AC 2007-583: EXPANDING ENGINEERING DIVERSITY BY TEACHING ENGINEERING TO COUNSELORS AND TEACHERS

Bruce Gehrig, University of North Carolina-Charlotte

Assistant Professor of Civil Engineering Technology in the Department of Engineering Technology at the University of North Carolina at Charlotte and PI on the NSF sponsored Teaching Engineering to Counselors and Teachers (TECT) project.

Lyndon Abrams, University of North Carolina-Charlotte

Assistant Professor in the Department of Counseling, Special Education, and Child Development at the University of North Carolina at Charlotte

Deborah Bosley, University of North Carolina-Charlotte

Associate Professor in the Department of English and Director of the Center for Writing, Language, and Literacy at the University of North Carolina at Charlotte.

James Conrad, University of North Carolina-Charlotte

Associate Professor in the Department of Electrical and Computer Engineering at the University of North Carolina at Charlotte.

Stephen Kuyath, University of North Carolina-Charlotte

Assistant Professor of Electrical Engineering Technology in the Department of Engineering Technology at the University of North Carolina at Charlotte and PI on the NSF sponsored Diversity in Engineering Technology (DIET) project.

Dawn Denney, Northwest Cabarrus High School

National Board Certified Math Teacher at Northwest Cabarrus High School in Concord, North Carolina

Kelly Teague, J.M. Robinson High School

National Board Certified Teacher and Guidance Counselor at J.M. Robinson High in Concord, North Carolina

Bill Welch, J.M. Robinson High School

National Board Certified Physics Teacher at J.M. Robinson High School in Concord, North Carolina

Expanding Engineering Diversity by Teaching Engineering to Counselors and Teachers

Introduction

The future of America's global competitiveness depends upon a well-educated, technologically literate workforce. However, if proactive measures are not taken in the near future, the United States will face a serious shortage of scientists, engineers, technologists, and mathematicians because high school students, especially those from underrepresented groups, are increasingly losing interest in these subjects.[1] The key in reversing this trend lies in our ability to promote science, technology, engineering and math (STEM) subjects and professions in a more socially relevant, real-world context and to recognize the differences in learning styles and self-efficacy between males, females and minorities.[2,3,4] As STEM teachers and school guidance counselors will be the catalysts for introducing students to engineering and technology subjects and careers, the **T**eaching **E**ngineering to **C**ounselors and **T**eachers (TECT) professional development workshop is being developed by the University of North Carolina at Charlotte to strengthen the way in which high school teachers and counselors approach the integration of engineering based materials into their courses and counseling. It is believed this improved pedagogy will convince a broader, more diverse range of students to pursue engineering and technology careers.

The TECT workshop, a National Science Foundation (NSF) funded proof-of-concept project, incorporates the well-established STEM model that hands-on activities improve student learning and comprehension. To reinforce this approach, the project builds upon a successful existing NSF sponsored project that funds high school clubs and summer camps focused on students who are underrepresented in engineering related majors. The TECT workshop will make use of the summer camps as a time to conduct concurrent teacher and counselor in-service education and promote best practices that reach across the diversity of student learning styles and interests. In the TECT workshops the teachers and counselors will be observers of students, learners of new engineering and pedagogical content and participants in teaching the summer camp activities.

As the project is currently on-going, empirical data concerning the effectiveness of the approach is not available. Rather, this paper focuses on some of the lessons-learned by the project team during the development of the materials for the workshop. The paper first presents the framework for the project and how its methodologies are grounded in the research literature. Next, the paper discusses some of the innovative materials and content developed with particular emphasis on efforts made to tie the content to curriculum standards and everyday high school classroom realities. As the project leadership involves a diverse multi-disciplinary team of faculty from the College of Engineering, College of Education, and College of Arts and Sciences as well as high school teachers and guidance counselors, the paper also discusses some of the benefits (and challenges) associated in bringing such a diverse team together. Finally, the paper concludes by highlighting the future direction of the research and project.

