Defining the Role of Technology Education by Its Heart and Its Heritage

By Mark S. Snyder

The Committee on Technological Literacy (CTL), a group guided by the National Academies of Science and Engineering, the Institute of Medicine, and the National Research Council, recently concluded that "it is in the best interest of all Americans to understand more about technology" (Pearson & Young, 2002, p. 103). According to A. Thomas Young, the chair of the CTL, "the committee hopes technological literacy will be put 'on the map' and the way will be cleared for a meaningful movement toward technological literacy in the United States" (Pearson & Young, 2002, p. viii). The CTL recommended that governmental agencies set education policy to "encourage the integration of technology content into K-12 standards, curricula, instructional materials, [etc.]" (Pearson & Young, 2002, p. 103). If this does, in fact, occur, then technology education offers a clear solution towards helping the committee realize its aims.

This article was written from the perspective that technology is a discipline of its own that is best taught through a variety of methods that necessarily include experiential learning. By definition, technological literacy is, and has always been, at the very heart of technology education. In fact, the phrase *technological literacy* is not new to this field—it has been in use since 1947. Although science and technology are closely linked, they are not the same; learning about science is not the same as learning about technology. Technology education has evolved from a discipline that mostly taught psychomotor skills to one that now emphasizes more cognitive as well as affective learning principles. Nonetheless, a hands-on, problem-solving instructional method is the heritage that endures as one of the best ways to help students learn about and fully understand technology.

Of the Heart

There are numerous definitions for the term *technology*. Etymologically, it is an adaptation of the Greek word tecnologia, which meant a "systematic treatment of grammar," and was formed from the root tecnh, meaning "art" or "craft." Therefore, in the sense most closely related to its origin, the expression is used to signify "technical nomenclature."

The Compact Edition of the Oxford English Dictionary (1971) identified a different use for the word, first applied around 1615. This definition of technology is perhaps the most general: "a discourse or treatise on an art or arts; the scientific study of the practical or industrial arts" (p. 3248). In this sense, technology is considered a body of knowledge, just as sociology is considered a field of study. DeVore (1980) posited that technology is indeed a discipline, which he defined as "the study of the creation and utilization of adaptive systems including tools, machines, materials, techniques, and technical means and the relation of the behavior of these elements and systems to human beings, society, and the civilization process" (p. 4).

Webster's New World Dictionary of the American Language offers similar versions, as well as the following: "The system by which a society provides its members with those things needed or desired" (Guralnik, 1980, p. 1460). DeVore (1980) also recognized that technology exists as systems "ranging from tools, and their use, to the social impact and influence of tools, technics and products on the lives of particular individuals and groups" (p. 4).

Specific artifacts developed by human beings for the advancement of material culture can also be thought of as technologies. The CTL stated: "Technology comprises the entire system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves" (Pearson & Young, 2002, p. 13). Johnson (1989) wrote, "Technology is best described as a process, but it is more commonly known by its products and their effects on society" (p. 1). This observation is tenable and seems appropriate as an explanation for the prevalent modern perception of the term.

Technology is also used at times to mean "a method, process, etc. for handling a specific technical problem" (Guralnik, 1980, p. 1460). However, in this case, the term *technique* seems more appropriate. Technique refers to the methods of procedure, or way of using basic skills, in carrying out a technical or mechanical operation.

The term *technics* describes the basic skills necessary for the utilization of techniques. DeVore (1980) defined technics as "specific technical skills associated with a particular technological act or behavior" (p. 3). In 1989, Chant wrote:

> The proposed technics/technology distinction has yet to find its way into much academic, let alone popular, discourse, even though it offers a way of tidying up some of the present confusion, and perhaps further a way of relating that confusion to the central historical relations of this volume. For if technics is identified with products and processes, this leaves technology as a form of knowledge. (p. 45)

Chant's (1989) application of the term *technics* is convenient, and yet it seems an oversimplification to contrast technics and technology. Admittedly, technology may be considered a form of knowledge, as when defined as the study of practical or industrial arts. However, technology is also an active discipline that requires a familiarity with technics and their application through techniques. Essentially, technics can be distinguished as a separate but integral element within the realm of technology.

