is difficult to pursue intelligent public policy, develop valid curricula, or establish programs to attain desired levels of technological literacy (1992, p. 61).

Certainly diversity has its advantages in that some authors identified or clarified aspects of technological literacy that others ignored or left vague.

However, due to the complexity of the subject matter and the potential for multiple and varied interpretations, a definition was necessary that identified specific characteristics of technological literacy. Warner (1947) said that, “a definition is therefore needed that can be stated in the context of application or program. In short, a definition needs to identify the principle functions of Industrial Arts [Technology Education] and then to indicate how they should be applied” (p.41).

A review of the definitions for technological literacy cited in Table 1 allowed for the development of the following table which categorizes the attributes of technological literacy common to two or more definitions.

Table 3. Attributes of Technological Literacy

• Knowledge about and the ability to use: tools, resources, procedures, and systems. (See Table 1 items 1, 10, 14, 16, 19, 22, 23, 24, & 25)
• Knowledge about and the ability to do critical thinking and/or problem solving. (See Table 1 items 3, 9, 14, 16, 17, 18, 19, 20, & 25)
• Knowledge about and the ability to perform management responsibilities - evaluating alternatives, assessing impacts, and making decisions. (See Table 1 items 11, 13, 18, 19, 20, & 24)
• Knowledge about and the ability to engage in designing and developing, or inventing. (See Table 1 items 9 & 22)
• The ability to learn or synthesize new insights. (See Table 1 items 7 & 12)
• Knowledge related to the historical development of tools, devices, methods systems, and resources; specifically how humans have used these to alter the environment, and how their invention and use have shaped human history. (See Table 1 items 8, 15 & 21)

Since each definition was in various ways unique, the above listed attributes of technological literacy represent this author's best efforts to discern the intended meanings and create reasonably compatible groupings. Given the subjective nature of this task, other readers may arrive at similar or different conclusions. Some of the difficulty in performing this analysis arose due to the way that the individual authors combined or connected various elements. For example: Dyrenfurth (1991) wrote about "an array of competencies" (p. 179), one of which was critical thinking (see Table 1, item 3). The Technology for All Americans project also used the words "critical thinking" (see Table 1, item 9) but connected them to "designing and developing products, systems, and environment to solve practical problems" (1996, p. 1). Besides critical thinking and problem solving, this statement introduced elements which seemed quite similar to DeVore's inclusion of "invention and innovation" (1992, p. 63) (See Table 1 item 22). To add to this, each component of the definition offered by Savage and Sterry (1990) included some element that implied critical thinking (see Table 1, items 16-20). They wrote about "utilizing technology to solve problems", "recognizing that problems and opportunities exist that . . . can be addressed by technology," and they also used the words "identifying, selecting" and "evaluating" (p. 20); all of which seemed to require critical thinking but in different contexts. As a result, one component of an author's definition often related to several components identified by another author. Needless to say, the potential for confusion and frustration was great.

An Operational Definition of Technological Literacy

For the purpose of establishing clearly identifiable linkages, and therefore, a greater degree of understanding, the operational definitions of technology and literacy were repeated here.

Technology was operationally defined as: *knowledge applied and created in response to perceived desires and needs, which alters the human and non-human environments through the use of tools or devices, methods, and systems in processes that convert and/or consume resources*.

Literacy was operationally defined as: *the combination of domain specific knowledge and ability that constitutes functional competency; wherein such domain specific knowledge and ability can be subdivided into measurable dimensions of a multidimensional construct*.

With the above in mind, technological literacy was operationally defined as: *a competent level of knowledge and ability related to altering the human and non-human environments through the use of tools or devices, methods, and systems in processes that convert and/or consume resources*; *in response to perceived wants and needs*.

Definite relationships were also readily observed between the above operational definition of technological literacy and the attributes of technological literacy identified in Table 2. Knowledge about tools, resources, procedures and systems and the ability to use them was obviously incorporated in this author's definition. The knowledge and ability to do critical thinking and/or problem solving is the application or creation of knowledge in response to perceived desires or needs. The ability to apply or create knowledge related to the alteration of human and non-human environments certainly demands the evaluation of alternatives and (if consciously done) the assessment of impacts as part of the decision making process. Applying knowledge in order to create knowledge is synonymous with inventing or designing and developing. Similarly, applying and creating knowledge to advance oneself is equivalent to synthesizing new insights or learning. Finally, the ability to apply knowledge assumes that knowledge exists prior to the intended application, and prior existence implies history.

Establishing an Operational Definition for Construction

Several definitions were reviewed in order to establish an operational definition for the term "construction". Although largely similar, some definitional variations were found because of difference in each authors' focus. For example, some definitions include aspects that suggest an industrial or work related aspect where others do not.

