2006-406: PLANNING A DUAL-SITE ELECTRICAL ENGINEERING PROGRAM

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Planning a Dual Site Electrical Engineering Program

Abstract

A new program in Electrical Engineering (EE) is being offered at the Department of Engineering & Design within the School of Computing and Engineering Sciences at Eastern Washington University (EWU). The program was designed responding to a request by the American Electronics Association to fulfill the critical need for electrical engineering graduates in the State of Washington. Although the program is currently offered at the Eastern Washington campus in Cheney, there is a current proposal to extend this program into the western side of the state. EWU is partnering with North Seattle Community College (NSCC) to plan a dual-site EE program that would provide a seamless transition for students from the Seattle Community College system into a four year, EE program.

Recently, funds from NSF were obtained to plan this novel partnership. This paper describes the planning process and it addresses the following elements. First, the curriculum will be modified to include effective, research-based pedagogies for teaching electrical engineering, particularly extensive experiential learning. EWU’s curricular revisions will include adding a laboratory component to each class in the EE major, developing a class for each year of study that includes a service learning component, developing a class for each year of study that requires work on a real industry project, and requiring an internship and a project-based senior project for each student. Second, the program will be offered in a dual-site mode in both the EWU’s Cheney campus and at North Seattle Community College (NSCC), a community college that serves a diverse, place-bound student body. Finally, the paper will document the design methods to recruit and retain underrepresented students in the EE program, both at EWU and at NSCC. These methods are adapted from strategies that have been proven effective at other universities.

This paper reviews the planning of a dual-site EE program that partners a Regional Comprehensive University with a Community College. It includes the significance, goals, objectives, curriculum, infrastructure, and laboratory requirements. The result of this research will be a model that could be replicated by other universities and community colleges.

Introduction

Eastern Washington University (EWU), a public comprehensive university located in Eastern Washington, developed an Electrical Engineering (EE) degree program that currently engages students typically underserved in the engineering sciences and helps them develop the skills they need to become effective electrical engineers. The EE program has been carefully designed to meet the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC of ABET). This project involved the following three main elements. First, improve the curriculum to include effective, research-based pedagogies for teaching electrical engineering, particularly extensive experiential-learning. EWU’s curricula revision will include adding a lab element to each class in the major, developing a class for each year of study that includes a service learning component, developing a class for each year of study that requires
work on a real industry project, requiring an internship and a project-based senior project for each student. Second, offer a dual-site EE program at both the EWU’s Cheney campus and at North Seattle Community College (NSCC), a community college that serves a diverse, place-bound student body. Finally, design methods to recruit and retain underrepresented students into EE at EWU and NSCC adapted from strategies that have been proven effective at other universities.

This project is designed to address several critical needs, such as the critical shortage of electrical engineers in Washington State; increase the number of underrepresented students in electrical engineering; advances the state-of-art for effective, efficient, cost saving transfer education in engineering; and advances the knowledge and understanding of models that are effective in recruiting and retaining women and minorities into electrical engineering.

The activities described in this paper include: coordinating and articulating with North Seattle Community College; planning laboratory, service learning, and industrial project content for core and elective classes in the curriculum; designing a detailed recruitment/retention plan for underrepresented students; developing systematic assessment methods for evaluating the EE program; and finally solidifying industrial and community partnerships.

**Motivation for Project**

A critical shortage of engineers exists\(^1\), according to NSF, industry, and educators. Approximately 5,000 new engineering positions are created each year in Washington State. However, Washington State universities are only graduating between 2,000 and 2,400 engineers each year. This leaves up to 2,500 engineering positions unfilled each year. In terms of creating an EE workforce, Washington State has a serious problem with capacity. The two public engineering schools – Washington State University and University of Washington – are not increasing the number of EE graduates, but their programs are in high demand. For example, the University of Washington only accepts 200 EE applicants per year, while receiving 350-400 applications. A recent American Electronics Association (AeA) task force called for Washington State institutions of higher education to “increase capacity and improve access for would-be students” and for the state government to address both funding and capacity. In response, the 2003 Washington State Legislature approved and Governor Locke signed into law EHB 1808, which provides the opportunity for all state universities to offer EE programs. Eastern was the first, and only, regional university in the State to obtain approval to offer the EE degree program.

