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NATIONAL CENTER FOR ENGINEERING AND TECHNOLOGY EDUCATION

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The overall impact of the NCETE is to strengthen the nation's capacity to deliver effective engineering and technology education in the K-12 schools.

Background

The National Science Foundation established the Centers for Learning and Teaching (CLT) program to address national needs in the science, technology, engineering, and mathematics (STEM) workforce. NSF recognized two problems, the large number of educators expected to retire over the next decade, and the growing number of educators inadequately prepared to teach STEM courses. They also highlighted the growing number of doctoral-level professionals needed to educate the K-12 instructional workforce and to conduct research related to learning and teaching in STEM areas. Finally, as the K-12 student population becomes increasingly diverse, the K-12 instructional workforce has not reflected the diversity of the student population. Nor has the K-12 instructional workforce substantially increased its ability to provide appropriate instruction for diverse learners.

The CLT program has three goals, based upon stated national needs. First, Centers are expected to renew and diversify the cadre of national leaders in STEM education. Second, Centers will increase significantly the number of highly qualified K-12 STEM educators. Third, Centers will conduct research on the nature of learning, teaching, educational policy reform, and outcomes of standards-based reform. To meet these goals CLTs must include four components:

1. A PhD program.
2. A teacher education component.
3. Linkages with K-12 schools.
4. A research program.

The NSF 04-501 program solicitation focused on a number of national needs that represented gaps in the existing CLT portfolio. One identified gap was a Center focused on engineering and technology education, with a requirement that it guide the expansion of engineering and technology education in the schools. To achieve CLT program goals, Centers are typically funded at a level of $10 million over five years.

National Center for Engineering and Technology Education

In 2003, a team of faculty members from nine universities met to develop a proposal in response to the program solicitation, NSF 04-501, Centers for Learning and Teaching. The goal of this team was to develop a proposal for a Center that would link engineering and technology education faculty in a partnership to build capacity and benefit the profession. However, stereotypical attitudes held by many in both *professions needed to be addressed.* Greg Pearson (2004), a Program Officer with the National Academy of Engineering, candidly stated the prevailing stereotype, "Let's face it, engineering is filled with elitists, and technology education is for blue-collar academic washouts." In the same article, he recommended that "leaders and influential thinkers in both professions have to decide that the benefits of collaboration outweigh the risks." During the development of the proposal for the National Center for Engineering and Technology Education (NCETE), investigators understood Pearson's message—the benefits of collaboration were well worth the risk.

On September 15, 2004, NCETE received funding from the National Science Foundation as one of the 17 CLTs in the country. The ultimate goal of NCETE is to infuse engineering design, problem solving, and analytical skills into K-12 schools through technology education and to increase the quality, quantity, and diversity of engineering and technology educators. This will be accomplished by teaming engineering faculty and technology educators in a systematic approach that involves:

1. Building a community of researchers and leaders to conduct research in emerging engineering and technology education areas.
2. Creating a body of research that improves our understanding of learning and teaching engineering and technology subjects.
3. Preparing technology education teachers at the BS and MS level who can infuse engineering design into the curriculum (current and future teachers).
4. Increasing the number and diversity in the pathway of students selecting engineering, science, mathematics, and technology careers.

NCETE addresses an important niche in the overall CLT portfolio as the only center addressing *technology **and** engineering education*. This powerful combination of research, graduate education, and professional

FEATURE ARTICLE



Figure 1: NCETE Partners

development could be applied to many levels. We have chosen to focus on Grades 9 to 12 during the first five years.

The Center includes partners with strengths in engineering and in technology education, including four land-grant university research partners and five technology education partners geographically distributed across the United States (see Figure 1).

PhD Granting Partners
- Utah State University
- University of Georgia
- University of Illinois
- University of Minnesota

Teacher Education Partners
- Brigham Young University
- California State University, Los Angeles
- Illinois State University
- North Carolina A&T State University
- University of Wisconsin-Stout

The Center also includes fifteen K-12 school district partners and is organized into four regional teams that facilitate collaboration among PhD programs, teacher education programs, and K-12 partners to build capacity and to share effective strategies and practices. Regional teams facilitate collaborative research, professional development, capacity building, and dissemination of research findings and model practices. The regional teams permit dissemination of research results that truly influence practice in the 9-12 classroom, as illustrated in Figure 2. NCETE also fosters and encourages long-term relationships between regional teams and industry. Industry partners support Center activities through funding, internship opportunities, and professional recommendations.

