though we right-handers learn to catch fly balls with a mitt on our left hand and master shooting layups from the left side of the basket, these skills are almost always less well developed than those of the right.

Over the last 20 years, we have moved away from traditional industrial education and strongly towards more rigorous forms of technology studies. We have sought to develop methods and programs that foster a higher order of thinking skills. Let us not do so at the expense of our ability to slip outside of conventional thinking and dream up really new paradigms. Think of Steve Jobs and Steve Wosniak at work in their garage, rethinking the ways that people and computers interact. Think of Einstein and his inability to master the algorithms of simple mathematics, yet able to rethink the universe. Remember Piaget's words, "The final form of learning is play." In our efforts to provide workers for industry and citizens for our society, the balance between training and education and between applying heuristics and solving problems with creativity is always a precarious one. In our secondary technology programs, we must take care that we do not lean more toward training than education.

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Dr. Schultz is an Assistant Professor in the Department of Vocational and Adult Education at the University of Nebraska-Lincoln.

5. Technology: The Heartbeat of Education

by William D. Paige

What does the term *technology* mean? What does the term *engineering* mean? Are they one in the same? One collegiate dictionary defines technology as "...a scientific method of achieving a practical purpose; or the totality of the means employed to provide objects necessary for human sustenance and comfort" (Mish, 1988, p. 1211). Wright and Lauda (1993) defined technology as "...a body of knowledge and action, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment" (p. 3). According to Savage (1991), technology is a body of knowledge and the application of resources using a systematic approach to produce outcomes in response to human needs and wants. Technology is "...the application of knowledge, tools and skills to solve problems and extend human capabilities" (Smith, 1994, p. 2). The common thread that runs through all of these definitions is that technology is about doing to extend human capability.

Engineering is defined as "the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people in structures, machines, products, systems, and processes" (Mish, 1988, p. 412). The Accreditation Board for Engineering Technology (ABET, 1997) defines engineering as "...the profession in which knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind" (cover). Both engineering definitions emphasize utilizing a combination of mathematics and scientific theories with materials and nature to satisfy the needs of humankind.

From these definitions, it is easy to see that engineering and technology are not the same. The field of technology is much broader in scope than engineering. When comparing technology and engineering, Dugger (1994) found several areas of similarity as well as several distinct differences. Both engineering and technology are concerned with "how to" and "the solution of problems" (p. 8), and both are driven by "social acceptance and success at the marketplace" (p. 8). Both are based on the study of the principles of science, mathematics, processes, and systems. However, a fundamental difference does exist between technology and engineering. Technology places a greater emphasis on the application of these principles to solve problems and produce products while the focus of engineering is towards research, design, and developing new products and systems. The study of technology is directed from something concrete to the abstract while engineering is directed by theory and ends in specific recommendations or solutions. However, a certain level of interdependence does exist between engineering and technology as well. Engineering and technology are both dependent, to some extent, on one another. True progress is not possible without both.

Bensen and Bensen (1993) proposed integrating technology and engineering experiences into the school curriculum. They asserted that engineering and technology content organizers are built around (a) disciplines, (b) systems, (c) processes, and (d) impacts. Furthermore, they stated that "it is readily apparent that most contemporary and relevant technology education programs already include most of this content in their design" (p. 5).

It is true that several states have adopted or are developing programs designed to utilize engineering concepts. One such program is the Principles of Engineering from the New York State Education Department. This program takes a generic look at engineering through design activities and case studies. Currently, there are approximately 100 schools in New York using this program as a direct result of the National Science Foundation (NSF) providing funds for in-service experiences to train the teachers. Approximately 15 other states have also sent their teachers to receive this in-service instruction.

The state of Virginia has developed an Introduction to Engineering program with the assistance of practicing engineers. Several other states have also developed programs that integrate the study of technology with academic courses. In most cases, these programs are using problem-solving activities and table-top technology to gain understanding of the processes and concepts. Several of these programs, such as the ones in Colorado and Texas, have been showcased at national conventions. Any proposal of integrating engineering and technology simply utilizing organizers, course titles, and outcomes may not provide the desired results. Nevertheless, this certainly does open another avenue for discussion as to what is the role of technology education in the whole realm of education.

With all that having been said, it is easy to recognize that a problem still exists within the field that must be resolved. This seemingly age-old problem is one of identity, with many still asking questions such as the following: Are we pre-vocational? Are we a part of tech prep? Are we pre-engineering? Are we general education? These questions have been hotly debated for decades and most certainly since the American Industrial Arts Association became the International Technology Education Association. In an editorial, Sanders (1997) pointed out that the name change was designed to fuel a paradigm shift within the profession that would cause the American public to associate the term *technology* with our field of study. History has recorded that this did not happen. Sanders goes on to assert that we must educate the public about technology education and the importance of a technologically literate society. To accomplish this, we have to put aside the old debates and move our discussions to a different level, hopefully resulting in an application-based curriculum that prepares learners for a productive future in an ever-changing world.

We are all aware that the primary focus of the SCANS Report for America 2000 (U.S. Depart. of Labor, 1991) is the identification of skills young people need to possess upon completion of their formal education. These workplace competencies and foundational skills can be immediately put into practice by all students—those who choose to enter the workforce directly and those who plan to continue their education at a college or university. It is interesting to note the similarities between SCANS recommendations and the new goals currently being proposed in the literature for engineering programs. Industry leaders contend that technical abilities alone are not enough—communication and interpersonal skills, a willingness to adapt to change, and a strong sense of ethics are among the qualifications necessary to meet the basic needs of today's industry.