A model to modernize Electrical Engineering Education

Undergraduate engineering education in the United States has received significant criticism for its lack of adaptation to the global changes in today’s economy\(^2\). It took decades for accreditation boards such as ABET to act on the fact that universities across the country were not giving enough attention to laboratories\(^3\). As a systematic approach towards overcoming this problem, Eastern’s EE program includes a laboratory component into every EE course in the curriculum. Labs will include projects that in many cases will be drawn from industrial partners. This aggressive move intends to close the gap between “real-world,” industrial design experience and traditional lecture-based curriculum. Eastern does not intend to minimize the theoretical
component in the classroom. Rather, this model is an attempt to reinforce the theory with laboratory exercises and projects.

A model for serving place-bound students in high demand fields
EWU will offer an EE degree to place-bound students in Seattle and Spokane. In both places, industry is experiencing a shortage of electrical engineers while people in the area, bound by commitments to their family and community, are seeking education that will lead to a satisfying professional career. This need for a match between industry and a future workforce is hardly unique to Washington State or electrical engineering. Employers will continue to experience a need for a highly educated workforce. The potential workforce is no longer typically young and able to move easily for education. Instead, these future employees may be on a second career, married to someone unable to move, or belong to an ethnic group where closeness to family is an essential value. Universities must be able to offer education in areas of regional and national need in the places where the potential workforce lives. The program described in this proposal creates a cost-effective, efficient model serving place-bound students.

A model for cost reduction
When universities provide programs to place-bound students, they typically offer programs through branch campuses. These programs are costly. Branch campuses come with a high cost of infrastructure in terms of human and physical resources. Often nearby community college laboratories and classrooms are not being used to capacity. At the same time, students frequently experience difficulty transferring from a program at their local community college to the branch campus in an efficient way. Differences in requirements and expectations can lead to more time to degree completion, wasting both student resources and state dollars. In Eastern’s model, valuable state resources are used efficiently and students experience a seamless transition into upper division courses. In other words, the electrical engineering program offered by Eastern Washington University is housed at NSCC, but without Eastern opening a branch in Seattle.

A model for serving underrepresented students
EWU’s plan to significantly increase the representation of women and minorities in EE is an opportunity to address what has been, in the past, a significant limitation to the improvement of workforce diversity and to the number of individuals pursuing an education in the engineering sciences. It serves the needs of Washington State citizens. Current demographic data from the Washington State Office of the Superintendent for Public Instruction indicates that Washington has an increasingly broad pool of potential non-traditional students. National statistics indicate a similar pattern. A commitment to underrepresented students builds the enrollment capacity within the EWU’s new School of Computing and Engineering Sciences (SCES) and the new EE program. A best-practices approach, integrating “experience-based learning,” defined as both service learning and industry collaboration, throughout the curriculum will serve as the cornerstone of the program. However, high school outreach, learning communities, mentorships, and culturally appropriate internships will also be used to attract and retain students. This program will provide a model for recruitment and retention that can be replicated in other universities.
Program Plan

The overarching goal of this project is to develop a dual-site EE program that provides students, including those underrepresented in engineering fields, with the skills and competencies to be effective employees in a global economy. The project has five principal objectives:

Objective 1: Create a dual-site EAC of ABET accredited curriculum in EE that emphasizes modern, research-based pedagogical strategies such as experiential, team-based, and service learning.
Objective 2: Provide access to an engineering baccalaureate degree to place-bound students.
Objective 3: Attract and retain underrepresented students in engineering.
Objective 4: Reduce costs of providing engineering education through a dual-site program.
Objective 5: Design the project in a systematic way so the model can be easily duplicated in universities nationally.

Eastern Washington University intends to develop an EAC of ABET accredited EE baccalaureate dual-campus program on its Cheney campus and on the campus of NSCC through the Department of Engineering and Design (E&D). The curriculum has been designed meticulously to meet and exceed ABET accreditation criteria, which is expected following the first graduating class. The dual-site program will prepare professional engineers to adapt quickly to new technologies and knowledge. From the first classes, faculty, community, and industry partners will engage students in the fundamentals of critical thinking, communication, and teamwork. Industrial collaboration will be combined with service learning to create an “experience-based learning” educational model. This combination will ensure a global and current engineering education while fostering lifelong learning. Moreover, the program will emphasize the best of engineering theory, professional practice, cutting-edge software, manufacturing and design processes. The result will be highly capable engineering professionals with both theoretical and active knowledge of engineering. Graduates will earn a Bachelor of Science in EE and will enter the workforce as electrical engineers, systems engineers, project engineers, digital engineers, computer engineers. They will find jobs in engineering firms, consulting agencies, governmental agencies, and manufacturing facilities where they work to design, develop and implement military, industrial and consumer products.

