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## **New Perspectives: Technology Teacher Education and Engineering Design**

Roger B. Hill  
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Initiatives to integrate engineering design within the field of technology education are increasingly evident (Lewis, 2005; Wicklein, 2006). Alliances between technology education and engineering were prominent in the development of the *Standards for Technological Literacy* (International Technology Education Association, 2000), and leaders from both disciplines have expressed support for the outcomes described in the *Standards* (Bybee, 2000; Council of the National Academy of Engineering, 2000; Dugger, Meade, Delany, and Nichols, 2003; Gorham, Newberry, and Bickart, 2003). The National Science Foundation (NSF) has also encouraged and funded opportunities for technology educators and engineers to work collaboratively. The *Bridges for Engineering Education* projects and more recently the \$10 million, 5-year funding for the *National Center for Engineering and Technology Education* exemplify the commitment of the NSF to support these activities.

The history of technology education is replete with trends and changes in curriculum, technical content, instructional materials and equipment, instructional strategies, and even identity (Lewis, 2004, 1999; Sanders, 2001). The profession has revised its name and made substantial efforts to affect public perceptions of the field. The historical benchmarks in technology education bear labels such as Industrial Arts Curriculum Project, Maryland Plan, Jackson's Mill, or Technology for All Americans. A movement to embrace engineering design as a focal element in technology education would be another significant event in the ongoing history of technology education and could become another benchmark in shaping the profession.

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Perspectives regarding the role engineering should play within the discipline of technology education vary considerably. These positions range from advocating that technology education take on the role of pre-engineering for high school students to arguments in favor of retaining a broad focus for technology education in which it treats engineering design as simply one of many forms of creative activity. The perspective underlying the position presented here is that technology education should retain a general education role, providing hands-on learning activities for all students and encompassing approaches to design and problem-solving that extend beyond engineering to embrace aesthetics and artistic creativity. Engineering design, however, can provide a focus for the field of technology education that is applicable for students in all grade levels and career pathways.

Implementing an engineering design focus within technology education has significant ramifications. Classroom teachers, teacher educators, and support staff will need additional knowledge and skills to successfully shift the focus of the field toward engineering design. Changes will especially affect the preparation of technology teachers. Curriculum, educational philosophy, instructional strategies, and collaborative relationships are among the facets that will be influenced by this initiative. In each of these areas there are perhaps more questions than answers, and thoughtful discussion and research are needed to guide decision-making. It is essential that the field recognize the key issues so that steps are taken to provide and facilitate necessary professional development.

### **Curriculum**

One theme that has arisen in conversations about an engineering design focus for technology education is the need for additional attention to analysis as a key component of the design process (Wicklein, 2006). Hailey, Erikson, Becker, and Thomas, (2005) identified analysis as the key difference between the approaches taken by technology educators and engineers. Table 1 was presented in their article and provides a side-by-side comparison of two design processes, one for engineering and the other for technology education. The list for technology education has more items and includes activities associated with fabricating

the designed product, but it fails to adequately address the analytical component included in engineering design, Further examination, however, reveals more substantial differences in the approaches to design taken by these disciplines.

Hailey constructed the list shown in the right-hand column of Table 1 based on the steps described in the *Standards for Technological Literacy* (2000) Standard 8 (C. Hailey, personal communication, February 22, 2006). This material, however, reflects an approach to design that has yet to be widely adopted within the technology education field. Hailey, an engineer, included “identifying criteria” and “specifying constraints” in the phases of the design process, but these steps are not widely practiced within the field of technology education.