Language may, unfortunately, introduce an obstacle to the clear understanding of this distinction. The book *Man and Technics: A Contribution to a Philosophy of Life* was an early study of technology by Spengler (1932/1960). In the translation from German, by Atkinson, the word *technics* was employed to describe Spengler's philosophical view of technology. The author was interpreted to say:

> *Technics is the tactics of living*, it is the inner form of which the procedure of con-

flict—the conflict that is identical with Life itself—is the outward expression…*Technics is not to be understood in terms of the implement.* What matters is not how one fashions things, but what one does with them…. Always it is a matter of purposive activity, never of things. (pp. 10-11)

Ellul's (1954/1964) *The Technological Society* was originally published in 1954 under the French title *La Technique ou Lenjeu du Siècle.* In the translator's introduction, Wilkinson interpreted this phrase literally to mean "Technology: The Stake of the Century." Wilkinson continued by stating: "*Technique*, the reader discovers more or less quickly, must be distinguished from the several *techniques* which are its elements. It is more even than the organized ensemble of *all* individual techniques which have been used to secure any end whatsoever" (Ellul, 1954/1964, p. x).

The French have since attempted to distinguish between technics and technology. Daumas (1970/1976) wrote, however, "in French the word *technologie* has no absolute meaning…. It will nevertheless remain true that the equivalent English word, technology, embraces both the French words *technique* and *technologie*" (p. 93).

In this discussion regarding the word *technology* and its related terms, it seems appropriate to offer one more passage that contains the critical elements necessary to accurately define technology: "Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1990, p. 2). This seems to be a tangible definition that is concise yet complete.

Mind Over Matter?

The terms *pure science* and *applied science* have often been used as references to science and technology, respectively. Buchanan (1976) wrote the following:

> Attempts to sharpen the definition with derivative terms such as "pure science" and "applied science" have tended only to convert imprecision into confusion. However, it can be agreed that there is a distinction between science and technology in present-day practice, coinciding in general with fairly discrete professional groups. (p. 76)

Price (1975) dedicated an entire chapter of his book *Science Since Babylon* to "The Difference Between Science and Technology" (pp. 117-135), and Chant (1989) summarized Price's philosophical view of this concern when he wrote: "Technology is not applied science, but rather science and technology are parallel structures in a symbiotic, weakly interacting relationship" (p. 76).

The juxtaposition of science and technology is an issue that has been discussed for centuries. As a result, a great deal of confusion has transpired regarding the distinction between the terms. Daumas (1970/1976) wrote, "Weighing these words *science* and *technology* against one another in a rather scholastic manner each historian strives either to assimilate one to the other or on the contrary to oppose them in pretty muddled antitheses" (p. 93). Science and technology have often incorrectly been used interchangeably, and fairly strong opinions have developed regarding the perception of these concepts as separate entities. Lisensky, Pfnister, and Sweet (1985) wrote:

> In discussions of technology, one finds the terms science *and* technology used in combination, as if the one cannot be considered without the other. Historically, however, technology developed without reference to science. The social process that is technology arose empirically, either by accident or as a matter of common experience. (p. 8)

The science/technology dichotomy can be perceived in a variety of ways. Ellul (1954/1964) thought technology was "auton- omous" and that "science had become an instrument of techniques" (p. 10). In his book *John Dewey's Pragmatic Technology*, Hickman (1990) contended that Dewey viewed science as a "type of technology" (p. 11). Chant (1989) described what has been referred to as the *linear sequential* model of technological innovation, stating, "Science is on this account an independent variable, developing largely by way of its own internal intellectual dynamic; technology is a dependent variable, pushed by scientific discovery and/or pulled by public and private need" (p. 42). Lisensky et al. (1985) promoted the view "that science is detached, concerned about knowledge for its own sake, while technology is more directly involved in the social process and is concerned about the solution of problems and application of knowledge to that solution" (p. 9). Johnson (1989) provided a sensible illustration of the relationship between science and technology in the following passage:

> Technology is also a technical process. It is different from science, whose role is understanding. Technology's role is doing, making, and implementing things. The principles of science, whether discovered or not, underlie technology. The results and actions of technology are subject to the laws of nature, even though technology has often preceded or even spawned the discovery of the science on which it is based. (p. 1)

Although the previous statement is a rather broad generalization, and contradictory points of view have been exemplified, this author accepts the premise of science and technology as separate, yet interactive and dependent, entities.