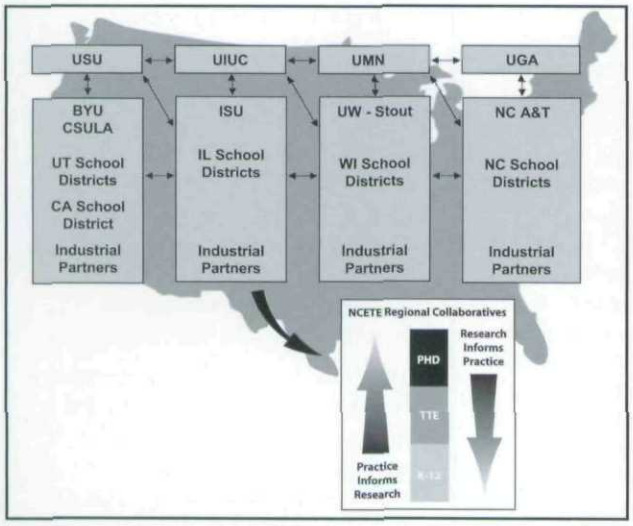


Figure 2: NCETE Regional Partners and Collaborations

NCETE has established partnerships with key professional societies to assist with its goals. Of particular importance, the professional society partners assist with dissemination of materials and provide an important mechanism for sustaining the NCETE mission. ITEA has assumed a leadership role in assisting NCETE with dissemination of materials by providing opportunities for publication in its journal and at the national conference.

Professional Society Partners
- International Technology Education Association
- Council on Technology Teacher Education
- American Society for Engineering Education

Engineering Design

One of the important goals of NCETE is to work with engineering and technology educators to prepare them to introduce engineering design concepts in Grades 9-12. The *Standards for Technological Literacy* (ITEA, 2000/2002) document identifies design concepts to be introduced throughout the K-12 curriculum, as four of the 20 standards specifically address design: Standards 8, 9, 10, and 11.

The design process described in Standard 8 is very similar to the introductory engineering design process described in freshman engineering design textbooks with two notable exceptions. Shown in Figure 3 is a comparison of the introductory engineering design process as described in the textbook by Eide, et al. (1997), and the Standard 8 design process for students in Grades 9-12. There are many similarities. Both processes are iterative and require a clear problem definition, an identification of constraints and requirements, an exploration of possibilities, and communication of results.

The primary differences in approach are highlighted in gray in Figure 3. The first highlighted difference shows

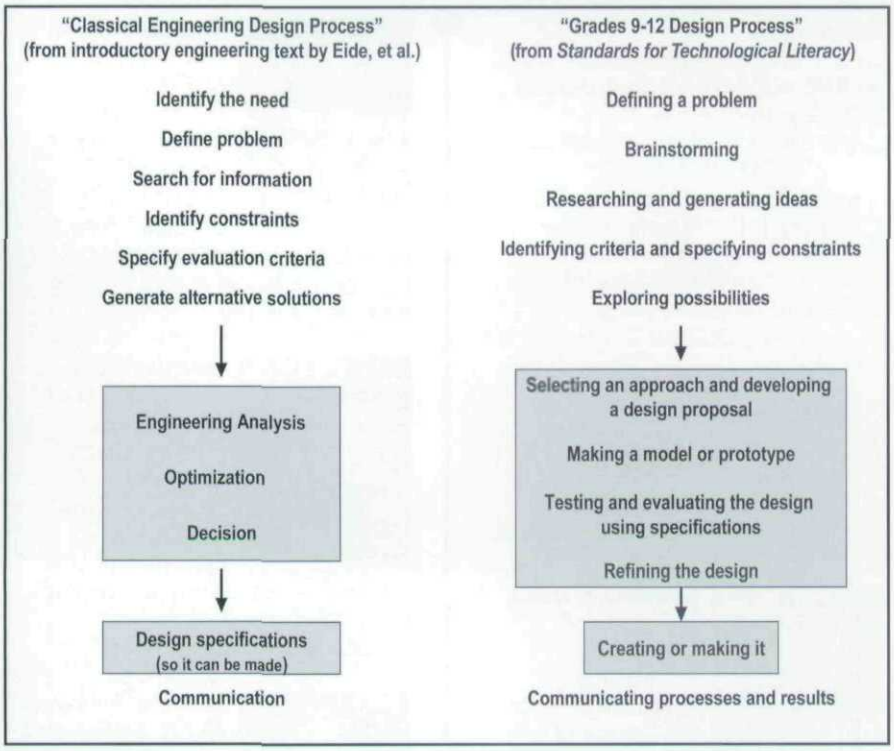


Figure 3: Comparison of an Introductory Engineering Design Process with the Standard 8 Design Process.

the role of analysis in introductory engineering design compared with Standard 8, which prescribes selecting an approach, making a model or prototype, and testing the approach. Engineering programs teach analysis as the decision-making tool for evaluating a set of design alternatives, where "analysis" means the analytical solution of a problem using mathematics and principles of science. By performing analysis, the engineer should arrive at an optimum solution by eliminating inferior solutions. A critical goal of NCETE is to introduce students in Grades 9-12 to the role of engineering analysis in the design process. This permits technology education to provide a role as the integrator of mathematics and science for a diverse community of learners.