The Challenge: Bridging the Engineering Awareness Gap

According to Thomas L. Friedman, in *The World is Flat: A Brief History of the 21st Century*, America now imports foreigners to do the scientific work that its citizens no longer want to do or

even know how to do.[5] Nearly one in five scientists and engineers in the United States is an immigrant, and 57 percent of doctoral candidates in engineering are foreigners.[6] In 2004, women only comprised 10% of the tenured/tenure-track faculty in U.S. engineering colleges, minorities only 5.3%.[7]

In addition, the NSF report *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000* states that, although some progress has been made at all levels of education and employment, women are still less likely to choose careers in science and engineering.[8] Additionally, the numbers and percentages of minorities in engineering related careers are decreasing.[9] If left unchecked, these trends will jeopardize the country's economic future; therefore, more effective action is required to expand the pool of scientists and engineers by including more women, minorities, and persons with disabilities.[10]

This requires us to teach more of our youth about the importance of science and technology in our rapidly changing, rapidly shrinking world. However, this becomes a formidable challenge as 90% of society at large indicated that they were not very well informed about the engineering profession.[11] Therefore, it is not surprising then that many high school students do not choose to pursue engineering careers. This lack of awareness and its impact is illustrated in a study performed by the Maui School System that reported significantly more females than males indicated they would enroll in more math and science classes ***if*** there were good job opportunities associated with math and science,[12] indicating that females were not aware of the extensive opportunities in STEM careers.

For many students, the primary exposure to technical professions comes from their STEM classroom teachers and/or their guidance counselors. However, a study performed by Ferris State University indicated that 51% of high school students felt that no one within their high school had been helpful in providing career advice or guidance.[13] In fact, studies have shown that girls are "tracked away" from math and science careers by both teachers and counselors.[14]

Teachers tend to have higher expectations for boys than for girls, especially in the area of math and science. These lowered expectations translate into less rigorous instruction for girls compared to boys.[15] Current research indicates that many female high school students feel that career counselors have discouraged them from taking math courses.[16] In addition, counselors tend to promote engineering only to their very best and brightest female students while at the same time encouraging academically average male students to consider engineering majors.[2]

Because of these and other observed failures in our STEM education system, the National Science Board identified the following priorities for ensuring a world-class education in STEM fields for all Americans:[17]

- Strong public support for the value of STEM education for all students and citizens,
- A high quality teaching workforce,
- Appropriate opportunities to learn for all students,
- Effective guidance counseling on STEM education and careers, and
- Assessment tools that reinforce learning in STEM fields.

The TECT Workshop Model

In response to this call to improve STEM education and to raise student awareness of engineering careers, the TECT project was developed with the following goals in mind:

GOAL 1: *Improve* STEM educational programs and career guidance counseling in high schools within the Charlotte region through enhanced STEM-based teacher professional development workshops focused on engineering.

GOAL 2: *Enlarge* the pool of technical and diversity trained teachers and counselors within the Charlotte region by recruiting and training mentors to conduct TECT-based training within their own school districts.

GOAL 3: *Broaden* the diversity of students engaged in STEM educational programs and opportunities in high schools within the Charlotte region.

The key component of the TECT project is a one week long professional development workshop for high school STEM teachers and guidance counselors that will be offered once during the summer of 2006 and twice during the summer of 2007. Each workshop will include ten teachers and five guidance counselors selected from local area high schools. As part of the NSF funded proof-of-concept project, each participant will receive a $500 stipend upon their successful completion of the workshop.

The focus of the workshop will be to teach the teachers and guidance counselors about engineering while training them in hands-on techniques and classroom practices that can be used to overcome latent gender and minority based biases that STEM teachers and counselors bring to the classroom.[2,18] If teachers are to be effective in stimulating student interest in engineering, they must be knowledgeable in the technical areas themselves.[19] In addition, we need to impact the information about engineering careers that school counselors give high school students. Moreover, the engineering topics and profession need to be presented in a socially relevant context.[2,3,4]

In order to reinforce the concepts presented, the TECT workshops will be integrated with engineering focused student summer camps currently being hosted by UNC-Charlotte as part of a separate NSF sponsored *Diversity in Engineering Technology* (DIET) project. The summer camps will allow the TECT participants to experience the diversity of students within the engineering camps, observe the hands-on activities and classroom techniques used during the camps, and to practice skills learned in the TECT workshop. The capstone practicum for the TECT workshop will require the participants to prepare a lesson plan incorporating a hands-on engineering activity and delivering the lesson to the summer camp students.