Heritage: The Instruction of Technics

From a historical perspective, the nomenclature surrounding this field can become a hindrance since a wide variety of labels have been applied to systems for the instruction of technics throughout the past. Apprenticeship was the earliest such organized system and has lasted for millennia. Since the advent of civil control over education, mechanical schools, polytechnics, schools of industry, mechanics institutes, lyceums, manual labor academies, technical institutes, workingmen's schools, manual training schools, sloyd schools, public school manual and industrial arts, and vocational schools have all been systems established essentially for the instruction of technics.

In 1918, Crawshaw and Varnum described in their book *Standards in Manual Arts, Drawing and Design* the following point of view:

> *Manual training* as the term is used in this bulletin refers to the method by which industrial work is developed under school control. It signifies a plan by which hand, tool and machine work is made educative through a series of progressively developmental problems.
>
> *Manual arts* as herein used indicates the content of the several subjects which are included in a division of the school dealing with industrial work.
>
> *Industrial education* as used herein refers to the study of all or a branch of *industry* (a manual art) by means of the most approved pedagogical and industrial methods. It includes both information about and practice in industry. (p. 5)

The term *industrial education* has continued to be used as a broad heading that has more recently included all forms of technical education that, as a group, derived their content from industry, whether their focus was vocational or general education. *Manual training* gradually evolved into *manual arts,* which, in turn, influenced the development of other forms of industrial education. There is no doubt that these areas of instruction contributed to the development of yet another system of instruction referred to as *industrial arts*. In 1934, Collicott and Skinner wrote:

> Industrial Arts has had its greatest development on secondary school levels. Here it has passed through two somewhat well-defined periods of professional growth and is now in the midst of a third. The first was "manual training," where the emphasis was on *hand* skill, chiefly in woodworking. The second was "manual arts," where the emphasis while still on skill, was extended to include the *making* of both *useful* and *well-designed* articles. The third is now "Industrial Arts," where the intent is to include all of the old that was good, but to broaden out from the limitation of an emphasis upon manual skill alone to an enriched conception where more of the child's interests and environment, and certainly many of the other school subjects, are involved. (State Committee on Coordination and Development, 1934, p. 5)

A similar passage by Bennett (1937) has often been cited to clear up confusion regarding the three terms used above to describe the slightly different approaches to technical instruction that chronologically overlapped during the early 20th century. It reads: "In the term industrial arts, the 'industrial' is emphasized; while in manual arts, the 'arts' is historically the distinctive word and, in the term manual training, 'manual' is the important word" (p. 455). Although there were subtle differences between these three methods, they all represented a form of instruction that used "hands-on" methods of learning technology-based content as part of a broad educational experience rather than job-specific training.

The emphasis of all these programs was on "learning by doing," but the focus of the content was always based in, or on, technology. Technology education evolved from, but is not limited to, this strong tradition of hands-on learning.

The Inception of Technology Education

In April 1947, a new interpretation of industrial arts, referred to initially as the "The New Industrial Arts Curriculum," was imparted by Warner, Gary, Gerbracht, Gilbert, Lisack, Kleintjes, and Phillips. Warner introduced this new plan at the fourth session of the eighth annual American Industrial Arts Association (AIAA) convention held in Columbus, Ohio. For Warner, it was the next logical step in the advancement of his philosophy and practices. Warner and his protégés defined industrial arts as follows:

> Functionally, industrial arts as a general and fundamental 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 for all. (Warner et al., 1965, p. 41)

Curtis wrote a review of Warner's conference presentation that was printed in the June 1947 issue of *The Industrial Arts Teacher*. He commented, "The presentation by Dr. Warner, and the interpretations that followed, completely redefined the position of industrial arts in general education in the public school, and solicited both re-evaluation of the present program and consideration of the implementation of the new" (p. 1).