Webster's New World Dictionary offered a fairly generic or nonwork-related explanation. However, to develop sufficient understanding a few associated terms needed to be examined. The noun *construction* was specifically defined as, "1. the act or process of constructing 2. the way in which something is constructed; manner or method of building" (1986, p. 305). Because a gerund and a verb form of construct were used in the preceding definition, the term *construct* was reviewed and found to mean, "1. to build, form, or devise by fitting parts or elements together systematically" (p. 305). For further clarification *build* was reviewed; and, related to this area of research, was defined as, "*vt*. 1. a) to make by putting together materials, parts, etc.; construct; erect b) to order, plan, or direct the construction of *vi*. 1. a) to put up a building b) to have a house, etc. built" (Guralnik, 1986, p. 185). Consideration of all of the components identified did provide some idea about the basic nature of construction. The examples pointed towards structures in which we live and work, but the actual definitions of construct and build did not specify any unique characteristics which would provide a means of discriminating between construction and manufacturing.

The authors of the Industrial Arts Curriculum Project (IACP) *A Rationale and Structure for Industrial Arts Subject Matter* wrestled with the problem of differentiating between these two production systems.. They stated that, "at the highest levels of generality there are no differences between production technology in manufacturing and construction" (Towers, Lux, Ray, Stern, 1966, p. 214). They felt that differences could be identified "when combinations of generic classes of processes are applied to the specific production problems of manufacture or construction" (p. 214). Even so, they determined that they were not able to present an "adequate classification system . . . for man's constructed works, because their largely custom and multi-function nature defies classification" (p. 230). They did provide, however, the following list of characteristics which could be used to identify and categorize a product of construction.

Characteristics of constructed works:

1. Ownership
    1.1 Private
        1.1.1 Local
        1.1.2 Group
    1.2 Public
    1.2.1 Local
    1.2.2 State
    1.2.3 National
    1.2.4 International

2. Location
    2.1 Air
    2.2 Land
    2.3 Water
    2.4 Space
    2.5 Underground

3. Function
    3.1 Family
    3.2 Education
    3.3 Religion
    3.4 Government
    3.5 Economic

4. Process
    4.1 Mass
    4.2 Reinforced

5. Form
    5.1 Building
    5.2 Non-building (p. 231)

In the textbook *(The World of Construction)* which followed the *A Rationale and Structure for Industrial Arts Subject Matter*, the authors supplied a simple definition of construction along with examples. They wrote,

"Construction is building something on a site. Examples of construction are:

1. Building a house,

2. Putting in a sewage system, and
3. Building a bridge over a river" (Lux and Ray, 1970, p. 4)

To further clarify the difference, they wrote that, "*manufacture* is producing products in a factory or plant" (p. 4).

Reflecting back on the more theoretical rationale and structure document and the hesitancy the authors expressed with regard to differentiating construction from manufacturing, the citation from the text seemed indicative of a compromise; perhaps due to the fact that the two publications targeted different audiences. The idea that construction takes place on a site as opposed to manufacturing taking place in a factory seemed to be a natural and effective, although possibly imperfect, means of separating the two production systems.

Previous to the work done by the IACP authors, Warner (1947) provided similar examples of construction when he described it as, "simple fabrication, housing, public works, industrial, national defense" (p. 41). Considering that "simple fabrication" could apply to almost any form of production, it appeared that Warner was not overly concerned about establishing areas of exclusivity for construction or manufacturing.

Similar to Warner's approach to defining construction, Savage and Sterry (1990) provided examples of constructed works, and described the production aspect of it in fairly broad terms. They determined that constructing means "to produce goods to fill society's living, working, and transportation needs (e.g. homes, buildings, bridges, railways, roads, tunnels, canals, dams)" (p. 18). Without the above examples this definition was not only applicable to manufacturing, such things as agricultural products would fit. Compared to the previously cited definitions, a unique aspect of this definition was the identification of the beneficiary, society, which the authors defined as “a group of people working as a cohesive unit bound together by its culture” (p. 7). While the inclusion of society appeared to demonstrate linkage with the “human wants and needs” (p. 7) portion of their definition of technology, it failed to incorporate individuals as part of the equation.

The definitions offered by Hale and Snyder (1981) and Henak (1994) had some similarities which were compatible with themes expressed in the IACP documents. They both noted the site related nature of construction. They also included an element which indicated an industrial technology constraint or delimitation as compared with a broader technology focus. This industrial slant was exemplified by the incorporation of the concept of efficiency. While efficiency is often important to individuals involved in a construction project, it is vital for industry in that profit levels are strongly affected by it. Efficiency and profit, however, may not always be the primary sources of motivation; if, for example, the management approach for a project was determined by cultural, religious, or artistic considerations.

Hale & Snyder (1981) defined construction as “a technical adaptive system *designed by people* to efficiently utilize resources to build structures or constructed works on a site” (p. 30). By crediting *people* with an active role in this system, this definition encompassed both society and individuals. However, “to efficiently utilize” seemed to imply a management function which relates to the earlier suggestion of an industrial limitation on the definition. This supposition was supported by the authors' statement that, "the production of constructed goods must be carefully managed" (p. 30). With respect to people as consumers or recipients of the output or consequences of technical adaptive systems, other portions of this document did consider these categories of interaction; this definition of construction, though, appears to have ignored them.

