Workshops for Enhancing Implementation of the Field of Study Curriculum for Engineering Education in Texas

Robert Lindsay Wells

Mechanical Engineering Department
The University of Texas at Tyler

Alan Morris

Engineering, Math and Physics Program
Kilgore College

Christine E. Hailey

Mechanical Engineering Department
The University of Texas at Tyler

Abstract

Community and junior colleges have long played an important role in providing students access to higher education, especially non-traditional and underrepresented student groups. When students who have completed a pre-engineering program at a two-year college begin study at a four-year institution, equivalent preparation is crucial for their academic success. In recognition of this fact, the Texas Higher Education Coordinating Board has established a Field of Study Curriculum for Engineering which allows a specific set of pre-engineering courses to transfer freely among two-year and four-year public institutions in Texas. This paper presents a strategy to develop faculty workshops to enhance the implementation of the field of study curriculum, providing students the greatest opportunity for success in the study of engineering.

Introduction

There is a national awareness of the important role two-year colleges play in providing qualified students to engineering programs. It has been estimated that at least one third of engineering graduates attend two or more colleges while pursuing their degrees, and that up to forty-six percent of students at many universities began their education at community colleges[1].

As an acknowledgement of this close relationship in engineering education between two-year and four-year schools, the Texas Higher Education Coordinating Board (THECB) established the Field of Study Curriculum for Engineering in 2002. A level curriculum was developed for

Calculus, Differential Equations (and Linear Algebra), Chemistry, Physics, Circuits and Engineering Mechanics (Statics and Dynamics). These courses provide many of the fundamental skills necessary for success in engineering, and the common curriculum promotes maximum transferability for students. Table 1 shows a summary of the curriculum (full details can be found at the THECB web site[2]).

Table 1. Summary of the Field of Study Curriculum for Engineering

Academic Topic	Courses (3 and 4 credit sequences)
Calculus	MATH 2313; MATH 2413 MATH 2314; MATH 2414 MATH 2315; MATH 2415
Differential Equations/Linear Algebra	MATH 2320; MATH 2420 MATH 2318; MATH 2418
Chemistry	CHEM 1312; CHEM 1412 CHEM 1112
Physics (Calculus-based)	PHYS 2325; PHYS 2425 PHYS 2326; PHYS 2426 PHYS 2125; PHYS 2126
Circuits I (for majors and non-majors)	ENGR XXXX
Engineering Mechanics (Statics & Dynamics)	ENGR 2301; ENGR 2401 ENGR 2302; ENGR 2402 ENGR 2303; ENGR 2403

For the engineering field of study curriculum to be implemented successfully, a working partnership must exist between two-year and four-year college faculty. This is essential for ensuring that the pre-engineering experience is as level as possible at both types of institution. The authors of this paper propose that peer-to-peer faculty workshops are one way of building this partnership, and tackling the challenge of implementing a successful field of study program.

The Workshops

The proposed workshops could address a wide variety of topics in engineering education, but initially the concentration will be on five key areas of interest to two-year and four-year schools:

- Implementation issues for the field of study curriculum in engineering
- Recruitment and retention of freshmen and nontraditional students
- Introduction to engineering courses in two-year and four-year colleges
- Providing a common "engineering context" for field of study courses
- How to implement a continuous improvement process that is shared by accredited two-year and four-year programs.

Apart from the specific educational materials that will be developed in the workshops, the experience of working as a team in the workshops will have the significant benefit of building communication, and a sense of common purpose, between two-year and four-year faculties. Let us examine the five targeted activities more closely.

Implementation Issues

The workshops will begin by examining the status of the implementation of the field of study curriculum in Texas. This would ensure that all participants share a common understanding of the issues (and barriers) involved. For example, one issue would be how the three-credit version of a course can cover the same topics as rigorously as the four-credit version of the same course. This overview of the field of study curriculum would set the stage for developing the resource materials described below.

Recruitment and Retention

Two-year colleges have significant experience in recruiting and retaining beginning students, and especially underrepresented and non-traditional students[3]. In the workshops, faculties from two-year schools will share strategies for building enrollment, and techniques for engaging and retaining students who may otherwise not succeed in a four-year program.

A key benefit of the workshops for faculty is the dialog that would be encouraged between mathematics, physics, chemistry and engineering faculties within both two-year and four-year programs. All partners would better understand the relationship of science, math and engineering in the common engineering curriculum.

Introduction to Engineering

One product of the workshops will be to create a more common experience in introduction to engineering courses. Common course content would be developed covering such topics as ethics, communication skills, and design.