Industrial representatives will be deeply engaged in the development of the program. They will provide input into curriculum and laboratory refinements and identify current skill sets required in the EE work environment through the advisory broad. These relationships will help faculty to identify a series of industry related problems that exemplify current and cutting-edge trends and related workforce preparation needs to be addressed in the classroom.

The junior year of the EE program started in the Cheney campus in the Fall 2005 quarter. The first graduating class is scheduled to be in the 2006-2007 academic year. NSCC classes are planned to begin Fall 2007. Table 1 summarizes the projected full time student enrollments for the first 5 years. Note that the expected pool of students attending the program at the NSCC campus is not restricted to current NSCC students, but includes potential students in pre-engineering from other community colleges in the region. The necessary preparatory freshman
and sophomore classes have been part of the E&D Department’s Engineering curriculum for many years.

Table 1. Size of Program (Junior and Senior years only)

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Fall 2005</th>
<th>Fall 2006</th>
<th>Fall 2007</th>
<th>Fall 2008</th>
<th>Fall 2009*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EWU</td>
<td>43</td>
<td>60</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>NSCC</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Total Headcount</td>
<td>40</td>
<td>60</td>
<td>95</td>
<td>110</td>
<td>120</td>
</tr>
</tbody>
</table>

* Full enrollment

The plan assumes that forty percent of these students will be women or ethnic minorities underrepresented in engineering, including African-Americans, Hispanics, and American Indians, for which a systematic recruitment and retention infrastructure is going to be added to the current periodic faculty visits to feeder community colleges and high schools. These percentages are based on internal data collected by the University’s recruitment office. A recruitment specialist has been hired by EWU specifically towards this end.

Dual Campus Program

EWU’s intention in creating this EE program is to serve the needs of the people of Washington State. Thus the program will be offered on two campuses – one that serves Eastern Washington and one that serves Western Washington. Eastern Washington students will take classes at EWU’s campus in Cheney and Western Washington students will take classes at NSCC, a community college five miles north of Seattle that serves nearly 19,000 students per year. EWU has chosen NSCC as its partner for the dual campus program for three reasons. First, it is located in Seattle, an area with a high demand for electrical engineers, but an area that has no additional capacity for EE students at local public universities. Second, NSCC serves a diverse student body. Almost 40% of NSCC student population comes from diverse ethnic backgrounds, 58% are women, and most are older (average age 31) and place-bound. Finally, NSCC has the capacity in terms of classrooms and appropriate laboratories to offer the program. It has electrical/electronics laboratories funded by NSF a number of years ago, and they are currently underutilized. These laboratory stations can accommodate an estimated enrollment of 96 students.

NSCC and EWU will each offer the first two years of the EE program independently; Eastern will offer the junior and senior year classes on both campuses, including lab classes. Instructors at both locations will conduct classes through the K-20 satellite link between Cheney and NSCC, giving lecture and instruction in their areas of expertise. EWU’s Department of E&D is experienced in this instructional method and offers distance education programs on three other community college campuses with highly successful results. This method is not limited to lecture but small group and other engaged learning. Cheney-based faculty will conduct their classes from and to one of three state-of-the-art distance education classrooms. Seattle based faculty will conduct classes from NSCC’s distance education facility.

All laboratories will be taught on-site in Cheney and at NSCC, and the experiential-based component of the curriculum will be designed separately for the Seattle-based and the Spokane-based industrial and community partners. Instructors in each of the locations will serve as
liaisons for these projects. Approximately one half of the full-time EWU EE faculty will be based in Seattle. They will advise students, monitor laboratories, conduct help sessions, do research, conduct classes, and serve as liaisons with industrial partners.

**Experience-Based Learning**

The EWU’s EE program will be organized around an “experience-based learning” approach that gives equal importance and attention to service learning as well as industrial collaboration.

**Each Course will have a Lab.** The EE curriculum will be laboratory-intensive. Each EE course, including senior electives, will have a laboratory component. The EE program will stress laboratory-oriented learning, while not straying from the theoretical background critical to understand the systems at hand. Laboratory experiences will be thorough and comprehensive. New and existing labs will be created in the new School for Computing and Engineering Sciences (SCES) facility and in the labs at NSCC.