**Table 1**  
*Design Process Comparison*

<b>Engineering Design Process</b> (Eide, Jenison, Mashaw, & Northup, 1997)	<b>Technology Education Design Process</b> (Standards for Technological Literacy, 2000)
<ol style="list-style-type: none"> <li>1. Identify the need</li> <li>2. Define problem</li> <li>3. Search for solutions</li> <li>4. Identify constraints</li> <li>5. Specify evaluation criteria</li> <li>6. Generate alternative solutions</li> <li><b>7. Engineering Analysis (applications of mathematics &amp; science)</b></li> <li><b>8. Optimization</b></li> <li><b>9. Decision</b></li> <li><b>10. Design specifications</b></li> <li>11. Communication</li> </ol>	<ol style="list-style-type: none"> <li>1. Defining a problem</li> <li>2. Brainstorming</li> <li>3. Researching &amp; generating ideas</li> <li>4. Identifying criteria</li> <li>5. Specifying constraints</li> <li>6. Exploring possibilities</li> <li><b>7. Select an approach</b></li> <li><b>8. Develop a design proposal</b></li> <li><b>9. Building a model or prototype</b></li> <li><b>10. Testing &amp; evaluating the design</b></li> <li><b>11. Refining the design</b></li> <li><b>12. Make it – create it</b></li> <li>13. Communicating results</li> </ol>

The phases of another design process described by Culbertson, Daugherty, Fuerborn, and Loepp (2005) in the Project Probases materials are more typical of those used in the field of technology education (see Table 2). In the Project Probases design process there is no explicit mention of consideration of constraints and criteria. The Project Probases phases consist of (a) identifying and clarifying the problem, (b) brainstorming ideas, (c) selecting a potential solution, (d) modeling and prototyping, (e) testing, (f) evaluating and refining, (g) implementing, and (h) communicating results.

It is important to note that for both technology educators and engineers the design process is iterative with repetition of steps expected. Providing the activities for completing the design process in a numbered list is useful for explaining design activities, but technology educators and engineers seldom go through these steps in a linear fashion.

In comparing design processes typical of technology education, such as that of Project Probases, to those of an engineering design process, the identification of possible solutions without explicit consideration of constraints and criteria as well as the absence of analysis as an activity are noteworthy. Eide et al., in describing the search phase of engineering design activities, specifically stated that “at this point no formal list of

**Table 2**

*Project Probases Design Process*

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**Project Probases Design Process**

(Culbertson, Daugherty, Fuerborn & Loepp, 2005)

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1. Identifying and clarifying the problem
  2. Brainstorming ideas
  3. Selecting a potential solution
  4. Modeling and prototyping
  5. Testing
  6. Evaluating and refining
  7. Implementing
  8. Communicating results
-

solutions has been developed” (2002, p. 90). Engineers spend time researching relevant facts, identifying constraints, and developing criteria descriptive of optimal solutions before they reach the stage of generating alternative solutions. These stages not only illuminate the initial selection of designs to be considered, but they provide the basis for analyses performed to identify and select an optimal solution. The message here is that designers need to “do their homework” before settling on a design. Developing possible solutions based on familiar materials and processes or technologies that are a part of the designer’s past repertoire of experiences often results in status quo products.

For engineering design to become a focus for technology education, the list of design activities provided by the engineering profession should be adopted. The design process should not progress to identification of specific solutions prior to a thorough investigation of relevant science, patents, similar products, and a careful consideration of constraints and criteria. Technology educators should endeavor to communicate the importance of spending time and energy in researching the context, the related technologies that already exist, and considering the balance of constraints and criteria before locking in on possible solutions. This will pay dividends when selecting a design model or prototype since these early stages provide the basis for the analytical components of engineering design that technology education should also consider incorporating.

Lewis and Zuga (2005) recommended three possible approaches for technology educators to take with regard to the analytical component of engineering design. These options consisted of (a) limiting instruction to the conceptual portion of the engineering design process, (b) addressing the analytical component using worked out engineering design cases, and (c) using a collaborative approach in which technology teachers team with mathematics and science educators as well as with practicing engineers. These recommendations accurately reflect the realities imposed by the limited capabilities of technology educators to address the mathematical analyses required for engineering problem solving.

While it would be ideal if technology education teachers mastered mathematics through the first level of calculus,

calculus-based physics, and chemistry and studied the principles of statics, dynamics, strength of materials, electronics, and fluids, these levels of mathematics would be problematic for many existing members of the profession as well as for the numerous entry-level teachers participating in graduate level alternative certification programs.