Henak (1994) aimed his attention at a somewhat bigger target; *construction technology*, and defined it as, "the study of the efficient practice of using production and management processes to transform materials and assemble components into buildings, and heavy industrial and civil structures that are built on site" (p. 1). As was previously suggested, this definition had an industrial slant. Henak's " efficient practice of using production and management processes" conveyed a big business image of construction; certainly not one which embraced do-it-yourselfers. The examples of constructed works he provided were also noteworthy in that they could be interpreted as an exhaustive representation of the major classifications of construction projects.

Construction Operationally Defined

After considering the work of the authors cited in this section and in conjunction with the operational definition of technology, an operational definition for construction was developed. In was this author's intention that the definition reflect the unique characteristics of this construct in such a way that it could be meaningfully used to devise curriculum. With this in mind, construction was defined as: *a site-specific human enterprise which involves the use of tools and devices, methods, and systems in processes that convert and/or consume resources for the purpose of creating, maintaining, and modifying environments in response to perceived wants and needs*.

To increase the likelihood that readers of this definition will perceive it in a fashion congruent with the author's intended meaning, the following explanations have been offered.

- The *site-specific* aspect of a constructed work implies that the product is the altered site. This is different than an orange grove, for example; where the land or the site is obviously changed but the product, oranges, is shipped to the market place.
- While other living organisms do construct nests, burrows, tunnels and more, this study focused on human activities and the definition was delimited accordingly.
- As has been discussed before, the concept of *in response to perceived needs and desires* is subjective and the interpretation of benefits is dependent on the values and perception of the person who is assessing the product. For example, if a dam is built to generate hydroelectric power, some may appreciate being able to light and heat their homes. At the same time, the downstream effect on the river environment may be devastating.

Because this study was concerned with construction as an organizer of technology education, and technology education was considered to be general education rather than vocational education or training for industry, constructed works have been divided according to how they are used or how people interact with this form of technology. Therefore, the following three categories have been established:

1. *Residential construction* or homes such as apartments, condominiums, and houses.
2. *Commercial/industrial construction* or work-related structures such as office buildings and factories.
3. *Infrastructure* or public works such as publicly owned schools, roads, sewage plants, power lines, airports, and dams.

Establishing an Operational Definition for General Education

In his review of general education, Luetkemeyer (1973) identified a number of important aspects, but above all, he determined that, “general education is considered to be that education which every individual must have” (p. 236). He noted that it begins with needs and intellectual behaviors that are common to all people, and it provides a variety of knowledge and skills which allow the student to function in their environment and interpret it. He credited John Dewey and Frederick Bonser with establishing “the theoretical rationale for industrial arts as general education” (p. 237).

In discussing changes in education that had taken place during the 1880’s and 1890’s, Dewey (1902) cited the inclusion of such learning activities as “drawing, music, nature study with the field excursion and the school garden, [and] manual training" (p. 11). These he claimed, "are the working counterparts of the commands to follow nature; to secure the complete development of the child; to present the real before the symbolic" (p. 11). Assuming the reader fundamentally accepts that manual training led to manual arts which led to industrial arts and then to technology education, these quotes identify both the meaning and period of time during which general education and technology education began their association.

To define general education, it was important to consider education generally, that is without regard for any particular discipline. Dewey did that when he indicated that education should "secure the complete development of the child" (p. 11). This theme was also expressed in the *Cardinal Principles of Secondary Education*. Regarding fundamental educational goals for the United States, the authors determined that a democracy organizes society so:

> each member may develop his personality primarily through activities designed for the well-being of his fellow members and society, . . . [and therefore,] the school should develop in the individual the knowledge, interests, ideals, habits, and powers whereby he will find his place and use that place to shape both himself and society toward ever nobler ends (Department of the Interior Bureau of Education, 1918, in Armentrout, 1971, p. 58).

The General Assembly of the United Nations supported a similar but slightly more expanded viewpoint when it adopted Article 26 of the Universal

Declaration of Human Rights on December 10, 1948. The article began as follows:

> 1. Every person has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.
>
> 2. Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.
>
> (Piaget, 1973, p. 41)

Knowing that the United Nations is a political organization and Article 26 established policy standards for member nations, it made sense that more than a simple definition of general education was addressed. However, education "directed to the full development of the human personality" (p. 41) seemed to offer a parsimonious but sufficient definition of general education. To enhance our comprehension of this definition it was necessary to consider the meaning of personality . Therefore, the following dictionary definition was included:

> Personality 1. the quality or fact of being a person 2. the quality or fact of being a particular person; personal identity; individuality 3. a) habitual

> patterns and qualities of behavior of any individual as expressed by physical and mental activities and attitudes; distinctive individual qualities of a person, considered collectively b) such qualities applied to a group, nation, etc. or a place (Guralnik**,** 1986, p. 1062).

By applying this definition of personality, general education was seen as more than a mental process. Full development of the personality requires that the psychomotor, affective, and cognitive aspects all be incorporated. Furthermore, this definition of personality comprehended the unique qualities of the individual while recognizing that individuals cannot be separated entirely from their social environment.

Therefore, “the full development of the human personality” was adopted as the operational definition of general education for this study.