**Emphasis on industry/service problems.** Industry and community partners will be able to request that EE classes (faculty and students) tackle real problems on their behalf. Regional technology companies through the recently formed EE Advisory Board, non-profit organizations, government agencies, and start up non-technical businesses will propose projects or assignments with an expected outcome to the E&D Department. Faculty will evaluate the proposal for compatibility with the curriculum, ensuring it provides a problem-solving approach to learning, and for its potential for a favorable outcome within a reasonable timeframe for students. If a proposal is accepted, a representative from the company or organization must commit time to the project at the university, serve as a mentor, member of the advisory board, guest lecturer, or oversee an internship. These assignments are expected to encompass a wide variety of industry-related theoretical and practical problems. A recent sample project involved helping a local company with a software/hardware problem. A device was being designed to measure fetal heartbeat, but special detection techniques were needed for twins. The company provided the heartbeat data files, and students in the laboratory built filter systems to detect and measure the separate heartbeats. They tested the system and reported their findings to the company.

**Freshman Design Experience.** All EE students will enroll in Freshman Design. The class will have an experiential basis and is designed to engage students into engineering early on their college career.

**Internships.** Students may obtain practical experience for credit toward their academic degree, while opening the door for future permanent employment. Internships will match students according to the location of the internship and the ability of the placement to meet the needs of the student (promotes workforce diversity, maintains flexible hours, employment potential, etc.).

**Service learning.** One required EE class each year will include a service learning element to ensure that students have the benefits of service learning. The following classes will include service learning, and have been newly developed or revised. ENGR 197 and ENGR 490 will be revised, while ENGR 260 and ENGR 331 are newly developed.

1. **Freshman Design (ENGR 197).** A course with introductory projects to introduce students to engineering in general, with part of the class dedicated specifically to EE. In previous
years, ENGR 197 was TECH 197 and consisted of introductory topics in Engineering Technology, invited speakers, and a final project. Under the new structure, it will keep its previous content, while including a service learning component designed to intrigue, motivate, and challenge students. Since this is a first year class, the service learning project will be combined with the senior ENGR 490 Design Capstone class (see item 4 below). ENGR 490 students will act as mentors for ENGR197 students, engaging them as an integral part of the design and implementation process, while exposing them to team-based interaction.

2. **Microcontroller Systems I (ENGR 260).** The experience-based learning concept is newly incorporated into a traditional microprocessor class for sophomore level design. This class will provide students with hands-on experience for community or industry. Faculty members will choose a project appropriate for sophomore students from those supplied by the industrial or community partners. A combination of industrial sponsors and Eastern faculty will act as mentors for the projects. Students may be partnered with ENGR 331 (Electronics II) students according to the scope of the project. Note that these projects will always be team-based. An example of this type of projects is designing a message display board for the Cheney School District. This project was suggested by the City of Cheney and involves designing the intelligence (i.e. controls) and interface for the message display board for Cheney’s schools.

3. **Electronics II (ENGR 331).** The Electronics class is newly developed to absorb the experience-based learning concept at the junior level class. This class will add an industrial, team-based project. Faculty members will select a project at an appropriate level for EE junior students. Faculty members in collaboration with industry members will guide it. A potential project is creating a signal amplifier (or repeater) design for networks in Cheney, another project suggested to Eastern by the City of Cheney.

4. **Senior Capstone (ENGR 490).** The Senior Capstone class models a team-based industrial environment, where students with a variety of academic and skill backgrounds collaborate to design and implement a given project. The class is largely designed to combine the skills and knowledge from the team of students for solving a community-based engineering problem. This class needs no further revisions, since it was recently redesigned to accommodate the service learning component. However, students will additionally improve their teamwork and managerial skills by becoming mentors of ENGR 197 students during the class. Both classes will be taught in the same quarter.

**International Service Learning Class.** Each summer Eastern will offer an elective service learning engineering class in an international location. Eastern’s program will be modeled after international projects such as Engineers without Borders. Student chapters of this organization have undertaken projects that improve rural water supply and sanitation and develop local energy availability in developing countries.