A key issue in preparing technology education teachers to adequately address analysis in the design process is the choice of design problems to work with. Conducting research in conjunction with the development of design solutions and using analysis to select a favorable design, along with employing the other design activities implemented by both engineers and technology educators, can be implemented in age appropriate ways. The engineering design process can be applied to problems that require only elementary levels of mathematics. While upper level high school and college level technology education students might research patents, learning activities involving exploration of products on store shelves might be used with elementary or middle school students. Activities related to analysis can be handled in similar fashions, with older students performing relatively complex mathematical calculations while younger students compute averages or perform other manageable tasks. In any case, technology teachers should develop strategies for addressing all of the engineering design elements so that students learn to apply them each time they undertake a problem solving activity.

Implementing an engineering design emphasis in technology education would also require changes in technology teacher education courses. This second element of curricular change would involve integration of optimization and analysis into technology teacher education course content, particularly in conjunction with hands-on assignments and problem solving activities. Technology teacher education courses would need to emphasize that prototypes should not be constructed until design parameters have been developed and analyzed in a systematic way. Technology teacher education students would be expected to master appropriate mathematical computations, and class participants would avoid trial and error approaches to solving problems.

Technology teacher education curriculum materials include a wide array of books, modules, computer software, and other instructional resources. Adapting these materials for use in an engineering-design-focused program would necessitate the specification of constraints in problem solving activities. For example, in a class preparing participants to teach transportation or research and experimentation, it would not be unusual for students to be challenged to design and construct a rocket that achieves the maximum possible altitude using a given propulsion unit and payload capacity. This problem would provide better opportunities to focus on an engineering design perspective if it included specific constraints such as a specified altitude or a downrange target. These constraints would provide opportunities for analysis and design directed toward an optimal solution and would establish a more realistic problem. NASA would have little use for a rocket designed to simply go “as high as possible.”

If engineering design becomes a focus for technology education, changes in curriculum materials would drive changes in the competencies expected of technology teacher educators. They would need the appropriate analytical skills and instructional resources to model and facilitate learning involving engineering design problems. This, in turn, would require some retooling of technology teacher education curriculum and some creative instructional approaches by technology teacher educators. With the sources of assistance available to most university professors, the task could be accomplished, but would require investments of the teacher educators’ time and resources. A systemic change in the profession could not easily occur if technology teacher educators chose not to prepare themselves to contribute to the process.

A third curricular component that infusion of engineering design would bring to the forefront is the development of the social capacity of its learners. In an engineering conference held at the University of Georgia on October 28, 2004, the keynote address was delivered by Dr. Richard Miller, founding President of Olin College. One of the prominent points made in this talk was that the engineering profession was urgently seeking engineers who (a) had good communication skills, (b) could work well in teams, (c) were skilled in social interactions, and (d) had



good business and ethics skills. Miller noted that there was no shortage of programs to prepare engineers to solve analytical problems and identify optimal solutions. What was needed, he stated, were effective methods to infuse development of social skills into the preparation of engineers.

The field of technology education is ideally positioned to collaborate with the discipline of engineering education to develop these desired affective attributes. Delmar Olson (1963) suggested that the purpose of industrial arts was to acquaint students with their technological environment and to aid them in the discovery and development of their own potential. Standards 4 and 6 of the *Standards for Technological Literacy* (2000) address the cultural, social, economic, and political effects of technology and the role of society in the development and use of technology. Technology education has a long heritage of addressing the issues that the engineering profession lists as its priority needs.

In March of 2004, the 53<sup>rd</sup> CTTE Yearbook entitled *Ethics for Citizenship in a Technological World* was published by Glencoe/McGraw-Hill. The key constructs used as organizers for this book include “integrity, responsibility, fairness, caring, initiative, interpersonal skills, and dependability” (Hill, 2004, p. 10). Availability of this book for technology teacher educators to use in conjunction with new curricular materials related to analysis and optimization has positioned the profession to effectively address engineering design in a holistic manner. The ability to deal with affective issues should be a point of emphasis when contrasting the proficiency of technology educators to that of math and science educators for dealing with engineering design in K-12 education. Ethics, communication skills, and teamwork should be prominent within the curricular content of technology teacher education programs.

### **Educational Philosophy**

Implementing an engineering design focus in technology education has ramifications for the educational philosophy and conceptual framework guiding teacher preparation. For almost as long as school programs related to technological literacy have existed, there have been philosophical differences concerning whether technology education (industrial arts) programs should

be pre-vocational or included as a part of general education. Evidence for these differences is still demonstrated by the existence of the Technology Education Division (TED) of the Association for Career and Technical Education (ACTE) and the International Technology Education Association (ITEA).