At the conclusion of the workshop, participants will be required to develop work action plans describing the engineering content and activities they intend to incorporate into their classrooms during the course of the next semester. A one day follow up meeting with all participants will be held at the end of the semester in which participants will be asked to report and critique their experiences in incorporating TECT concepts into their classrooms.

The research hypothesizes that this mix of diversity awareness based teacher professional development training coupled with improved career guidance counseling training will provide a necessary foundation to increase the number and diversity of students entering STEM related fields. However, the real impact comes from the synergy created from the integration with the DIET project and summer camps.

The DIET project is a collaborative effort between UNC-Charlotte, local community colleges and local area high schools. The key component of the project is the establishment of Junior Engineering Technology Society (JETS) clubs within the local high schools. In order to receive funding from the project, a high school's JET club must have a population of at least 50% non-traditional engineering student types. The clubs compete in regional competitions such as balsa wood bridge building, trebuchets, robotics, and math competitions, etc. The purpose of the clubs and activities is to promote student interest in engineering and technology.

Therefore, the TECT and DIET projects, in combination, are addressing 3 out of the 4 primary components required to increase the numbers and diversity of students entering engineering related majors: students, teachers, and counselors. The remaining component yet to be effectively addressed is parents. A schematic flowchart illustrating the integration of the two projects is shown in Figure 1.

TECT Workshop Content

Studies have shown that any effective pre-college outreach program geared towards increasing diversity in engineering must:[2,18]

1. Promote awareness of the engineering profession;
2. Provide academic enrichment to participants;
3. Address teacher effectiveness; and
4. Support the educational system of the participants.

The TECT project has been structured to meet these criteria through its integrated career guidance training, teacher development, and student summer camp activities.

The learning objectives, describing what participants should be able to do by the end of the TECT workshop, are outlined in Table 1.

To achieve these learning objectives, the workshop will be presented in series of modules covering the following topics:

- "Why K-12 Engineering Education?" Introduction
- Diversity in Learning Styles and Self-Efficacy
- Collaborative and Active Learning
- Engineering Profession Overview and Academic Pathways