**Justification for Experience-based model.** Current research suggests that a program focused on experienced-based education is a logical approach to teaching engineering. Experience-based learning teaches students how to use individual and group skills to successfully reach their goals, while fulfilling class objectives. These experiences foster the development of self-reliance, confidence, self-esteem, time management skills, communication skills, and the necessary fundamentals to be able to solve technical problems both in industry and society. It fosters
qualities professionals’ need while retaining students in the field. Professionals need to learn new engineering knowledge quickly, work in teams, solve problems creatively, communicate, and respect diversity. Keys to recruiting and retaining engineering students include engaging them early through courses that articulate and integrate the relevance of engineering to early requirements such as math, physics, design, communication, humanities, and other requirements and use active learning so they can apply theory and practice, and fostering a sense of community and communication with instructors. Two National Academy of Engineering Reports, Assessing Capacity of the U. S. Engineering Research Enterprise and The Engineer of 2020 Report both recommend that schools implement innovative curricula that address the realities of contemporary engineering practices and the needs of the nation. Further, globalization of the world’s economy must be addressed in changes in engineering education, since engineers will now be working under a worldwide framework. To retain and engage students, teachers must provide an avenue for innovation and creativity. Traditional lectures in science and engineering education result in a passive form of learning and may not be the most efficient for student education. Constructivists assert that learning is “constructed” in the learner’s mind through experiences. The reference goes on to assert that this is particularly true for women and minorities. Practical/industrial projects elevate student interest. Thus, focusing more on increasing active student involvement through teamwork, cooperative learning, and use of current practical projects should be an engineering education priority. These concepts encouraged Eastern’s E&D Department to focus on experience-based learning – not only in introductory courses, but also throughout the curriculum.

One component of experience-based learning is service learning. Service learning is typically organized around community partnerships of students, faculty and community members working together to tackle a community project. In this process students and faculty become connected to the community and learn about community needs. Students apply and expand their engineering skills and knowledge and become familiar with social issues. Faculty open up new learning capabilities for the student and may be able to find new research opportunities. Community members learn about engineering capabilities and better understand the university. Service is provided to the underserved or for the common good of the community and benefits the students, faculty, the department, the local community, the institution, and the private sector. Note that one important fact about service learning is the reflection component done by the student. It has been shown that over 65% of the students recognize the civic engagement portion of service-learning as a critical part of their education.

Today engineering curriculum lags behind other disciplines in offering service learning programs. This is unfortunate, because it is an effective pedagogy for helping accredited programs to meet ABET EAC 2000 Engineering Criteria. Through service learning students learn to apply concepts and theory to real problems, to undertake the entire product design-manufacture-delivery process, to solve problems in an interdisciplinary team, to understand the profession and its ethical responsibilities, etc. However, some successful engineering-based service learning endeavors exist, and EWU will apply the lessons learned from these projects. A very well known, long-term, large-scale, team-based, multidisciplinary undergraduate engineering design program called EPICS (Engineering Projects In Community Service) is at Purdue University. Multidisciplinary undergraduate design teams work with local community organizations and agencies to solve issues put forward by their community partners. The
EPICS program is now found on many university campuses with a diverse collection of projects ranging from home system design for energy to construction efficiencies and therapeutic device design for persons with disabilities. A team faculty members will visit Purdue, to directly correspond with and learn from the successes of the EPICS program.

The engineering service learning programs that do exist tend to focus on only one course and one project in the engineering or engineering technology curriculum. Typically this design experience occurs only during the freshman year, leaving the remaining three years of study without any service learning activities. To more effectively facilitate student learning in teamwork, communication, and ethics, Eastern’s EE program incorporates service learning projects into at least one of the required courses each year.

Due to the nature of business today, some of the projects conducted by EWU’s students in this experience-based approach will be global in scope. The days of designing, developing, and manufacturing products in one location are long gone. Instead the product may be designed in one country, developed perhaps in a second country, and manufactured in a third country, while it will be used through out the whole world! Technology has played a big part in making this globalization of industry possible. Since computers can be networked across companies, countries and continents, geography or time no longer weighs down the transfer of information. International service learning opportunities allow students to apply their knowledge in real-world applications, make a difference, extend their cultural diversity, and prepare them for potential foreign assignments.

**Recruitment and Retention**

While the E&D Department has historically been committed to student recruitment and retention, underrepresented groups, such as women, ethnic minorities, older students, and displaced workers in technology programs are still not a significant part of the student population. Eastern strives to establish a solid recruitment and retention infrastructure specifically targeted to underrepresented students.

EWU’s EE program is designed around pedagogical strategies that are particularly effective with women and ethnic minorities, groups that are underrepresented in engineering. Research indicates that women learn most effectively when theory is linked to real world situations. Further, women students excel in hands-on, collaborative, and verbal oriented educational settings. Research further shows that minority students learn by constructivistic models and Hispanic students tend to learn more effectively in collaborative environments such as team-based projects. Using the experience-based learning approach fits well into these learning models.

