2006-2417: UTILIZING COLLABORATION FOR A REAL WORLD ENGINEERING EDUCATION

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Utilizing Collaboration for a Real World Engineering Education

Abstract

It is becoming increasingly difficult for educational institutions to offer quality engineering programs. The costs associated with laboratory and related equipment continues to escalate while the funding for the programs remains stagnant or is declining. This leads to a mounting budget shortfall. The outcome is a widening gap between what is required to effectively offer a leading edge engineering program and the resources currently available for instructional purposes. This dilemma directly affects the capability of engineering schools to train and graduate engineers with the abilities to work on state-of-the-art projects in a highly dynamic and increasingly competitive technical environment.

While new technological developments have in many ways created this dilemma, they may also offer the solution to deal with the increasing budget gap in an effective and timely manner. That is, not the technology itself but the businesses that design, develop, and manufacture it along with associated peripheral organizations. The solution is to establish and utilize a series of collaborative arrangements with a variety of partners, some immediately obvious and others rather obscure.

This paper focuses on essential partnerships, cooperative agreements, and other opportunities that must be utilized by engineering programs in order to transform their graduates into a competitive force in the global engineering marketplace. It concentrates on the efforts undertaken at Eastern Washington University’s Department of Engineering & Design. These include collaborations with government agencies, industrial firms, professional societies, and charitable foundations. Engineering programs that have successfully implemented and employed these techniques are able to graduate engineers prepared to prosper in the highly competitive global environment while those that haven’t are struggling with limited resources and budgets.

Introduction

The Department of Engineering & Design (E&D) at Eastern Washington University (EWU) was at a crossroads. It was housed in an aging building that was full of equipment from bygone days. Cheney Hall had served the Department well for over forty years but times had changed as well as the needs of the students, faculty, and staff. In fact, both the Department’s name and mission had changed a number of times throughout the years. Beginning as an industrial arts facility and moving into technology, graphic arts, and then engineering technology. Today the Department is diversified into engineering, engineering technology, and visual design leading to its most recent name.

Keeping up with all of this change required a continual renewal of resources including facilities, lab equipment, and instructional paraphernalia. This was an expensive process that was severely limited by the Department’s annual budget. As a state supported regional institution EWU was generously awarded funds allowing it to offer a quality comprehensive education. However, as
technology progressed at an ever accelerating pace the needs of certain departments exceeded the available financial support. This dilemma was recognized by the Washington State Legislature through the allocation of supplementary funds that greatly helped improve the situation. Even with this additional support, more had to be done in order to insure that a quality technical education could be offered in engineering, engineering technology, and related fields.

It became increasingly obvious that the Engineering & Design Department would find it difficult to remain competitive and graduate engineers with the skills required by today’s state-of-the-art industries. As a result, the search began immediately to locate additional sources of funding for the Department’s current and future needs. At the same time the search was broadened to include avenues for all types of resources including money, equipment, and personnel. All of the typical sources were investigated along with many inquiries into some rather uncharacteristic ways for assistance. As the process continued it became progressively more evident that the answer wouldn’t be found in any one place, but rather in an ever increasing circle of smaller solutions. It all boiled down to collaboration with an array of partners from a variety of organizations.

Collaboration

“Collaborative arrangements involve two or more firms in which the partners hope to learn and acquire from each other the technologies, products, skills, and knowledge that are not otherwise available” (Narayanan, 2001, p. 269). This type of operation is typically found in the daily operation of business organizations and infrequently established in relationships between organizations in different fields. However, in terms of educational matters two distinctive characteristics have been discovered. The first is simply knowledge transfer between groups or institutions. The second relates to selecting the partners and what each hopes to gain from the cooperative effort.

The educational goal is to share information with the students and faculty in order to better prepare the graduates for employment in the real world. This is a very critical aspect as mentioned by Hughes (2005) along with Jones, Butcher and Prey (2005). The university gains through this dialogue with industrial or other counterparts engaged in engineering on a day to day basis. Knowledge is transferred from experienced engineers to students as they study for their technical careers. The collaborative organizations gain access to the students and can influence their education leading to better prepared graduates that they can hire. Both parties win, but the biggest winners are the students.