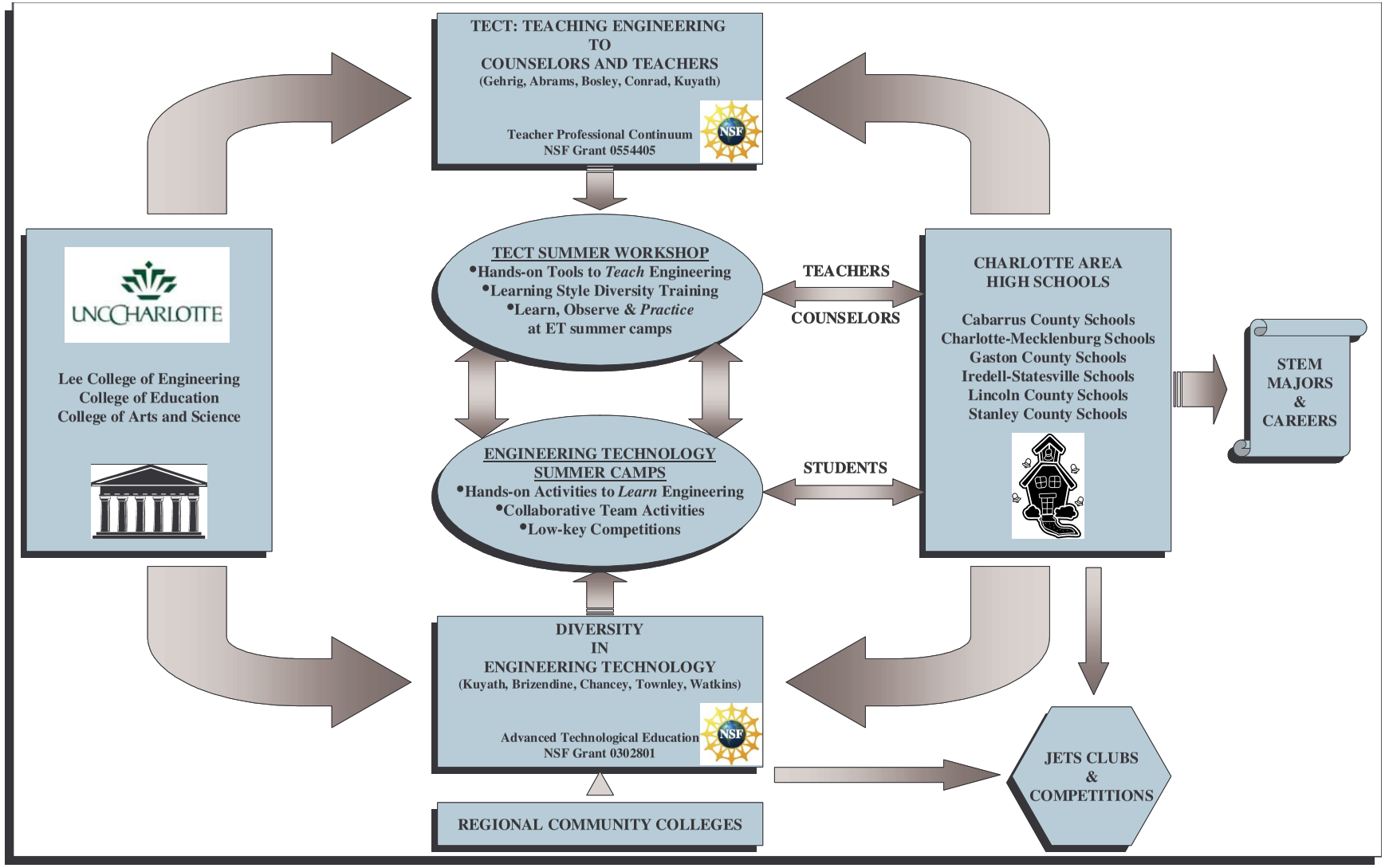

Figure 1: TECT Project Integration with DIET Project

Table 1
Learning Objectives for TECT Workshop

1. ***Articulate*** the importance of K-12 engineering education.
    a. Recognize the nation-wide shortage of engineers and technologists.
    b. Describe the overall decline in students entering engineering related majors.
    c. Characterize the demographics of students entering engineering related majors.
2. ***Explain*** engineering career opportunities within a global and societal context.
    a. Identify and contrast the engineering disciplines as outlined by ASEE.
    b. Relate the changing roles and skills of the engineer-of-the-future.
    c. Outline academic preparation requirements and available academic pathways.
3. ***Critique*** the impact of diversity in promoting engineering careers.
    a. Recognize student differences in career and identity development.
    b. Identify and evaluate differences in student learning styles.
    c. Assess the need to improve the self-efficacy of marginalized students.
4. ***Formulate*** lesson plans incorporating engineering content that support North Carolina Standard Course of Study objectives.
    a. Correlate specific academic discipline topics to related engineering content.
    b. Identify and access available K-12 engineering education resources.
    c. Evaluate the effective use of competitions and team building activities.
    d. Plan, complete and evaluate an assigned hands-on engineering activity.

- Civil and Construction Engineering Discipline
- Mechanical Engineering Discipline
- Electrical and Computer Engineering Discipline
- Biomedical Engineering Discipline
- Competitions, JETS clubs and Other Extracurricular Opportunities
- Peer-to-peer In-service Strategies

The exact content and sequence of each module is still being finalized, however, each module will be approximately one-half day long and designed to include opportunities for active individual and group participation, interaction with the student summer camps, and collaborative assessment of learning activities.