The retention and recruitment strategies that will be used in this project are an outgrowth of initial efforts conducted by the E&D Department. They are aimed at the successful completion of the EE program by all students including those considered underrepresented in science and engineering. In addition to embracing pedagogical strategies that have been successful with underrepresented groups, the following approaches will be used to increase diversity.
The University-wide activities to be undertaken include:

- Develop an in-depth and holistic admissions review criteria including, but not limited to, community service activities, leadership records, and interviews that may be considered with g.p.a. and standardized test scores (with the goal of determining the student’s potential to be successful at Eastern given their background and the services available to them once on campus);
- Expand the performance-based transfer competency program being piloted with Spokane Community Colleges to community colleges within the state with high enrollments of underrepresented students;
- Obtain institutional approval to create faculty development plans (required for tenure and promotion) in which faculty get credit for mentoring and retaining underrepresented students in their departments; and
- Expand outreach to K-12 schools and organizations supporting the educational development of nontraditional students.

Faculty in the E&D Department are currently involved in traditional recruitment activities such as site visits, advertisements and circulation of Internet, multi-media CDs, and hardcopy information on the EE program in conjunction with Eastern’s recruitment team in Student Affairs. Moreover, every faculty is in charge of advising of students, since it has been empirically observed that the rate of recruitment and retention of students is larger when faculty are directly involved in the process. Furthermore, faculty develop courses designed to interest college students in the field of engineering, especially targeting those who exhibit desirable qualities but have not yet committed to a major. Finally, faculty currently identify industry mentors and establish culturally relevant internships for underrepresented students (i.e., minority owned businesses, businesses located in the student’s home community, etc.).

As part of the recruitment and retention effort, the E&D Department works with high school guidance counselors in ethnically and culturally diverse areas to develop a formal school to university relations and transitions program for EE. As a parallel effort, the Department is currently expanding working relationships with the region’s Gear-up, Upward Bound, Talent Search, MESA (Math, Engineering, Science Achievement) and HAAP (Hispanic Academic Achievers Program) programs to develop initiatives that pique student interest and participation in EE.

**Eastern Washington University’s Capacity**

EWU’s mission, goals, expertise and capacity make it well suited to successfully carry out this project. EWU is a mid-sized comprehensive university that offers nearly 100 baccalaureate degrees and 75 master’s programs to more than 9,000 students. It has been cited by US News and World Report as one of the ten best comprehensive universities in the West, and has twice been named one of the 201 best universities for the real world. Eastern’s students are typically low-income and first generation, and the university has fulfilled, especially for the Eastern Washington region, the role of preparing these students for challenging careers - including those
Eastern has made a commitment to the region and the state to address current workforce needs, particularly as they apply to the regional technology sector, through excellent student learning, recruitment, and retention. In 2000, Eastern began the Technology Initiative for the New Economy (TINES) to meet that need. The faculty in E&D, Computer Science and Physics have united within a new academic unit named the School of Computing and Engineering Sciences (SCES) where interdependent programs can focus on student learning within the context of the ever-increasing demand for technology connected degrees.

The Washington State legislature has funded the design and construction of a new state-of-the-art building to house the School and its programs. The building has been designed to include laboratories that support curriculum for an EE degree. The facility includes 15 classrooms (three wired for distance education) and 21 laboratories, more than doubling the usable space available for students in high-technology disciplines. Laboratories are furnished with the latest equipment and software thanks, in part, to significant donations from industry partners, helping students to understand and use these technologies as professionals. Specialized labs and equipment also aid faculty in their research and foster industry partnerships, with the goal of developing new technologies and new applications for current technology.

The SCES facility and its programs have garnered support at multiple levels. A congressionally directed grant, (through the US Department of Education) to the SCES funded curriculum development to enhance the foundational learning in computing and engineering sciences, including EE. This grant supported the development of an experience-based learning paradigm, which will include heavy industrial experience and service learning components in the curriculum. Industry has responded by donating or committing to equipment in support of the EE program. Companies such as Mentor Graphics, Xilinx, Agilent, and Fluke have already donated software and equipment such as power supplies, oscilloscopes, data acquisitions units, waveform generators, timer/counters, frequency counters, multimeters, spectrum analyzers, etc. Others have promised equipment, including Schweitzer Engineering (power laboratory equipment), XN Technologies (routers and switches), etc. Other companies supporting the program include Microsoft, ITRON, Bremerton Shipyards, Boeing, Bonneville Power Administration, etc.