Linking General Education and Technology Education

As was noted previously, Dewey (1902) believed manual training to be an essential part of a child’s educational experiences. With regard to the high school curriculum, he argued for a “wider outlook” (p. 74); one that included manual training. About such a curricular approach he wrote:

> The wider high school relieves many of the difficulties in the adequate treatment of the individual as an individual. It brings the individual into a wider sphere of contacts, and thus makes it possible to test him and his capacity more thoroughly. It makes it possible to remedy his weak points by balancing more evenly the influences that play upon him. (p. 75)

Clearly Dewey's concern for the development of the individual reflected a general education emphasis.

Calvin Woodward (1887), founder of the St. Louis Manual Training School and a leader in the manual training movement, was convinced of the general education benefits of the program offered at his school. He claimed that manual training "would lead to better intellectual development, more whole-some moral education, better choice of occupations, a higher degree of material success, sounder judgments of men and things, and the solution of labor problems." (p. 202). Moreover, he wrote that the skill training offered by his school was of lesser importance than "the development of the mind and body, the simultaneous culture of the intellectual, physical and moral faculties" (p. 224).

Like Woodward, Bonser and Mossman (1930) valued the overall develop-ment of the child over the acquisition of specific skills. In their text, *Industrial Arts for Elementary Schools* they described the characteristics of industry centered vocational education and stated that it " includes that provision for gaining both a knowledge of its processes and sufficient practice in their execution to develop skillful and efficient production" (p.6). They believed that the study of the indus-trial arts offered something quite different. They felt that lengthy practice for the purpose of developing proficiency "has no place in the elementary school nor in the early years of the junior high school" (p. 6). Rather, they believed that "the more important industries may be studied for the values which such study affords in one's everyday life, regardless of his occupation" (p.6). They empha-sized a general approach to the study of industry which would prepare students to become competent consumers and citizens, and they suggested that such a course of study was supported by “a body of experience and knowledge . . . which is of common value to all, regardless of sex or occupation” (p.20).

With regard to the essential benefits offered by the industrial arts, William E. Warner (1947, 1965) was closely aligned with Bonser and Mossman. He stated that:

> *Functionally,* Industrial Arts as a school subject in a free society is concerned with providing experiences that will help persons of all ages and both sexes to profit by the technology, because all are involved as *consumers*, many as *producers*, and there are countless *recreational* opportunities (p. 41).

While Warner focused the curriculum on the economically powerful industries and, de-emphasized or ignored the industries observable in the home, such as the repair and making of clothing and the preparation of foods which had been suggested by Bonser & Mossman, they fundamentally agreed about the scope of the industrial arts at the elementary and junior high school levels. Warner wrote that the industrial arts should provide “the basis or means for integrated activity programs” (p. 41) whereas Bonser and Mossman (1930) wrote that the industrial arts “offers a means of bringing most of the other subjects of study into a close and vital connection with the situations in which their subject matter is directly useable” (p. 68). Warner (1947, 1965) felt that the junior high school industrial arts program should offer a broad overview as “the orientation program concerning technology” (p.41) and not skill training which Bonser and Mossman had also rejected. Philosophically, Maley did not associate the industrial arts with the acquisition of skills in preparation for a job in industry. For him the industrial arts was “intrinsically general or educational because it reflects the economy and not necessarily any particular or specialized employment” (p.42).

Even though Warner was recognized as an influential leader and suggested a curriculum that was “derived via a socioeconomic analysis of the technology and not by job or trade analysis” (p.41), his protege, Delmar Olson (1963), wrote that the common form of the industrial arts curriculum was crafts based which resulted in students being routed “through a series of prescribed experiments leading to mastery of a tool or a machine tool” (p. v). Here, one might question what difference if any existed between the industrial arts and vocational education. Olson noted the discrepancy between theory and practice and wrote that “the issue of industrial arts as general education versus industrial arts as mere trade-competence training, while supposedly settled on one hand, is fully alive on the other” (p. 25). The emphasis on skill training within the field of industrial arts caused him to question whether the “general education value of industrial arts can be measured by achievement in technical progress” (p. 25). In an effort to address this issue Olson pointed out the need for reflection and suggested a new way of looking at the industrial arts. He suggested that the industrial arts be “placed in the context of today’s technology” (p. vii) and by doing so the school could meet its responsibility “to acquaint its students with the nature of the technological culture and to assist them in discovering and developing their talents” (p. vii).

Ten years later, in *TECNOL - O - GEE: Industrial Arts - Interpreter of Technology for the American School*, Olson (1973) again referred to the need to ground the industrial arts in technology in order to provide a general education experience for students. To this end he wrote:

> Industrial arts, a discipline in general education, is the study of technology . . . for purposes of acquainting the student with the technological culture, aiding him in the discovery and development, release and realization of his own native potential therein, and enabling him to better cope with cultural and environmental change caused by technological advance (p. preface).

Although Olson was focused on the field of industrial arts, the importance he placed on the development of the individual was very similar to the views expressed by Dewey approximately 70 years earlier.