After kicking off the workshop by providing an overview of the importance of K-12 engineering education, the meat of the workshop is it focus on the diversity in student learning styles and self-efficacy, effective collaborative and active learning strategies to address the range of diversity, the in-depth overview of the engineering profession, and the use of engineering related activities to strengthen STEM classroom instruction. In order to expand the diversity and number of students pursuing engineering related majors, teachers and counselors must be able to effectively recognize the diversity in how students learn and choose careers and adapt accordingly.

For example, studies have shown that girls tend to feel less confident, are less assertive and often feel that their comments are incorrect.[20,21] As a result, they feel they have little input to offer in groups and prefer same-sex groups over mixed group settings.[20] They also prefer problem-

centered and socially relevant topics and activities.[2,3,4] Research also indicates that females and minority students tend to prefer cooperative activities over competitions.[22,23]

In addition, STEM students from underrepresented groups have identified cultural factors as having the greatest impact on their retention. This seems to beg attention for enhanced cultural understanding by those who are responsible for supporting students and mentoring these developing professionals.[14] Multicultural counseling and teaching has emerged as a concern over the years. In the early 1990's multicultural competencies for human services were developed.[24] These competencies centered on three cornerstones:

1. Awareness of self,
2. Awareness of worldview of others, and
3. Awareness of culturally appropriate teaching or counseling.

As traditional classroom and counseling approaches and practices tend to ignore these differences which results in disinteresting females in engineering and technology, a portion of our effort is to take aim at the ambient bias in the educational process by sensitizing educators to potential sources of bias within traditional educational and school counseling settings. To that end we intend to utilize the prevalent research literature[25] on bias in counseling, advising, and pedagogy related to STEM as a potential career choice for underrepresented groups.

Therefore, as part of the workshop, teachers and counselors will be schooled in techniques that raise a student's self-confidence and self-efficacy beliefs and have been shown to be successful in encouraging female and minority students to enroll in more math and science courses. Techniques regularly used by teachers with the best record for encouraging more female and minority students to take more math and science classes and to participate in advanced placement math and science classes include:[26,27]

1. Cooperative learning strategies and individualized learning strategies rather than public drill and practice
2. More hands-on learning and more problems with practical applications and opportunities for creative solutions
3. More active, open-ended learning situations rather than drilling students on "correct" textbook answers
4. Active career guidance, stressing the importance and usefulness of math and science for the future career choices
5. Using multiple texts (or other sources of information) with information and pictures indicating the involvement of all races and both genders in math and science to avoid the use of racist or sexist materials
6. Rotating the leadership of teams, ensuring that all students have an opportunity to use the equipment.

As many of these practices have been incorporated into the student summer camps, the camps become effective tools for demonstrating and reinforcing the concepts taught in the TECT workshop. The student summer camps use team-based, hands-on activities that culminate in low-key competitions in order to introduce students to various engineering disciplines. Summer

camps have been shown to be an effective tool for attracting minorities and women into engineering.[28] In a study of a girls-only camp, 50% of the participants went on to study engineering with 72% of those who did pursue engineering indicating that the camp experience was a deciding factor.[29] UNC-Charlotte's experience with its camps has been similar.[30]

Beyond the diversity based learning styles and self-efficacy training, TECT workshop participants will also receive in-depth instruction concerning the engineering profession and its various disciplines. Participants will be given an overview of the engineering profession as a whole with all of its various disciplines and possible academic pathways. Additional emphasis will then be given to four of the disciplines: civil and construction engineering, electrical and computer engineering, mechanical engineering, and biomedical engineering. The first three were chosen because they correspond with the engineering disciplines offered at UNC-Charlotte. The last one, biomedical engineering technology, was chosen because it is a field that tends to attract a larger percentage of female students and it provided a ready vehicle for adding content to the workshop that would better address the needs of life science teachers that may be in attendance.