An important component of any teacher education program is facilitating opportunities for each participant to develop a coherent, philosophical perspective. For those enrolled in technology teacher education this would include thoughtful consideration about the extent to which K-12 technology education should equip students to consider or enter a particular career, to what extent technical content should be shaped by current technologies used in the workplace, whether or not curricular content should be aligned to prepare students for entry or advanced placement within a particular post-secondary degree program, what level of academic rigor should be implemented, and which kinds of students should be targeted for enrollment. All of these issues are associated with significant philosophical positions, and all teachers should be challenged to consider the consequences of related decisions.

Most professionals within the field of technology education would recognize two particular realities pertaining to these discussions. One is the federal funding associated with career and technical education. Federal vocational or career and technical education funds have often been used to support technology education programs taught by educators who viewed their courses as general education, on a par with mathematics, science, English, and history. Another reality most technology educators would have insights into is the stigma associated with career and technical education. Societal influences do an effective job of shaping the psyche, beginning at an early age. In only a few years most children have predictable perceptions about what it means to be a physician as compared to a plumber, a banker as compared to grocery store cashier, or a corporate CEO as compared to a carpenter. Similar perceptions within education might align “academic” teachers with the former and career and technical education teachers with the latter of these occupations. This dynamic can entice technology educators to embrace an

identity with “academic” teachers and the general education sector within school settings.

On the other hand, there is a strong likelihood that incorporating an engineering design emphasis in secondary technology education will cause the field to be perceived by many as an excellent elective course for students who aspire to become engineers. Those within the engineering community have indicated a desire to have greater influence in secondary schools so that more students choose engineering as a major in college. While arguments can be made for the general education value of engineering-design-focused technology education for all students, identifying the field with the work of engineering may move it toward a pre-engineering educational camp.

Both of these realities have philosophical and, to some extent, ethical aspects. The discussion is relevant to the question of introducing an emphasis on engineering design within technology education because engineering brings with it an association with an occupational area of higher status than those of plumbers and carpenters. One of the questions to be considered by the general education technology educator is whether having their discipline associated with a particular career track is more acceptable if the profession is high status. If so, there are related philosophical issues to be considered and discussed within the context of technology teacher education.

Infusing engineering design into technology education could be based on a hybrid philosophical model not unlike the role many technology education programs combined with related trade and industry (T&I) courses have collectively provided. High school technology education courses have sometimes been identified as providing opportunities for students to explore a variety of occupational areas, while more in-depth T&I courses are seen as allowing students to achieve proficiency in specific technical areas. In the absence of an extant high school subject area to develop proficiency in engineering design, technology education might encompass the entire array of courses emphasizing engineering design. Introductory experiences, while retaining an emphasis on engineering design, would be appropriate for all students and retain primarily general education objectives. Additional coursework would focus more

directly on pre-engineering and would be designed for students planning to pursue engineering or a related field of study as a college major.

### **Instructional Strategies**

Implementing an engineering design emphasis within technology teacher education would have an impact on its instructional strategies, the equipment and instructional materials used in its coursework, and its co-curricular activities. Technology education has been identified as action-based, and the use of hands-on instructional activities has always appealed to students who prefer learning by doing. Engineering design, on the other hand, while maintaining strong ties to applications of math, science, and technology, largely focuses on analytical processes that lead to optimal solutions. With the extensive array of computer modeling tools now at the disposal of engineers, solutions can often be developed and tested without physical prototypes. Incorporating an engineering design emphasis in technology teacher education will affect the quantity and types of learning activities involving fabrication and machine operations that technology teachers traditionally employ in their classrooms. Instructional time is a finite resource so added attention to analytical activities is likely to reduce opportunities for hands-on fabrication and experimentation.