DeVore (1968) like Olson promoted technology as the appropriate foundation for the industrial arts. When discussing different content approaches for industrial arts programs, he wrote that, “a study of Man and technology provides a better base from which to implement the purposes and objectives of general education” (p. 2). DeVore, however, did not offer a definition of general education nor did he make the link between technology and general education explicit. He emphasized the need for a comprehensive approach to the study of technology; one that was not limited by geography or national origin, which would provide the basis for “understanding any culture” (p. 2). These aspects appeared to constitute his rationale for concluding that the study of technology was consistent with the criteria for general education. He also added that "education is integrally related to the culture of each period" and because of the technological nature of society it was logical and timely that technology should be reflected in the curriculum.

Towers, Lux, Ray and Stern (1966) made several assumptions about the nature of the industrial arts, two of which seemed closely related to general education. First, they stated that the study of industry "is an essential part of the education of all students in order that they may better understand their industrial environment" (p. 2). Second, they determined that the study of praxiology, or "man's way of doing which brings about through efficient action what is valued" (p. 9), constitutes a body of knowledge. Third, they wrote that "all domains of man's knowledge must be included in an effective general education program." (p, 3).

To investigate the appropriateness of educational content derived from a study of praxiology, Towers et. al considered the work some of the leading educational theorists of the time. Fundamental to this study they cited the work of Phenix (1964) who wrote that "the highest good to be served by education is the fullest possible realization of the distinctively human capacities" (p. 267). Phenix compared general education with specialized education and wrote, "The curriculum of general education contains those provisions for learning that are necessary for the development of the person in his essential humanity" (p. 271). On the other hand, he defined specialized education as "that education which includes provisions for the development of particular competences for other purposes than the becoming of a person as a person" (p. 271). Towers, et. al. (1966) also referred to Phenix in support of their stance that "a systematic coverage of man's knowledge of practice" (p. 11) was attainable, and therefore, through praxiology the industrial arts qualified as a discipline from which curriculum could be derived. By virtue of the existence or potential existence of such a discipline, they concluded that "the school should include elements of such study [a practical discipline] in the curriculum" (p. 14). In addition, they determined that a developmental study area different from the basic sciences was necessary if students were going to be able to comprehend " how our universe, our institutions, and our culture, that is our technologies our ideologies, our arts, and our sciences came to be what they now are" (Broudy, Smith, & Burnett, 1964, in Towers, et. al., 1966, p. 14). However, if the industrial arts as one of the subjects within such developmental study area were to be capable of informing us about "what we need to know about those disciplines that are devoted to anticipating the needs of our society or to meeting its current problems" . . . [or enhance our ability to] to make sense of life as a whole and to find a meaningful goal for it" . . . [the industrial arts] "must undergo radical revision to serve the general education need" (p. 15).

In spite of this call for radical change and in spite of the fact that the Industrial Arts Curriculum Project (IACP) was one of the more influential forces in the industrial arts field during the late 1960's and early 1970's, in 1977, Donald Lux, one of the IACP co-authors, was still exhorting industrial arts teachers to "settle the question of whether the field of study is liberal or specialized education" (pp. 10 - 11). To this end he wrote:

> If we accept familiarization with a few selected skilled trades as our mission, we will continue to offer experiences which are of limited liberal education value. Trade-based education cannot produce the comprehensive industrial literacy which is in such dire need today and which will only become more urgently needed year by year. (p. 11)

Three years later, in the December, 1980 issue of *Man Society Technology*, Willis Ray, another IACP co-author, suggested that the industrial arts "would have profited more had we, earlier, established "technology" as our subject matter base" (p. 9). By focusing on that base, he concluded, "we would have moved well past the 'trade skills and knowledge' influence. We would have moved more rapidly toward the broad-based reservoir of concepts, principles, generalizations and unifying themes of the science of efficient human action" (p. 10). Later in the same article he expanded on this theme by offering the possibility that the industrial arts field reach a consensus and "broaden the scope of subject matter concern to selected systems of product use such as communication and transportation" (p. 10). He felt that "this expanded emphasis would move the field away from a direct prevocational stance to one which might be considered a truly liberal, humanistic education" (p. 10).

These quotes from Lux and Ray were revealing in that they demonstrated the changeable nature of the curriculum content and at the same time the relatively stable characteristics of general education. While skill training was an integral part of manual training and subsequently the industrial arts, and was considered by many as a means for promoting individual development, skill training, later came to be viewed as an impediment to understanding the socioeconomic and cultural aspects of industry, industrial technology, and technology, and therefore, was perceived as limiting. Similarly, the IACP concept of the industrial arts which was delimited to construction and manufacturing, that is, those industries "engaged in the forming of material to satisfy man's wants for good" (1966, p. 41) was later seen by one of its co-authors, Willis Ray, as a form of prevocational or specialized education and not general education.

Through the 1970's and into the 1980's as technology began to gain acceptance as the paradigm for the industrial arts, Bonser and Mossman's (1930) beliefs that:

> the purposes or outcomes of general study are realized in the degree in which it helps one become efficient in the selection, care, and use of the products of industry, and to become intelligent and humane in the regulation or control of industrial production. (p. 6) were reemphasized.