Olson (1963) said of this effort, "It was too far ahead of the times to gain general acceptance, but like all advance thinking it has had its impact on the profession" (p. 15). Warner, himself, had a slightly different feeling about the acceptance of the project as evidenced by the following which he wrote retrospectively:

> The result, as herein reported, was featured at the AIAA Convention of 1947 which I revived in Columbus, Ohio, following World War II, and where we were fearful of the outcome until the discussions which followed, when our findings were not only accepted, but praised on all sides. (Warner et al., 1965, p. 5)

Eventually, "The New Industrial Arts Curriculum" became known as *A Curriculum to Reflect Technology*, with content that was "derived via a socio-economic analysis of the technology and not by job or trade analysis as of old . . ." (Warner et al., 1965, p. 41). It included six subject matter classifications: power, transportation, manufacturing, construction, communication, and management. Latimer (1981) summarized:

> For the most part, it remained a proposal, probably because Warner did not have the funds to promote and enhance it nationally. The plan was probably too far ahead of its time . . . .
>
> Even though the curriculum was never totally implemented, today there are many elements of *The Curriculum to Reflect Technology* present in educational systems throughout the United States. (p. 48)

Gordon O. Wilber, the ninth president of the American Industrial Arts Association (AIAA), was another effective industrial arts educator with timely insight. He referred to the influence of technology in his book *Industrial Arts in General Education* when he defined industrial arts as "those phases of general education which deal with industry—its organization, materials, occupations, processes, and products—and with the problems resulting from the industrial and technological nature of society" (Wilber, 1948, p. 2). Wilber also expressed the conviction that education was critical to the development of technology by stating: "If society did nothing more than transmit its culture there would be no progress or improvement. Education has the further objective, therefore, to provide for extending and improving the way of life" (p. 6). This could be accomplished, he believed, through instruction that challenged the critical thinking skills of students.

In 1951, Meyer, an associate professor of industrial arts and vocational education at the University of Florida, Gainesville, asked of his peers, "Industrial Arts—What Next?" Meyer knew that "every boy and girl, regardless of present interest or future occupation, is forced to an acquaintanceship with the products of technology" (p. 15). As a result he felt that "work with materials and toward a grasp of technology needs to be a part of the experience of every boy and girl" (p. 15).

Technological Literacy—The Aim of Technology Education

In 1948, Williams, who was a professor of education at the University of Florida as well as the vice president of the AIAA, declared that "Industrial Arts Faces a New Era." In an article by that title for *The Industrial Arts Teacher*, Williams wrote the following:

> For a time the true educational concept of industrial arts was lost, and its position was relegated to a secondary place in the scheme of general education. Now, under the pressure of a complex technological society the narrow view of the manual arts concept is fast giving way to a more comprehensive and flexible interpretation of industrial arts or technology. That a crucial need exists for technological literacy is apparent. (p. 1)

In suggesting one course of action, Meyer (1951) recognized that "as teachers of industrial arts, a field yet young in education, we have groped for truth and sought our role in leading youth toward a real and functioning technological literacy" (p. 16). Meyer continued by stating:

> Our problem is not that of substituting something new for something old. It is not to discard the *classics* in the interest of the *technics*—for this will destroy both. Our task is to provide the cultural matrix of the arts, the sciences, and the humanities so that the equally cultural technologies can find their rightful place and make their vast and vital contribution. (p. 16)

The phrase *technological literacy* has since been employed unrelentingly by technology educators, which is appropriate since the development of technological literacy has been identified as a major goal of the discipline. In 1968, DeVore wrote:

> In today's world, when there is a greater need than ever before for technological literacy, we discover the contemporary status of the industrial arts to be one of confusion and perhaps indecision, with a few notable exceptions. Teachers in the profession, however, are becoming increasingly aware that the confusion is the result of our heritage, and indecision the result of inadequate perspective. (p. 1)

In the 1983 *Professional Improvement Plan* of the America Industrial Arts Society, the transition from industrial arts to technology education was described as "a national concern," "a mission for education," and "a stimulus for a new curriculum with new goals directed toward technological literacy" (Starkweather, 1983, p. 8). The plan itself identified three major goals:

> I. Pursue the ideal form of industrial arts/technology education to ensure technological literacy of all people.
>
> II. Profit from personnel development exercises developing and nurturing programs that apply technology to societal problems.
>
> III. Exchange ideas and practices within and outside the profession to foster a positive, consistent view of industrial arts/technology education. (AIAA, 1983, p. 4)

According to the goals listed, the leaders of industrial arts education planned to improve the technological literacy of all people through innovative new programs that would involve more of the cognitive and affective content of technology and apply it to solve problems. There was also a successful movement underway to change the name of industrial arts to technology education.