The second highlighted difference shows the importance of creating or making the design, as prescribed by Standard 8, in contrast with the introductory engineering design process, which prescribes that students develop "design specifications" so someone can create the design, not necessarily the engineer or engineering student. The "hands-on" component of Standard 8 design, the actual creation of the final design, is often a stated goal of engineering educators, but not always achieved in the classroom. As Pearson points out (2004), "one growing concern in engineering education is the entering freshman's lack of hands-on, tools skills." Creating the final design is a strength of the Standard 8 design process.

NCETE Research Agenda

One of the important roles of a CLT program is to support research into STEM education issues of national importance. In the Overview for the AAAS Conference on Technology Education Research, Cajas (2000) noted that, "while technology education is being introduced as part of the education of all citizens, we have almost no idea of how children learn technological ideas and skills. We need a research program that can shed light on how children learn at least the principles of technology most relevant for literacy." Likewise, as engineering design and analysis are infused into K-12 schools, we know little about how students learn engineering and how teachers can effectively teach it. As a result, NCETE has identified three overarching research themes:

- How and what students learn in technology education (engineering and technological concepts, critical thinking, and creative problem solving).
- How to best prepare technology teachers to teach engineering design and deliver effective engineering and technology education programs.
- Assessment and evaluation of learning and teaching engineering concepts (K-12, teacher education, and graduate levels).

NCETE Program of Work

NCETE has an ambitious program of work over the five years of funding. The major activities for the first year include:

1. Recruiting 12 doctoral fellows and developing a recruiting and retention strategy to guide the Center.

2. Developing four Ph.D. core courses that will introduce the doctoral students to engineering analysis, and infusing engineering design into technology education, as well as cognitive science in engineering and technology education.

3. Developing nine engineering challenges (curriculum activities) to be used in teacher professional development and in K-12 schools.

4. Conducting teacher in-service experiences that prepare practicing teachers to be able to deliver instruction to infuse engineering content and design into the curriculum.

5. Focusing the research agenda and initiate research projects.

6. Evaluating current pre-service technology teacher education programs in order to refocus them to infuse engineering analysis and design content into the curriculum.

Impact

The overall impact of the NCETE program is to strengthen the nation's capacity to deliver effective

engineering and technology education in the K-12 schools. To accomplish this, NCETE will increase the number of doctoral-level leaders and researchers in emerging engineering and technology education areas. Center partners are creating a body of research that improves our understanding of learning and teaching engineering and technology subjects and evaluates the benefits and shortcomings of engineering content for student learning in diverse K-12 settings. In preparing leaders and researchers, the Center will support PhD and master's students, and will prepare several technology education teachers, through pre-service and in-service programs, who can effectively infuse engineering content into K-12 schools. The combined strength of our partners is revitalizing engineering and technology education and preparing a diverse instructional workforce.

Acknowledgement

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REDEDICATION OF OSBURN HALL AT MILLERSVILLE UNIVERSITY

On Thursday, October 21, 2004 the Department of Industry and Technology at Millersville University, in coordination with the 150th anniversary celebration of the university and the 75th anniversary of the department, was pleased to rededicate Osburn Hall. Originally opened in 1960, the facility is named after Dr. Burl Osburn, who served as the Director of Industrial Arts at Millersville from 1941 until his death in 1962. Over the course of the last 44 years, a number of small-scale remodels and partial renovations have occurred to the facility as the needs of the program and the university have changed. The renovation leading to this rededication was by far the most extensive. Architectural planning for this project began in 2002, with construction starting in April 2003. The renewed and expanded Osburn Hall now has main entrances on all three levels and 70,000 square feet to support the programs of the department. Currently serving over 500 majors in degree programs such as industrial technology, occupational safety and environmental health, technology education, and master's degree and supervisory certification programs, the facilities of Osburn Hall will now be able to accommodate the expected enrollment increases in each of these programs for many years to come.



The dignitaries who led the ceremonies at Millersville University to rededicate Osburn Hall are, from left to right, President Dr. Francine McNairy, Provost Dr. Vilas Prabhu, School of Education Dean Dr. Jane Bray, Chair of the Council of Trustees Mrs. Sue Walker, Pennsylvania Congressman Scott Boyd, and Department Chair Dr. Perry Gemmill.

(Photograph was taken by Mr. James Yescalis and is courtesy of Millersville University Communications & Marketing Services.)

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