Each module will contain one or more discipline specific hands-on engineering activities that participants will perform. Participants will be shown how to make connections between the activities and specific classroom topics and content tied to the North Carolina Standard Course of Study. Participants will be given the opportunity to explore and develop lesson plans that they would be able to deliver when they return to their classrooms.

Each engineering discipline specific module will be run concurrently with the same discipline module being presented in the student summer camps. This will provide the participants with the opportunity to observe similar hands-on activities and classroom strategies. In addition, TECT participants will be expected to deliver their lesson plans developed as part of the biomedical engineering module to the summer camp students as part of a teaching practicum. Afterwards, participants will critique and discuss their experiences and lessons learned.

The last part of the workshop will focus on available extracurricular activities and resources for promoting engineering within the schools. Information will be provided concerning the JETS club program and the process of establishing such clubs within their own schools. In addition, as the summer camps utilize competitions, strategies for the effective use of competitions within the classroom and clubs will be presented. Although the research literature is mixed concerning the effectiveness of competitions as an educational tool, competitions have been shown to be useful in promoting student interest in engineering and science.[31,32] A NSF report examining competitions indicated that the participation rate of girls in competitions was comparable to that of boys.[32] In addition, other studies have noted that both genders felt that competitions were enjoyable and integral to the class atmosphere and that competition competency between males and females was similar.[23] Our observations of the summer camps have indicated that coupling collaborative teamwork with the competitions effectively engages all participants in the activities regardless of gender or race.

Challenges and Lessons Learned to Date

One of the primary challenges that had to be addressed early on in the project was the multi-

disciplinary requirements of the project. Successful development of the TECT workshop and materials requires expertise in engineering, education, counseling, and technical communication. Therefore, a collaborative team of faculty from the William States Lee College of Engineering, College of Education, and College of Arts and Sciences was formed. Based on their collective educational and professional backgrounds, the five member faculty team is able to provide expertise in various fields of engineering, guidance counseling, technical communication, teacher professional development workshop development, engineering education outreach, and active learning strategies.

Despite this level of expertise, the faculty team wanted to make sure that the TECT project remained firmly grounded in the realities of actual high school classrooms and counseling. Therefore, the team was expanded to also include two STEM high school teachers and one high school guidance counselor from local area high schools. In addition in assisting with the development of workshop materials, their primary responsibility is to act as consultants and to ensure that all materials developed are fully compatible with typical day-to-day realities in the high schools. This is important because we recognized that teachers and counselors have limited time, limited resources, and a constrained ability to deviate from established standard course of study requirements (and that we, as university faculty, are not fully aware of all of the limitations found within the high school setting). Therefore, we knew that anything proposed in the workshop that was perceived as overly burdensome was not likely to be adopted in actual classroom practice.

Once the full TECT team had been organized, the task of determining the extent of the content to be included in the workshop began. This proved particularly difficult as there is much more information available then could be presented within the one week timeframe of the workshop. One could easily offer an entire one week long workshop on diversity in learning styles and self-efficacy. The same could be said about the other topical areas as well. And, of course, individual faculty members have a natural tendency to want to focus on their areas of expertise. Therefore, prioritizing the content became part of an on-going discussion that continues even now to some extent.

In addition to the prioritizing, the amount of available information on K-12 engineering education and other educational topics was overwhelming and contributed to a general sense of "where do we start?" by many of the team members. One of the high school teachers clearly expressed this sentiment after making an attempt to explore many of the activities and lesson plan links that are found on ASEE's K-12 engineering education web page. So, just maintaining a focus on the really necessary and important information, and suppressing the desire to want to cover and present everything, proved to be a challenge.

When it came to tying the engineering content to the standard course of study and other subject matter, as a faculty, the greatest difficulty came in recognizing that making such connections is not obvious to non-engineers. As engineers knowledgeable about our fields, it is an easy, almost natural skill to recognize the ties between basic math and science concepts to engineering concepts and activities. However, high school STEM teachers and counselors are not engineers and what may appear obvious or straight forward to us is not necessarily obvious or straight forward to them. Therefore, the challenge is not to try to cover too much (because we incorrectly

assume it's easy) but rather to cover a select few engineering topics or activities in sufficient depth as to ensure a sufficient level of understanding. This may seem obvious since teaching engineering concepts is the purpose of the TECT workshop, however, one must exercise care not to lose sight of that fact.