In 1986, Loepp identified the need to increase the technological literacy of our citizenry as “an educational challenge.” He described six characteristics that a technologically literate person should exhibit: the ability to recognize and use the appropriate technology in given situations; anticipate undesirable outcomes of the use of technologies; identify alternate courses of action if the technology fails; understand basic mechanical, thermal, fluidic, and electronic principles utilized by technologies; gather and interpret data, or information; and use basic tools, materials, and processes of technology.

An individual who displays such capacities has not only managed to develop fundamental psychomotor skills but also the cognition of many academic disciplines. Values are also important when making decisions regarding the appropriateness and outcomes of the utilization of technologies. Hopefully, in the future, such judgments will be made from well-educated perspectives. Technology education aims to provide learners with the opportunity to develop such capabilities as described above, and therefore contribute to the growth of society.

Conclusion

The CTL has recognized a need that technology educators first identified nearly 50 years ago: Americans need to understand technology and become technologically literate. As the profession has evolved, it has become evident that technology is and has always been the very heart of what we teach.

The CTL also has distinguished a “capability” dimension of technological literacy that justifies the need for psychomotor learning by stating:

> Someone who is knowledgeable about the history of technology and about basic technological principles but who has no hands-on capabilities with even the most common technologies cannot be as technologically literate as someone who has those capabilities. (Pearson & Young, 2002, p. 22)

Technology education has taught about technology, through hands-on experiences, for a long time; most believe that to be the strongest aspect of its heritage. Another of the CTL’s conclusions is that education for technological literacy requires a multidisciplinary approach and suggests that technological literacy could be a “thematic unifier for many subjects now taught separately in American schools” (Pearson & Young, 2002, p. 23). Custer (2002), a technology teacher educator and member of the committee stated: “This should not be interpreted in any way as a devaluing of technology education. Rather, the committee clearly came to view technological literacy expansively, as a critical matter of national importance that inherently spans academic disciplines” (p. 6).

American schools are being evaluated constantly and criticized for the quality of education that they provide. Although the majority of graduates do not pursue a postsecondary liberal arts education, almost every American student is prepared as if this were the expectation. The majority of curricula in our schools is based on knowledge we have established over centuries to be “truth.” While learning these truths is necessary, understanding how these truths have been applied to our society through technology is also valuable. Maybe there are better ways for students to learn these truths—or to learn them better.

> Perhaps, the field which has been continuously evolving into technology education has always been an essential educational enterprise that links classical knowledge to our culture. If this is true then a broad interdisciplinary approach involving technology education should be considered a natural outcome of general educational practice. (Snyder, 2000, p. 36)

Technology education has evolved to a point where it is uniquely positioned for meeting the aims of the CTL. The CTL itself stated:

"Technology educators are playing an increasingly important role in the development and delivery of technology-related content to students in K-12 classrooms, and technology teachers represent an important resource for attempts to boost U.S. technological literacy" (Pearson & Young, 2002, p. 80). Herein lies an opportunity for technology education to clearly define its role in the American education system. Its strength is its emphasis on the development of students' capabilities through design and problem-solving activities, but it must find its place among a broad interdisciplinary approach and address issues related to how students think about, and act on, technology-related issues. Technology education engenders the academic ideal of developing students who can think, and live, independently. Technology education also prepares students to apply knowledge and introduces new ideas and practices that enable individuals to perpetuate the advancement and development of a strong, safe, well-educated, and technologically literate society.

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References

American Industrial Arts Association. (1983). *Professional improvement plan.* Reston, VA: Author.

Bennett, C. A. (1937). *History of manual and industrial education 1870-1917.* Peoria, IL: The Manual Arts Press.