This project will be carried out by Department of Engineering and Design (E&D) within the SCES. The department graduates students who accept positions as production managers, project engineers and managers, designers, engineering technologists, and technologists in manufacturing, instrumentation, testing, production, design, construction, and other scientific fields. The department has established an excellent reputation within the industrial community with graduates accepting positions at Agilent, The Boeing Company, Hewlett-Packard, Microsoft, Keytronics Corporation, Bayliner Marine Corporation, Avista, Intel, and others.

**Work Plan**

The E&D Department has designed for the Cheney campus four new EE labs and has plans prepared to renovate three labs to better meet the current curriculum objectives of the EE
program. All will be located in the new SCES facility. The four new labs include the Microelectronics/VLSI lab, the Controls lab, the Communication Systems/Signal processing lab, and the Power lab. The three renovated labs are the Networking lab, the Circuit/Digital lab, and the PC lab. Each will provide necessary hardware and software resources to incorporate the experience-based learning method described in this paper. Much of the equipment needed for these labs has been either purchased or donated by industry and has been placed in the labs in the new Computing and Engineering Building.

Preliminary curricula for the EE program have been developed, including incorporating the classes taught at the freshman and sophomore levels at NSCC into the EE curriculum. The curricula include a yearly service learning course, which will be culminated by a Capstone Design class in the senior year. Additionally, faculty in the E&D Department have already developed a substantial part of the specific freshman- through sophomore-year curricula.

The program was designed to meet the EAC of ABET criteria that provides a set of program standards that must be met including number of program instructors, a minimum number of credits (180), certain curriculum elements, assessment criteria (i.e. the student must be able to design experiments, communicate effectively, etc.), advisory board formation, administration criteria, etc. All curriculum planning, including the identification of program objectives and outcomes will be conducted with this final goal in mind.

To effectively carry out the objectives outlined in this paper, carry on the following activities:

- **Activity 1**: Coordinate and articulate with NSCC.
- **Activity 2**: Plan laboratory content for core and elective classes in the curriculum. Elaborate this keeping in mind the inclusion of experience-based projects into these laboratories.
- **Activity 3**: Establish a detailed recruitment/retention model for underrepresented students.
- **Activity 4**: Develop systematic assessment methods for evaluating the EE program, not only in its incipient years, but also as a long-term self-evaluation model.
- **Activity 5**: Solidify industrial and community partnerships.

**Coordinate and articulate agreement with NSCC**

EWU Faculty have been in close contact with faculty and administrators in NSCC and issued discussed include the following:

- Determine laboratory needs at NSCC. These labs will be designed to emulate the Cheney labs.
- Creating a course-by-course one-to-one mapping of EWU’s and NSCC’s currently existing lower division classes.
- Study current retention and recruitment methods existing in NSCC.
- Identify potential industrial partners for the industrial collaboration component of the experience-based model.
- Identify potential community partners for the service learning component of the experience-based model.
- Work out logistics such as classroom scheduling, facility charges, and parking and library use.
- Hire additional EE faculty.
• Create Memorandum of Understanding agreement ready for signatures.

Plan laboratory content for core and elective classes in the curriculum.
• Conduct site-visits to three universities with innovative curricula methods, including the EPICS service learning program at Purdue University.
• Engage Dr. Richard Felder, the co-director of the ASEE National Effective Teaching Institute, and fellow of the ASEE to consult on effective curricular methods and activities.
• Create synthesis of research from site-visit and literature and make recommendations for integrating learning strategies and problem-solving techniques throughout the curriculum.
• Pilot Teach Team oriented projects in three classes and assess results.
• Revise Freshman Design class and Microprocessors I to include service learning components.
• Elaborate laboratory exercises for all EE classes in the EE curriculum. Note that this includes all classes that have the ENGR prefix.
• Design laboratory structure for junior and senior classes that are thorough and comprehensive, real-world, and are effective in the EWU and NSCC labs (slightly different exercises might be necessary at each location); and
• Develop a proposal for an extended service learning EE summer session in a Central- or South- American country helping to enhance the quality of life for a community.