As one example, consider the freshman design experience. Students in the introductory engineering course at a four-year school will typically have a team-based design experience. However, two-year schools often do not have a similar experience in their introductory engineering courses. This leaves students transferring from a two-year college at a disadvantage.

Following a model established by engineering educators in Washington State[4] the workshops will develop transportable design materials and methods that can be shared in both two-year and four-year introductory engineering courses. The modules will be constructed in such a way that two-year and four-year freshman students can work together on their design projects, including perhaps competitions at the end of the semester, thus building a sense of comradeship among the

students. Activities of this kind have already been undertaken at the University of Texas at Tyler as a recruitment tool for high school students[5].

Engineering Context

An important instructional product of the workshops would be educational materials to help pre-engineering students understand the "engineering context" of their courses. Brief course modules could be developed showing, for example, how topics in Physics I will reappear in Statics and Thermodynamics, how topics in Calculus reappear in Dynamics and Electronics, and how topics in Differential Equations will reappear in Fluids and Automatic Controls. Developed materials could be as simple as slide show presentations, or as ambitious as computer-based video presentations.

Educators have found that this "bridging" between pre-engineering courses and upper division engineering courses has had positive effects on students' comprehension and motivation as they begin taking engineering courses[6].

Continuous Improvement Process

As we know, most accrediting agencies today require that some form of institutional effectiveness plan be in place, along with assessment instruments and a means for generating improvements based on results of the assessment. Most familiar among these to engineering educators are the ABET EC2000 accreditation requirements for four-year schools, but two-year schools also have accreditation requirements. A key activity in the workshops will be to share continuous improvement strategies. An example of this would be developing consistent sets of course objectives for pre-engineering courses, along with assessment tools to measure how the objectives are being met[7].

Aside from assessment methodologies, it is also essential that the needs of both partners in the workshop process be acknowledged. For example, two-year schools are assessed, in part, on how many associate degrees are awarded. Four-year schools should be prepared to give maximum transfer credit to students so they are encouraged to complete their associate degrees before transferring.

Impact of the Workshops

Initially, the Electrical and Mechanical Engineering Departments in the College of Engineering and Computer Science at the University of Texas at Tyler will work with the pre-engineering coordinators at Kilgore College and Tyler Junior College to seed the workshops. The program would then be expanded to include workshop presentations to the two-year colleges in East Texas with pre-engineering programs.

If the workshops turn out to be an effective tool at a regional level, the strategy could then be developed for statewide (and ultimately national) dissemination. Since the larger universities in the state have programs that typically do not take advantage of the full two-year college preparation, the authors propose developing the workshops through a collaboration of smaller four-year schools in the state system, and public two-year colleges.

Effectiveness of the workshops would be assessed by several means, including comparative tracking of student performance, surveys to measure "cooperative attitudes" of faculty involved at two-year and four-year institutions, and measures of retention of students within two-year college programs and four-year institutions. Figure 1 shows the workshop development process.

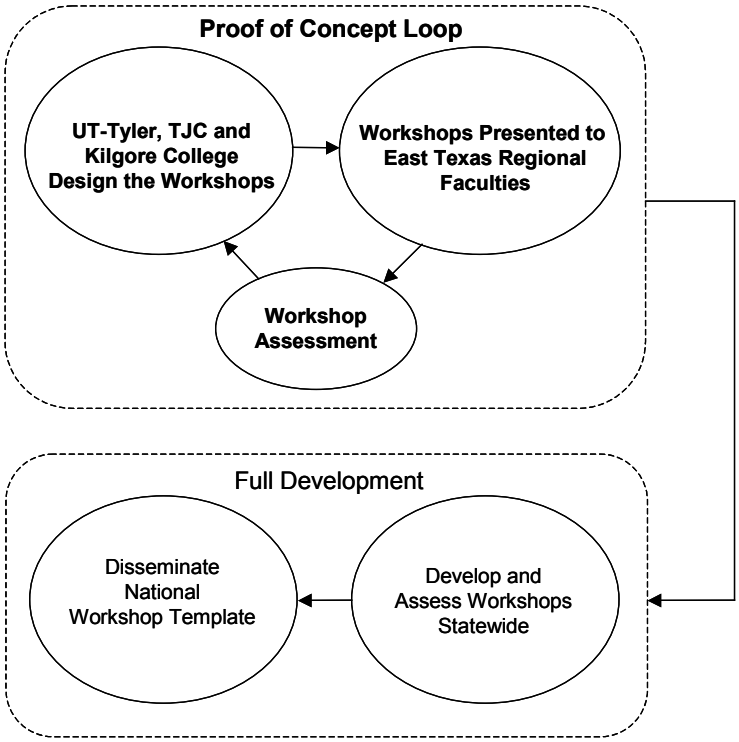

Figure 1. Workshop Development Process.