One area that is common to technology education and engineering education is the use of discovery or problem-solving activities in their coursework. These activities can have a lasting effect on students because nowhere else in formal education are students given the opportunity to participate in creative problem solving. Problem-solving activities, however, are not the end, simply the means by which one can reach a goal. They are a framework upon which one can build an understanding of technology. Problem solving is a method that can be used as a part of the overall educational experience to help produce technologically literate students. It is imperative that today's students not only develop the necessary foundation to appropriately select and use current technologies effectively, but also to make informed decisions about the technologies of the future.

Savage and Bosworth (1992) identified five strategies that will help produce technologically literate students:

> 1. Utilize technology to solve problems or meet opportunities to satisfy human needs and wants.
> 2. Recognize that problems and opportunities exist that relate to and often can be addressed by technology.
> 3. Identify, select, and use resources to create technology for human purposes.
> 4. Identify, select, and efficiently use appropriate technological knowledge, resources, and processes to satisfy human wants and needs.
> 5. Evaluate technological ventures according to their positive and negative, planned and unplanned, immediate and delayed consequences. (p. 1)

In conclusion, it is essential that all people have an understanding of technology and use it appropriately in today's world. Whether technology education merges with the field of engineering as suggested by some, or remains as a separate and distinct field of study, it simply must become an integral part of the educational program for every citizen. Technology is the essence of our way of life. The impact that technology has on all of our lives will do nothing but expand in the future. Therefore, to borrow and slightly modify a well known phrase, "Technology is the heartbeat of America," it must become the heartbeat of education.

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Dr. Paige is a Professor in the Department of Technology and Human Resources Development at Clemson University, South Carolina. He is Trustee of the Gamma Tau Chapter of Epsilon Pi Tau.

6. A Learning Styles Instrument to Enhance Learning in Technology

by Larry D. Kuskie and Marlene M. Kuskie

The technology curriculum has been defined and redefined, and it continues to evolve to keep pace with technological discoveries. As a consequence, most states have written and implemented technology programs within schools, which have acquired impressive equipment. But, the technology teacher needs to address how the technology equipment and curriculum can be utilized to best enhance student learning.

We believe that matching students to their learning styles can be the vehicle to the successful implementation of curriculum and the appropriate use of technology equipment to meet student learning outcomes. The student learning inventory discussed in this article was developed to demonstrate how the creation of an easy-to-understand inventory and minor adjustments in the teaching-learning process can make a significant difference in the learning process.

Learning styles or modalities are the manner in which students learn or change as the result of an experience (Roundtree-Wyley, Frusher, & Ficklin, 1988). Research shows that attention to teaching methodologies that address student learning styles increases learning and develops the potential ability of students to learn (Carbo, Dunn, & Dunn, 1986; Foriska, 1992; Henak, 1992). According to Jenkins (1988), when teachers begin to adjust instruction to diagnosed learning style differences, academic achievement increases and attitude toward learning is more positive. As a result, many learning style inventories (James & Galbraith, 1985; Kolb, 1985; Myers & McCaulley, 1985) have been developed for a wide variety of populations.

For the purpose of this project, information processing and instructional categories of learning styles were considered. Interestingly, Johnson and Thomas (1994) discovered that novice learners without a knowledge base concerning a particular problem relied upon the senses to guide the learning process. Johnson and Thomas also found that the ability to select an appropriate strategy is an essential element of the problem-solving process. Assisting students to use the appropriate learning modality of visual, auditory, or psychomotor senses has the potential of enhancing problem solving and student learning outcomes.

After a review of the literature (Flaherty, 1992; Geisert & Dunn, 1990; James & Blank, 1991; Loper, 1989; Orsak, 1990; Roundtree-Wyley et al., 1988) and in an attempt to develop a learning style inventory that would be compatible in the technology classroom and that would be readily understood by a variety of students, the authors chose and developed the categories of visual, auditory, and psychomotor for their instrument, the Learning Channels Inventory(LCI). Waetjen (1993) stated that all three modes are used in the technological process of learning. All modes are equally important, but each style has advantages and disadvantages for the student learner.

The uses of the LCI for the technology classroom is multifaceted. The primary goals are (a) to enhance the learning of the technology curriculum, (b) to consider how students might most effectively learn and use the technology equipment, and (c) to expand the instructional methods of the technology teacher. By considering learning styles, students become more involved in the learning process, cooperative learning groups can be structured to value the diversity of learning styles, and students can be more successful in the learning process.

LEARNING CHANNELS INVENTORY

We developed the LCI for technology teachers in the middle and secondary school classroom. We administered the inventory twice to students over a period of a semester for a test-retest reliability of 80. Although students have the ability to learn in all three styles, the inventory will indicate a predominant style or modality.

A visual learning style is used by those students who would rather see the ideas on the printed page, on an overhead, or be shown how to do an activity. These students profit best by reading materials (textbooks or other such materials rather than lectures), by taking notes and writing reports, and by demonstration and observation. These students will seek information by reading rather than by asking another person. These students will take notes to better remember the concepts but often need to be shown how to do an activity.

The auditory learning style, described