Another way an infusion of engineering design will affect technology teacher education is in its approach to teaching certain concepts. Engineers, mathematicians, physicists, and chemists approach problem solving from a different perspective than technicians. One example of this is the different methods used to solve DC circuit problems. Both technology educators as well as engineers might ask their students the question, "In a DC circuit, does current flow from positive to negative or from negative to positive?" Instructional strategies in technology education might have their students approach this question from the electron-flow theory prevalent in training for technicians. Engineers, however, typically find the answer using conventional-flow theory as adopted and taught in physics courses. The solution to a DC circuit calculation comes out the same with either theory (as long as one is consistent), but the question to

consider here is to what extent technology teacher education instructional strategies should be aligned with those of the engineering profession.

The method used to solve time and motion problems provides another example of differing instructional approaches. Time and motion problems are typically stated in narrative form such as, "An airplane is traveling 550 mph with a heading of  $N28^{\circ}E$ . The airplane is flying into a 40 mph wind out of due north. What is the resultant velocity and heading?" A technology education solution might involve graphical vector analysis using Bow's notation, a vector scale, a space diagram, and a vector diagram, and the solution would be determined by physically measuring the resultant drawn on a piece of paper. An engineer, however, would likely solve this problem using trigonometry, and while a vector sketch might be used, the solution itself would be determined mathematically. Again, the question for technology teacher educators is which approach to apply as they prepare technology teachers. Should both techniques be employed? Should traditional technology education problem solving strategies give way to those of engineers?

There are additional examples to illustrate ways traditional technology education instructional strategies differ from approaches used in engineering education, but the point is that differences exist. It will be important for technology teacher education programs to encourage each future technology educator to thoughtfully consider choices related to instructional practice. Just because a particular approach is used by engineers, it is not necessarily better for the purposes of technology education. One of the motivations behind some of the NSF Science, Technology, Engineering, and Mathematics (STEM) funding initiatives has been to encourage improvements in engineering education instruction. Certainly, implementing an engineering design emphasis within technology teacher education will result in changes in instructional strategies, whether due to time constraints for presenting multiple approaches, unnecessary redundancy, or desirable outcomes provided by approaches used by engineers.

Most laboratories used by technology teacher education programs have equipment available for use by their students. In

some instances this apparatus is similar to that found in middle school and secondary technology classrooms. In other cases it includes machines and tools acquired during the industrial arts era. Regardless of what is available to support students as they learn to deliver traditional technology education instruction, changes can be expected with a shift to an engineering design emphasis.

For example, the laboratory apparatus used to test the strength of bridges, towers, or other structures fabricated from balsa or similar materials might not serve in a technology education laboratory with an engineering design focus. A typical learning activity is one that challenges students to construct a tower that conforms to specified size and weight constraints and achieves maximum strength when tested to the point of failure with a vertical load. Solutions to the problem typically involve research and experimentation related to trusses, beams, and adhesives. The culmination of the assignment consists of destructive testing of completed towers and generates great excitement on the part of those with the strongest structures.

When an engineering design emphasis is overlaid on the structure problem, the objectives of the activity can change, and the strength analyzing equipment must perform tasks many are not presently capable of. Rather than designing for maximum load, an engineering design problem would likely be directed toward support for some specified load. Calculations would be needed to analyze the available structural materials, and the strength analyzer might need to measure the strength of a single balsa component. Problems arise when the testing device is designed around the traditional technology education activity and is not capable of measuring the small loads of an individual component. Moving technology teacher education toward an emphasis on engineering design will involve changes in the laboratory equipment needed for hands-on activities. In many instances these changes can be accomplished with minimal cost, and in other situations new or different apparatus might be needed. However, all cases require thoughtful consideration of the ramification of bringing an engineering design perspective into the process.

Also to be considered is that engineering educators can provide the field of technology education with useful tools and techniques for solving problems that might not have been a part of technology teachers' previous repertoire. Some of these involve minimal costs, but can significantly affect the procedures technology teacher education programs impart to their students. An example is the use of an engineering design notebook. This tool consists of a bound notebook of cross-section paper, an indexing system, and a process for documenting all aspects of work toward a design solution. Bringing these types of tools and techniques into the array of technology teachers' instructional strategies will enrich the experiences of their students and encourage systematic approaches to problem solving.

Over the past decade immense amounts have been earmarked in many states to purchase updated equipment for use in technology education programs. Many universities have followed this pattern in an effort to provide teacher education students with equipment comparable to that which they will use in their classrooms. In some respects engineering design brings a lessened emphasis on equipment as the focus shifts to mathematical computations and applications of science. The most important equipment may become a good scientific calculator in the hands of every student. Laboratory equipment will still be important, but the emphasis will shift toward the tools and apparatus needed for engineering analysis and optimization.