Having a team of eight individuals spread over four academic departments and two high schools presented its own management difficulties. The TECT team attempted to hold progress meetings every two weeks but just trying to coordinate the schedules of all eight team members proved problematic. As a result, there was not a single instance during the first six months of the project where all eight team members were at the same meeting at the same time. In addition, meetings often broke down into a series of two or more simultaneous conversations. This was no doubt due in part to inadequate planning on the PI's behalf (this can be fairly stated as this paper is authored by the PI). However, the PI has found that administrating an academic grant involving faculty is significantly different than his experience in administrating engineering projects within industry. That being said, recent attempts to improve the situation have been made that breaks up the team into three groups, content co-PI's, technical communication specialists, and high school consultants, as far as progress meetings are concerned. Whether or not this arrangement proves to be an improvement remains to be seen.

Future Direction of Research

The first of the TECT workshops will be offered during the summer of 2007. Workshop participants will be surveyed both before and after the workshop in order to assess any improvement in their awareness of engineering and TECT workshop content. Participants will also be surveyed during the one-day follow up meeting to be held approximately six months after the workshop completion. This survey will be used to assess any impact the workshop had on actual classroom teaching and counseling. The results of the surveys will be used to direct modifications to the workshop materials for use during the summer of 2008. Results will also be disseminated in the research literature.

As a proof-of-concept project, the TECT project will be evaluated to determine its potential effectiveness and long term viability. If the workshop proves effective, strategies for expanding the project and developing its sustainability after NSF funding has expired will be explored. However, pending the results, we believe the integrated mix of diversity awareness based teacher and counselor professional development training and the summer engineering camps will provide a necessary foundation to increase the number and diversity of students entering STEM related fields.

References

[1]Clark, J.V., *Minorities in Science and Mathematics: A Challenge for Change,* Virginia Parent Information and Resource Center, 2000.

[2]Baum, Eleanor, "Recruiting and Graduating Women: The Underrepresented Student", *IEEE Communications Magazine*, December 1990, pp. 47-50.