Olson (1973) was clearly aligned with this philosophy and wrote:

> It is herein assumed that what man creates he must be able to understand, to use wisely, to control, and to change, and that the school has the major responsibility of all American institutions in developing this capability. (p. Forward)

The authors of the Jackson' Mill Industrial Arts Curriculum Theory also agreed and stated that:

> The study of industry and technology, with the goal of understanding and enhancing human potential, may be accomplished if a reasonably accurate and well defined model is derived from which curricular and programmatic decisions can be made. At issue is how to structure the study of industry and technology for basic or general education of all youths. Schooling should provide insight into the relationship of technical means to human beings, social purpose, and the environment. A study of human adaptive systems will contribute to such insight" (Snyder, J & Hale, J, 1981, p. 14)

Although DeVore had been calling for it since at least 1964, when he published *Technology: An Intellectual Discipline*, the preceding citations of Ray in *Man Society Technology* (December, 1980), Olson (1973) and Savage & Sterry (1981) were indicative of an emerging trend, wherein a connection was being forged between technological literacy and general education. One of the requisites for full development of the individual had become basic preparation for living and participating in a technological world. This is not say that similar views were not held with respect to the study of industry, rather, the focus on industry was somewhat more narrow, and therefore, somewhat less likely to address the whole person. As the keynote speaker of Symposium 80, Lauda (1980) pointed out the more expansive nature of technology education . He noted that there were three major camps within the industrial arts which he identified as, “technical skill education, American industry education, and technology education.   When considering the three camps as possible curriculum choices he stated:

> If you choose the latter, you will move into the next hallmark of our discipline - technology education. With this model you study the culture from the perspective of the basic human survival activities. Those activities that helped man to face the four horseman of appocalypse (flood, fire, famine, and pestilence). Those activities that help today's and tomorrow's citizens cope with finite resources, rapid change, new social systems, and the inherent positive and negative potential of our contrivances. This model subsumes the first two models. It includes technical skills because reality included such skills. It attempts to identify materials and processes that represent today and tomorrow. At the same time it can (and should) include a study of our productive enterprise since it is a fundamental part of our economic structure. (p. 2)

Unfortunately good intentions and good theories didn't necessarily effect change. Lauda (1982) in discussing the need to disseminate a workable model for the technology curriculum in the public schools wrote, "It is one thing to generate a philosophy of education, but another to see it unfold in the public school setting" (p. 7). Bame & Miller (1982) in summarizing the findings of the *Standards for Industrial Arts Programs Project* which asked "principals, IA chairpersons, and guidance coordinators" (p. 14) to evaluate the importance of certain goals or purposes of industrial arts programs, concluded that: "Those purposes of IA education most obviously associated with a general education approach (consumer education and understanding the relationship between technology and culture) were currently emphasized the least" (p. 21). The results of the study revealed that little change had occurred with respect to the perceived importance of the purposes of industrial arts since the 1966 Schmidt Pelly study. Therefore, it was not incongruent when Maley was quoted in *Man Society and Technology* (Dec. 1980) as saying, “There has been a pressing need to have the teaching (elementary, middle, and secondary levels) catch up with the “preaching”. There has existed a serious gap between theory and practice and in my opinion the practice was the problem” (p. 9). He also went on to say that, "The profession could have made a more concerted effort to deal with the student as a human being. The lessons from developmental psychology were lost in a preoccupation with the mechanics of construction and limited interpretation of the processes of industry. (p. 9)

Whether technology will provide a more effective curriculum for addressing the general education needs of students is yet to be determined. While the broad nature of technology seems to be theoretically appropriate other problems may inhibit its implementation. For example, Volk (1993) found that, “The number of universities offering IA/TE programs has decreased since 1970” and, “the number of graduates prepared to enter the teaching field as industrial arts/technology education teachers has declined” (p. 54). Without teachers prepared in teacher education programs which are grounded in the philosophy and content of technology education, the goals of technology education, general education or otherwise, are not likely to be realized. Another problem which may also defeat carefully crafted curriculum based on sound educational theory is the current terminological problem related to differentiating between technology education and educational technology. Or possibly even more insidious is the current use of the word *technology* as a synonym for computers or computer related technology. The authors of *Technology for All Americans: A Rationale and Structure for Technology* found this issue concerning enough to address it on the first page where they wrote “Technological literacy is more than just knowledge about computers and their application” (1996, p. 1). One might question how effective their effort will be when technology and technological literacy have been interpreted in different ways by different people. For example, the lead paragraph for the U.S. Department of Education’s *Technological Literacy: A National Priority* (June, 1996) quoted President Clinton who said:

> Our country was built on a simple value that we have an obligation to pass better lives and better opportunities on to the next generation. Education is the way we make that promise real. Today, at the dawn of a new century, in the middle of an information and communications revolution, education depends upon computers. If we make an opportunity to every student, a fact in the world of modems and megabytes, we can go a long way toward making the American Dream a reality for every student. Not virtual reality -- reality for every student (p. 1)

Further review of this document revealed an emphasis on funding educational technology and in particular purchasing computers. While it would be difficult if not useless to argue against efforts such as these to improve classroom facilities, there is a real possibility that the pursuit of technological literacy may come to be defined as skill training on the computer. General education in the field of technology education would not be accomplished if this were to be the result.