Establish detailed recruitment/retention infrastructure for underrepresented students.
• Conduct a study of EWU’s resources and environment regarding underrepresented students.
• Utilize a consultant for recruitment and retention of underrepresented students in engineering disciplines and to help create a comprehensive plan.
• Write a comprehensive recruitment/retention plan with detailed activities for implementing the plan.
• Write job description for and advocate for funding to hire a Student Relations Coordinator to be responsible for recruitment/retention infrastructure and initiatives.

Develop assessment methods and procedures for EE program
• Develop program and class learning outcomes.
• Establish a master course description for all core and elective courses currently offered and/or planned on being offered.
• Explore possible assessment for these outcomes and report on them to department faculty.

Solidify industry relationships
• Extension of advisory board members to include persons with a background in EE and non-technical members in the Seattle-area who can assist with both curriculum development and student recruitment and retention. Note that the advisory board currently is entirely formed with industrial representatives from Eastern Washington.
• Attend Industry and Education Collaboration Conference.
• Contact technology companies, non-profit organizations, government agencies, and start up non-technical businesses to prepare them to propose projects and/or service learning activities appropriate for the EE curriculum in both Seattle and Spokane.
- Identify appropriate EE internship sites, including sites with a commitment to underrepresented groups, in Seattle and Spokane and formalize these relationships.

**Evaluation**

Eastern EE faculty, the Project Director, Dean of the College of Math, Science and Technology and the Advisory Board will meet at the end of the project to evaluate this planning effort and to plan future action. Evaluation of the project will be done in alignment with the assessment and evaluation methods of the two ABET accredited programs in the E&D Department. This includes assessment method such exit surveys, alumni and employer’s surveys, student portfolios, etc.

Project evaluation will be both formative and summative. Formative evaluation will include answering questions such as the following: Did the E&D Department accomplish steps in the work plan and were all outcomes accomplished? Have agreements been reached with NSCC? Were new classes piloted? Is there a comprehensive recruitment and retention plan for underrepresented students? Is the Advisory Board complete? Are there formal relationships with mentors, internship sites, and industry partners? The second set of evaluation criteria is examining the progress the University has made toward meeting project objectives and identifying the critical next steps for meeting these objectives.

Table 2 displays the objectives and measures for the objectives as well as possible future steps that might be taken by the E&D Department as it moves into an implementation phase of this program:

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Measurement</th>
<th>Possible Future Steps</th>
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| Objective 1: Create an ABET accredited curriculum in EE that emphasizes modern, research-based pedagogical strategies such experiential, team-based, and service learning. | 1) Curricula Materials.  
2) ABET accreditation.  
3) Review of use of experiential, team-based, and service learning in each class.  
4) Assessment of student learning outcomes. | 1) Hire additional faculty (one will be hired in 05/06.)  
2) HEC Board Approval of dual site plan.  
3) Purchase additional lab equipment.  
4) Incorporating changes in additional classes.  
5) On-going assessment of learning outcomes.  
6) Partnering with businesses to allow experienced engineers to spend a sabbatical year at Eastern and/or Eastern would spend sabbatical year in industry. |
| Objective 2: Provide access to an engineering baccalaureate degree to place-bound students. | 1) Numbers of students in program.  
2) Number of underrepresented students in program. | 1) Furthering ties with NSCC.  
2) Increasing numbers of students in program. |
| Objective 3: Attract and retain | 1) Number and percent of | 1) Hire Student Relations |
underrepresented students in engineering.
2) Fall-to-fall retention rates of students in program.
3) Graduate rates.

Objective 4: Reduce costs of providing engineering education through a dual-site program.
1) Evaluate costs of program and compare with option of expanding program at EWU.
1) Continue to seek cost-saving measures.

Objective 5: Design project in a systematic way so the model can be easily duplicated in universities nationally.
1) Is design written in comprehensive way?
2) Number of articles and presentations about the project.
1) Partner with different universities and/or community colleges.
2) Visit other institutions as consultants and/or collaborators in implementing similar models.
3) Give workshops on the model.

Summary

This paper has detailed the planning process involved in developing a dual site electrical engineering program between EWU, a regional comprehensive university in Eastern Washington, and NSCC, a community college in Western Washington. The issues considered include modifying the curriculum to include experiential learning classes throughout the four-years of study, recruitment and retention, and planning of laboratory content. The underlying theme throughout this project is to address the need for more electrical engineers in the State of Washington, while tapping into the already existing resources in the community college in order to keep costs to a minimum.

Bibliography