[3]Extraordinary Women Engineers Project, "Extraordinary Women Engineers Final Report, April 2005", National Science Foundation Grant No. EEC-0438810.
[4]Zuga, K.F., "Addressing Women's Ways of Knowing to Improve the Technology Education Environment for All Students", *Journal of Technology Education*, Vol. 10, No. 2, 1999, pp. 57-71.
[5]Friedman, T.L., *The World is Flat: A Brief History of the 21st Century*. New York: Farrar, Straus, Giroux, 2005.
[6]Chubin, D.E., May, Gary S., and Babco, E.L. *Diversifying the Engineering Workforce*, Journal of Engineering Education, January 2005, p 73-86.
[7]Engineering Workforce Commission of the American Association of Engineering Societies, *Engineering and Technology Degrees*, 1973-2003.
[8]National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000,* Arlington, VA. 2000. (NSF00-327).
[9]Milbourne, L.A., *Encouraging Girls in Science and Math,* The ERIC Review, Vol. 6, Issue 2
[10]Kowalenko, K., *Increasing Diversity in America's Science, Engineering, and Technology Fields,* The Institute, IEEE, Dec., 2000.
[11]Davis, L.A. and Gibbin, R.D., Editors, "Raising Public Awareness of Engineering", National Academy of Engineering, 2002, 108 pages, ISBN: 0-309-08624-8.
[12]Maui Economic Development Board, Inc. Women in Technology Project, "Assessment Report Part Two – The Maui County High School Technology Survey", Kihei, Maui, 2001.
[13]Career Institute for Education and Workforce Development, *Decisions Without Direction: Career Guidance and Decision-Making Among American Youth*, Hurley, D. and Thorp, J. editors, Ferris State University, 2002. http://www.constructmyfuture.com/pdf/dwd_report.pdf
[14]American Association of University Women Educational Foundation, "Shortchanging Girls, Shortchanging America", Washington, D.C., 1991.
[15]Sadker, M. and Sadker, D., "Failing at Fairness: How America's Schools Cheat Girls", New York: Scribner, 1995.
[16]National Research Council (NRC) Center for Education (CFE); NRC Committee on Science and Mathematics Teacher Preparation (CSMTP), *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium,* National Academy Press (NAP), 2001.
[17]National Science Board, *America's Pressing Challenge – Building a Stronger Foundation*, Arlington, VA. 2006 (NSB-06-02)
[18]May, G.S. and Daryl, E.C., "A Retrospective on Undergraduate Engineering Success for Underrepresented Minority Students", *Journal of Engineering Education*, Vol. 93, No. 1, 2003, pp. 1-13.
[19]Abbitt, J.D. III, and B.F. Carroll, *Applied Aerodynamics Experience for Secondary Science Teachers and Students,* Journal of Engineering Education, Vol. 82, no. 3, July 1993.
[20]Guzzetti, B. and Williams, W., "Gender, Text, and Discussion: Examining Intellectual Safety in the Science Classroom", *Journal of Research in Science Teaching*, Vol. 33, 1996, pp. 5-20.
[21]Shakeshaft, C., "Reforming Science Education to Include Girls", *Theory into Practice*, Vol. 34, No. 1, Winter, 1995
[22]Jones, G., "Gender Differences in Science Competitions", *Science Education*, Vol. 75, 1991, pp. 159-167.
[23]Milto, E., Rogers, C., and Portsmore, M., "Gender Differences in Confidence Levels, Group Interactions, and Feelings about Competition in an Introductory Robotics Course", *32nd ASEE/IEEE Frontiers in Education Conference*, November 6-9, 2002, Boston, MA.
[24]Sue, D.W., Arredondo, P., McDavis, R.J. Multicultural Counseling Competencies and Standards: A call to the Profession. *Journal of Counseling and Development, 70*, 477-486, 2002.
[25]Banks, J. A. Multicultural education: Historical development, dimensions, and practice. In L. Darling-Hammond (Ed.). *Review of Research in Education 19*, pp 3-19. Washington, DC: American Educational Research Association, 1993.
[26]Busch-Vishniac, I.J. and Jarosz, J.P., "Can Diversity in the Undergraduate Engineering Population be Enhanced through Curricular Change?" *Journal of Women and Minorities in Science and Engineering*, Vol. 10, 2004, pp. 255-281.
[27]Eccles, J., "Bringing Young Women into Math and Science," In M. Crawford and M. Gentry, eds, *Gender and Thought: Psychological Perspectives*, New York, NY: Springer-Verlag, 1989.
[28]Bottomely, L.J. and Parry, E.A., "Assessment of an Engineering Outreach Program: Hands on Engineering", *Proceedings of the 2002 American Society for Engineering Education Annual Conference and Exposition*, Toronto, Canada.
[29]Gilbride, K.A., Kennedy, D.C., Waalen, J.K, and Zywno, M.S., "A Proactive Strategy for Attracting Women into Engineering", *Canadian Journal of Counseling*, Vol. 33, No. 1, 1999, pp. 55-65.

[30]Kuyath, S. and Sharer, D., "Summer Camps in Engineering Technology: Lessons Learned", *Proceedings of the 2006 American Society for Engineering Education Annual Conference and Exposition*, Chicago, USA.
[31]Kimmel, H., Burr-Alexander, L.E., and Bloom, J., "Engineering Design Competitions: A Motivating & Learning Experience", *International Conference on Engineering Education*, October 16-21, 2004, Gainesville, Florida.
[32]Somers, L. and Callan, S., "An Examination of Science and Mathematic Competitions", National Science Foundation Grant Report, June 1999.

This paper is based upon work supported by the National Science Foundation under Grant No. ESI-0554405. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.