While these obstacles were perceived at the time this dissertation was being written, any impact on the long-term potential for realizing the principles of general education through technology education was unknown. With a foundation established by earlier educational theory and curriculum development efforts, projects such as A Conceptual Framework for Technology Education and Technology for All Americans did provide a basis for pursuing general education goals through the study of technology. In their own unique ways they supported a broad definition of technology and promoted the growth of the individual through the study of the social, economic, and environmental impacts of technology. Savage and Sterry (1990) wrote:

> It is necessary for all people to understand technology if they are to function effectively in their roles as consumers, voters, workers, employers, and family members . . . . Hence the mission of technology education is to prepare individuals to comprehend and contribute to a technologically-based society. (p. 20)

Similarly the Technology for All Americans Project (1996) described the need for technological literacy that individuals face in their roles as citizens, workers and consumers in the contexts of their individual needs, societal needs and environmental needs. With regard to the developmental benefits that might be derived from this curriculum, the authors stated that "technology education should be designed to help pupils learn and achieve the educational goals of the total elementary curriculum" (p. 36). In addition, the experiences offered through such a program "develop the students' perceptions and knowledge of technology, psychomotor skills, and provide a basis for informed attitudes about the interrelationship of technology, society, and the environment" (p. 36). The authors stressed the importance of design and problem solving activities and pointed out that, "research results from cognitive science [indicate that] this process of critical thinking and creative activity can help children construct what they are learning into more meaningful knowledge structures" (p. 36).

In conclusion, we have seen that the full development of the human personality has, at least in theory, been a part of what is currently known as technology education for close to 100 years. It appears that successful implementation of this principle is not as much dependent on the specific content as it is on the way the curriculum is related to the needs of the student and whether the learning experience allows the student to expand his or her horizons by exploring the interrelations of the field of study and the world with which they interact. Given the tremendous influence that technology has on us as individuals through alterations of our social, economic and physical environments, acquiring or constructing a basic level of knowledge about technology seems an essential part of human development.

Spheres of Interaction

In order to consider the whole person and how one relates to technology, a theoretical model was created. The model was designed to provide a method for organizing the technology education curriculum around the basic roles we assume in life. It takes into account the probability that our motivation to interact with technology may differ according to our perspective or role. By looking at the human/technology relationship in this manner, establishing an organizational system that would provide a means for visualizing and measuring the degree to which curriculum organizers contributed to the general education goal in technology education, seemed possible.

In the previous section on the linkage between general education and technology education various combinations or facets of the these roles were suggested by authors such as DeVore, 1964 & 1968; Olson, 1963 & 1973; Hale, J. & Snyder, J. 1981; Savage, E. & Sterry, L, 1990; and Technology for All Americans Project, 1996. While these authors mentioned the civic, personal, and work related aspects that deserve consideration when contemplating the industrial arts or technology education curriculum, they did not suggest them as a concise or cohesive unit. Interestingly, in 1918, the Reviewing Committee of the Commission on the Reorganization of Secondary Education clearly identified these divisions, but did so in a arena that was unrelated to any specific discipline or field of study. Instead, their efforts were focused on general education. They wrote:

> Within the past few decades changes have taken place in American life profoundly affecting the activities of the individual. As a citizen, he must to a greater extent and in a more direct way cope with the problems of community life, State and National Governments, and international relationships. As a worker, he must adjust himself to a more complex economic order. As a relatively independent personality, he has more leisure. The problems arising from these three dominant phases of life are closely interrelated and call for a degree of intelligence and efficiency on the part of every citizen. (Department of the Interior Bureau of Education, 1918 in Armentrout, 1971, p.53)

For the purposes of this research, these roles we assume or spheres in which we act and define the basic parameters of lives, have been identified as the Civic-Life Sphere, the Personal-Life Sphere, and the Work-Life Sphere. It is important to note that this author does not perceive humans simply as actors playing several roles. Rather, we are participants who actively alter our world while that world is simultaneously altering us. Therefore, the experience is interactive. The term sphere has been used to describe certain fundamental areas of our lives wherein our relationships, responsibilities, and ways of responding are delineated. These spheres are universal, that is, they are not limited to our interaction with technology. They are also exhaustive in that all aspects of our lives can be understood in terms of one or more of these spheres.

Figure 2 provides a graphic representation of this interactive relationship. While the model is two dimensional and relatively symmetrical, the interactive nature of humans and technology is dynamic and changes depending on the person, the circumstances, and/or the point in time. This graphic, therefore, should only be understood as one of an infinite number of possible combinations of the spheres and technology.