Buchanan, R. A. (1976). The Promethean revolution: Science, technology and history. In A.R. Hall & N. A. F. Smith (Eds.), *History of technology* (pp. 73-83). London: Mansell.

Chant, C. (1989). Science and technology: Problems of interpretation. In C. Chant (Ed.), *Science, technology, and everyday life 1870-1950* (pp. 40-58). New York: Routledge.

The compact edition of the Oxford English dictionary. (1971). New York: The Oxford University Press.

Crawshaw, F. D., & Varnum, W. H. (1918). *Standards in manual arts, drawing, and design.* Madison: The University of Wisconsin.

Curtis, D. K. (1947, June). The new industrial arts curriculum. *The Industrial Arts Teacher,* pp. 1-3.

Custer, R. (2002, November 1). Unpublished conference proceedings from the Mississippi Valley Conference, St. Louis, MO.

Daumas, M. (1976). The history of technology: Its aims, its limits, its methods. In A. R. Hall & N. Smith (Eds. & Trans.), *History of technology: First annual volume, 1976* (pp. 45-71). London: Mansell. (Reprinted from Revue d'Histoire des Sciences, 1970, 22)

DeVore, P. W. (1968). *Structure and content: Foundations for curriculum development.* Washington, DC: American Industrial Arts Association.

DeVore, P. W. (1980). *Technology: An introduction.* Worcester, MA: Davis Publications.

Ellul, J. (1964). *The technological society* (J. Wilkinson, Trans.). New York: Vintage Books. (Original work published 1954)

Guralnik, D. B. (Ed.). (1980). *Webster's new world dictionary of the English language.* New York: Simon & Schuster.

Hickman, L. A. (1990). *John Dewey's pragmatic technology.* Indianapolis: Indiana University Press.

Johnson, J. R. (1989). *A Project 2061 panel report: Technology.* Washington, DC: American Association for the Advancement of Science.

Latimer, T. G. (1981). William E. Warner: His philosophy and influence on industrial arts. In D. R. Herschbach (Ed.), *Industrial arts: A historical perspective* (pp. 43-50). Reston, VA: American Industrial Arts Association.

Lisensky, R. P., Pfnister, A. O., & Sweet, S. D. (1985). *The new liberal learning: Technology and the liberal arts.* Washington, DC: The Council of Independent Colleges.

Loepp, F. L. (1986). Technological literacy: An educational challenge. In M. Sanders (Ed.), *Technology Education Symposium VIII Proceedings* (pp. 37-40). Blacksburg, VA: Virginia Polytechnic Institute & State University.

Meyer, H. K. (1951, June). Industrial arts–What next? *The Industrial Arts Teacher,* pp. 15-17.

Olson, D. W. (1963). *Industrial arts and technology.* Englewood Cliffs, NJ: Prentice-Hall.

Pearson, G., & Young, A. (Eds.). (2002). Technically speaking: *Why all Americans need to know more about technology.* Washington, DC: National Academy Press.

Price, D. J. de Solla. (1975). *Science since Babylon.* New Haven, CT: Yale University Press.

Savage, E. N., & Sterry, L. (1990). *A conceptual framework for technology education.* Reston, VA: International Technology Education Association.

Snyder, M. (2000). Broadening the interdisciplinary approach of technology education. *Journal of Industrial Teacher Education, 37*(4), 24-38.

Spengler, O. (1960). *Man and technics* (C. F. Atkinson, Trans.). New York: Knopf. (Original work published 1932)

Starkweather, K. N. (1983, May-June). AIAA: Pioneering leadership in industrial arts/technology education. *Man/Society/Technology*, p. 8.

State Committee on Coordination and Development. (1934). *A prospectus for industrial arts in Ohio.* Columbus: Author.

Warner, W. E., Gary, J. E., Gerbracht, C. J., Gilbert, H. G., Lisack, J. P., Kleintjes, P. L., & Phillips, K. (1965). *A curriculum to reflect technology.* Columbus, OH: Epsilon Pi Tau. (Reprint)

Wilber, G. O. (1948). *Industrial arts in general education.* Scranton, PA: International Textbook.

Williams, W. R. (1948, February). Industrial arts faces a new era. *The Industrial Arts Teacher,* pp. 1-3.