One of the most important elements of good technology teacher education programs is the co-curricular involvement of students in a Technology Education Collegiate Association (TECA) chapter. This student organization provides tremendous opportunities for leadership development, service, professional learning, and collegiality. Reflecting another aspect of career and technical education influence, TECA is often a seamless component of collegiate teacher preparation programs rather than a recreational or extracurricular activity.

Among the most visible TECA activities are the competitive events conducted at regional conferences and at the annual ITEA conference. "Live" Communication, Problem Solving, Transportation, Live Manufacturing, and Teaching Lesson contests are capped with a Technology Challenge in which

teams from participating universities compete in a quiz-bowl type event. TECA competitions provide an excellent platform for technology teacher educators to show participants the value of co-curricular activities as a part of technology education. As technology teachers, they will have opportunities to involve their own students in the Technology Student Association (TSA) and its corresponding competitive events for middle and high school youth.

Technology teacher educators should consider changes in TECA and TSA competitive events if they are to reflect an engineering design emphasis. The logical starting point would be the TECA competitions since university faculty have significant involvement in planning, hosting, and administering those activities. There might be opportunities to begin by involving engineering students in TECA activities, but this should be thoughtfully considered. Competitive events pitting technology education majors against engineering majors could work against the community building that might otherwise be facilitated between the two disciplines through the event. Teams involving an equitable distribution of technology education and engineering majors would introduce new complexities to the management of these events, but joint activities with TECA and engineering student organizations hold great potential.

### **Collaborative Relationships**

Implementing an engineering design focus within technology teacher education would result in changed collaborative relationships. These changes would involve developing new working partnerships within the university and participation in new professional associations. Some of the technology teacher education programs that are moving to adopt an engineering design emphasis have implemented integral involvement of engineering faculty members in their programs. These engineering educators are able to provide the technical expertise to guide development of the content and instructional activities related to engineering design. This collaboration is critical since most technology teacher educators do not yet have expertise to be self-sufficient in this task.



Seeking assistance from engineering faculty can also be complex. Issues of instructional load and cross-unit work responsibilities can create challenges. These concerns can be ameliorated by external funding, and initial assistance can usually be obtained even if additional funding is not available. Moving beyond limited involvement depends on the levels of commitment on the part of the engineering faculty and their academic unit. The technology teacher education faculty will likely still have sole responsibility for direct instruction, but assistance in selecting or developing learning activities and identifying solutions could be sought from those with expertise in engineering. If engineering faculty are not accessible, seeking assistance from engineers in the community could provide an appropriate alternative strategy.

Technology teacher educators have traditionally been involved in professional associations such as the International Technology Education Association (ITEA), the Association for Career and Technical Education (ACTE), or the American Education Research Association (AERA). With the move to emphasize engineering design, some technology teacher educators have joined the American Society for Engineering Education (ASEE). This professional organization now has a K-12 education component along with an initiative emphasizing the importance of exposing students to engineering as a profession. Involvement with ASEE has the potential to both enhance technology teacher education as a profession as well as to detract from it. The ASEE provides resources and activities that can contribute to the professional development of technology educators, but if limited resources result in a technology teacher educator belonging to and participating in a single organization, teacher education professional associations might end up with fewer members. Diligence will be needed to balance these new opportunities for membership in engineering education associations with reduced participation in traditional technology education professional associations.

### **Technology Teacher Education and the Transition to an Engineering Design Emphasis**

Technology teacher education will be affected by moving to an emphasis on engineering design, and many aspects of university-level technology education programs will need to be thoughtfully considered. University faculty will also play a critical role in changes in K-12 technology education, particularly at the high school level. Aside from preparing the next generation of teachers, technology teacher educators hold critical leadership roles in the professional organizations in which teachers participate, and they are often the authors of the textbooks and instructional materials used in school classrooms. They serve on school advisory committees and as consultants. They help to establish standards for certification of teachers and programs. They participate in the development of state curriculum, benchmarks, and learning objectives. If technology education changes to an engineering design emphasis, the focus of these roles will have to change with it.