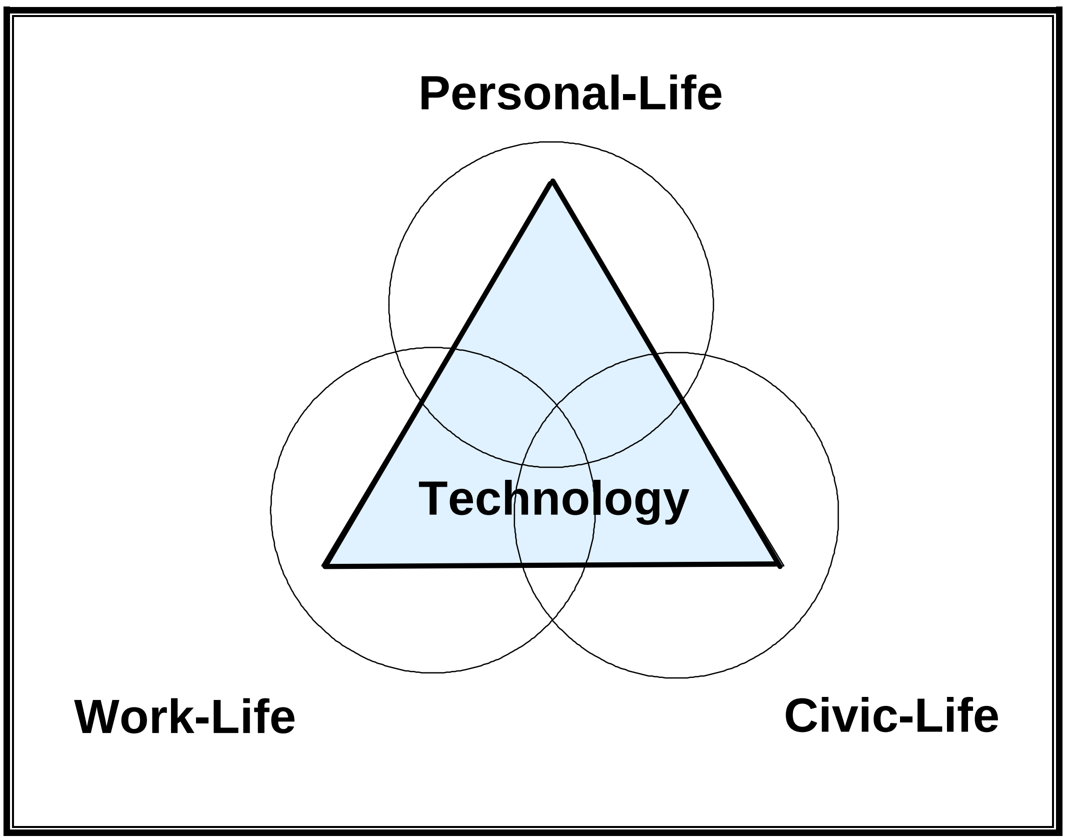

Figure 2. The Human/Technology Spheres of Interaction

Technological Literacy Related to General Education

The need for all humans to develop some level of proficiency in our technological world has been connected with the manual training / industrial arts / technology education field by various authors for approximately 100 years. As has been previously noted, Dewey (1902) pointed out that manual training was necessary “to secure the complete development of the child” (p. 11). As recently as 1996 essentially the same theme was restated by the authors of the Technology for All Americans project when they wrote:

> This document is about education and a subject vital to human welfare and economic prosperity. It is about invigorating the entire educational system with high interest, student-focused content and methods. It is about developing a measure of technological literacy within each graduate. (p. 1)

Using “the full development of the human personality” (United Nations Article 26, 1948 as cited in Piaget, 1973, p.) as the defining quality of general education, and considering that we live in a world where some degree of technological knowledge and ability is mandatory, then the question is not whether these two constructs are connected. Instead, the narrowness or breadth of the definition of technological literacy determines how effectively technological literacy contributes to general education. The effectiveness of this relationship is also determined by the usability of the definition of technological literacy. In other words, if the definition is difficult to interpret in terms of the attributes that comprise its meaning, then representative curriculum and content can not be accurately or efficiently derived from it. Therefore, the operational definition, synthesized for this dissertation, has been offered in hopes of increasing the discipline's ability to make a rich connection with the goal of general education. Again that definition for technological literacy was: *a competent level of knowledge and ability related to altering the human and non-human environments through the use of tools or devices, methods, and systems in processes that convert and/or consume resources*; *in response to perceived wants and needs*.

The Study of Construction Related to Technological Literacy

To make the connection between the study of construction and technological literacy logical, the following sequence of steps were intentionally taken during the writing of this dissertation:

1) Technology was operationally defined.

2) Literacy was operationally defined.

3) An operational definition of technological literacy was synthesized from technology and literacy.

4) An operational definition for construction was developed by incorporating its unique characteristics into the operational definition of technology.

Through this process, operational definitions were established which resulted in a readily observable linkages between technology and technological literacy, and between technology and construction. Consequently, if construction is an component of technology, and if technology is an component of technological literacy, then a competent level of knowledge and ability in the area of construction is a requisite component of technological literacy.

Linking Construction and General Education

Considering the linkage between technological literacy and general education, and the linkage between construction and technological literacy it is logical to conclude that the study of construction is a fundamental part of a general education focus within technology education. This linkage can break down, however, should the definition of technological literacy be so narrow as to mean, for example, computer literacy, or if the discipline and the public were to accept a definition that doesn't reflect all aspects of our technological world. Further, because construction technology dramatically affects human life in a multitude of ways, some positive and some negative, to ignore the knowledge and skills that one can apply in this arena, would certainly constitute a form of neglect with respect to the full development of the human personality.