Next Steps in the Process

An important issue to consider in implementing the workshops is what it will take to engage faculty in the process. Appropriate incentives might include a formal invitation to attend, a certificate of completion, and a stipend for participation.

Naturally, funding will have to be secured to allow the stipends, as well as covering the costs of the materials that will be developed. Consequently, the authors propose to submit an NSF "proof

of concept" proposal to the Course Curriculum and Laboratory Improvement -- Educational Materials Development track for the 2004 funding year. The proposal will seek to develop the workshops at the regional level. If the project is successful, the workshop model would be further developed for dissemination at first the state and then at the national level. Broader issues concerning the partnership of two-year and four-year institutions would be developed for workshops at the national level. Also, sustainability of the workshops year-to-year would have to be carefully considered.

Materials produced during the workshops will include two basic categories. First, peer-to-peer faculty materials covering recruitment and retention, and implementation of the continuous improvement process. Second, instructional materials for students covering introduction to engineering courses, and the "engineering context" of pre-engineering courses, at two-year and four-year schools. It is anticipated that the materials will be packaged in a set of computer Compact Disks for dissemination.

Summary and Conclusions

The authors propose developing a series of workshops to enhance the implementation of the field of study curriculum in engineering in the state of Texas. Topics in the workshops will include implementation issues for the curriculum, recruitment and retention, introduction to engineering courses, the "engineering context" of pre-engineering courses, and the continuous improvement process for program assessment.

Funding will be sought from the National Science Foundation for the project, and perhaps from other sources. The authors feel that the workshop concept is important, and plan to continue with workshop development until funding is secured. If the field of study curriculum for engineering can be implemented appropriately, there should be no discernable difference between two-year and four-year pre-engineering programs. Beginning students at both types of institution would benefit greatly from a curriculum that is of consistent academic content and caliber.

References

1. George, M.D., (1996) "Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology," http://www.ehr.nsf.gov/ehr/due/documents/review/96139/start.htm (15 Dec, 2002).
2. Texas Higher Education Coordinating Board, (2002), "Engineering Field of Study," http://www.thecb.state.tx.us/Ctc/ip/core11_00/EngineeringFOS.htm (7 Jan, 2003).
3. National Science Foundation, (2002) "Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology," http://www.nsf.gov/od/cawmset (15 Dec, 2002).
4. Calkins, D.E., Davis, D.C., Crain, R.W., Trevisan, M.S., Gentili, K.L., "TIDEE: The First Year of a Design Engineering Educational Partnership for Washington State," Proceedings of the 1996 Frontiers in Education Conference, IEEE/ASEE, pp. 1374-1378.

5. Mountain, J.R., Wells, R.L., "Engaging K-12 Students and Teachers Using Competitive Interactive Design," Proceedings of the 2002 Frontiers in Education Conference, IEEE/ASEE, pp. T3C-12 to T3C-17.
6. Pierson, S.W., Gurland, S.T., Crawford, V., "Improving the Effectiveness of Introductory Physics Service Courses: Bridging to Engineering Courses," *Journal of Engineering Education*, pp. 387-392, October, 2002.
7. Flinn, B.D., Silva, M.K, Carson, J.M., Liaw, B., Barba, J., Zhang, G., "A History of ECSEL Community College Interactions," Proceedings of the 1999 Frontiers in Education Conference, IEEE/ASEE, pp. 13a1-14 to 13a1-20.

ROBERT LINDSAY WELLS
Lindsay Wells is an Associate Professor of Mechanical Engineering at the University of Texas at Tyler. His teaching experience includes courses in introduction to engineering, dynamics, manufacturing, and measurement systems. He received his B.S.M.E. degree in 1985 from the University of South Florida, and his Ph.D. in Mechanical Engineering from the University of Florida in 1992.

ALAN MORRIS
Alan Morris is an Instructor in the Engineering, Math and Physics Program at Kilgore College in Kilgore, Texas. His teaching experience includes introduction to engineering, statics, dynamics, physics and developmental mathematics. He received his B.S.E.E. degree from Texas A&M University in 1980, and his M.S.E.E. degree from the Air Force Institute of Technology in 1984.

CHRISTINE E. HAILEY
Chris Hailey is a Professor and Chair of the Mechanical Engineering Department at the University of Texas at Tyler. Her teaching experience includes courses in thermodynamics, heat transfer and manufacturing. She received her B.S. degree in Mathematics from Colorado State University in 1977 and her Ph.D. degree in Mechanical Engineering from the University of Oklahoma in 1985.