Technology teacher educators also play a leading role in seeking funding for research projects and in conducting project activities for those which are funded. In the NSF-funded National Center for Engineering and Technology Education, for example, technology education faculty members at nine universities are involved in preparing twenty doctoral students to become the next generation of teacher educators. In any new endeavor, resources beyond the norm are often required. Funded projects will be critical to the successful infusion of engineering design as a focus for technology education, if that is the direction the field chooses to go.

### **Conclusion**

Technology teacher educators have much to consider with regard to integrating an engineering design emphasis in technology education. This change of focus represents a major paradigm shift for the profession and has ramifications for curriculum, philosophy, instructional strategies, and collaborative relationships. Significant commitment will be required on the part of all members of the profession to upgrade analytical

knowledge and skills. Professional development in this area will be particularly critical for teacher educators.

Each member of the technology education profession will have to determine what role they would play and how they would be involved in a move to emphasize engineering design in technology education. Such a change should not be taken lightly or without careful thought. There are reasons why this shift in the focus for the profession should be encouraged and supported, but the movement is not without risk. Venturing into an arena where others have greater expertise about a key portion of the instructional content than those in the profession requires trust and a commitment to change, as well as hard work. Whether the risks will be offset by benefits for constituents and members of the profession remains to be seen, but there is considerable evidence that this trend represents the future of technology education.

### References

- Bybee, R. W. (2000). Achieving technological literacy: A national imperative. *The Technology Teacher*, 60(1), 23-28.
- Council of the National Academy of Engineering. (2000.) *Statement on the ITEA Standards for Technological Literacy*. Retrieved July 18, 2006 from <http://www.engineergirl.org/nae/naehome.nsf/weblinks/NAEW-4NHMEQ?OpenDocument>.
- Culbertson, C., Daugherty, J., Fuerborn, M., & Loepp, F. (2005). *Construction Technologies*. Normal, IL: Project Probase, Illinois State University.
- Dugger, W. E., Meade, S. D., Delany, L., Nichols, C. (2003). Advancing excellence in technological literacy. *Phi Delta Kappan*, 85(4), 316-320.
- Eide, A. R., Jenison, R. D., Mashaw, L. H., & Northrup, L. L. (2002). *Engineering fundamentals and problem solving* (4<sup>th</sup> ed.). Boston: McGraw-Hill.

- Gorham, D., Newberry, P. B., & Bickart, T. A. (2003). Engineering accreditation and Standards for Technological Literacy. *Journal of Engineering Education*, 92(1), 95-99.
- Hailey, C. E., Erekson, T., Becker, K., Thomas, M. (2005). National Center for Engineering and Technology Education, *The Technology Teacher*, 64(5), 23-26.
- Hill, R. B. (Ed.) (2004). *Ethics for citizenship in a technological world*. New York: Glencoe McGraw-Hill.
- International Technology Education Association. (2000). *Standards for technological literacy: Content for the study of technology*. Reston, VA: Author.
- Lewis, T. (2005). Coming to terms with engineering design as content. *Journal of Technology Education*, 16(2), 37-54.
- Lewis, T. (2004). A turn to engineering: The continuing struggle of technology education for legitimization as a school subject. *Journal of Technology Education*, 16(1), 21-39.
- Lewis, T. (1999). Content or process as approaches to technology curriculum: Does it matter come Monday morning? *Journal of Technology Education*, 11(1), 45-59.
- Lewis, T. & Zuga, K. F. (2005). *A conceptual framework of ideas and issues in technology Education*. Retrieved July 10, 2006 from [http://www.coe.uga.edu/ttie/documents/CF\\_Total.pdf](http://www.coe.uga.edu/ttie/documents/CF_Total.pdf).
- Olson, D. W. (1963). *Industrial arts and technology*. Englewood Cliffs, NJ: Prentice-Hall.
- Sanders, M. (2001). New paradigm or old wine? The status of technology education practice in the United States. *Journal of Technology Education*, 12(2), 35-55.
- Wicklein, R. C. (2006). Five good reasons for engineering design as the focus for technology education. *The Technology Teacher*, 65,(7), 25-29.