This type of social interaction has lead to a team effort that excels in the sharing of information. “This has occurred because of a growing demand for specialization, the pressure of a global marketplace, the rise of the Internet as a collaborative tool, and … it takes collaboration to move a field of investigation forward” (Allen, 2003, p. 158). Synergism and social capital are created, both vital to educational success whether working on a project or solving a problem. In many cases engineering accomplishments can be directly related to team collaboration and social interaction. It is this combination of coordination and complementary capabilities that encourage achievement. Many advantages result from team effort encouraged by the mixture of individuals with assorted skills, abilities, experiences, and backgrounds. In fact, collaboration within a team
can be defined in terms of six factors: “communication …, cohesion …, work norms …, mutual support …, coordination of tasks …, [and] balance of member contributions and conflicts” (Dorf & Byers, 2005, p. 269). These factors are echoed in five principles outlining how to establish and form energetic social networks. On the whole they suggest to “deploy pervasive collaborative technology…, keep work visible …, build communities of trust …, think modularly …, [and] encourage teaming” (Evans & Wolf, 2005, p. 52). Essentially, these aspects all focus on working jointly as a team. Teams that can function well together typically attain their objectives and goals.

There are basically three reasons why groups of any type establish and maintain collaborative agreements. They are: “the resources required for a particular venture …, the risks associated with a venture …, [and] different firms have different capabilities” (Narayanan, 2001, p. 271). Many reasons can be listed for forming collaborative agreements or alliances. However, they can all be summarized into three forms of sharing: resource sharing, risk sharing, and competence sharing. In effect all three of these factors were important reasons why collaborative arrangements were sought by the Engineering & Design Department. Additional resources in terms of money, equipment, and expertise were needed. The risk of producing graduates unable to perform in today’s rapidly paced engineering environment had to be minimized and shared. Finally, the capabilities and competencies utilized by engineers working in actively in the field were required to provide students with motivation, encouragement, and direction to continue their studies.

Considering the various stimuli for forming the collaborative alliances, the results were very rewarding for all organizations involved. The Department received needed funds and equipment while the students were the overall benefactors. The participating organizations were able to influence the training of future engineers and potential new employees. The most frequently considered group for collaboration is industry. However, these alliances and collaborative agreements were established with a wide variety of diverse groups and organizations.

**Collaboration with State Government**

Perhaps the most important alliance or partnership was with the Washington State Legislature, the Governor, and the people of the State. They became the driving catalyst for improvement by initiating change both in the programs offered by and the facilities utilized by the Engineering & Design Department. Without their commitment and unwavering support the entire collaborative process would not have been possible.

In 2000, Eastern Washington University began the Technology Initiative for the New Economy, designed to help address current workforce needs, particularly as they applied to the regional technology sector, through excellent student learning, recruitment, and retention. As an integral part of this process, the faculty in the College of Science, Mathematics, and Technology (SMAT) including the Departments of Engineering and Design, Computer Science, and Physics reorganized. These departments were united into a new academic unit, the School of Computing and Engineering Sciences (SCES). This allowed for interdependent programs to focus on student learning within the framework of the escalating demand for technology connected degrees. Realizing the benefit of a new academic unit at EWU, the Washington State legislature funded
the design and construction of a new state-of-the-art building to house the School and its programs. As the result of other changes in the State law, the building has also been designed to include laboratories that support curriculum for a new Electrical Engineering degree as well.

The new SCES facility was completed in July of 2005 and ready for classes at the start of the Fall Quarter. The facility includes 15 classrooms (three of which are wired for distance education) and 21 laboratories, more than doubling the usable space previously available for students in high-technology disciplines. With more space (93,000 gross square feet and 60,000 assignable square feet), Eastern can now serve 51% more students in the E&D Department, while relieving space to increase enrollment in foundation programs (computer science and physics) in other buildings. The new facility was designed to accommodate students and faculty based on projections for enrollment at least eight years into the future. Laboratories were furnished with the latest equipment and software, thanks in part to industry partners, helping students understand how to use these technologies as professionals. Specialized labs and equipment also aid faculty in their research and foster further industrial partnerships, with the goal of developing new technologies for both current and innovative applications.

The new facility is completely wired for the Internet with wireless access available in most areas. In addition, all of the classrooms have enhanced presentation capabilities with wall talker boards and sound deadening. Flexibility was built into each classroom by utilizing raised floors that allow them to easily be converted into extra laboratory space with Internet access, electricity, and other capabilities prewired when needed.

The SCES facility itself is a living laboratory for engineering students and faculty, designed with monitors and controls throughout. HVAC, refrigeration equipment, building network equipment, building structural steel, atmospheric conditions in and out of the building, and system controls such as temperature and security monitoring will be instrumented to provide readings on stress and strain, power factor, heat loads, equipment efficiency, network statistics, and electrical load. Additional information on the new facility and the programs provided by the EWU School of Computing and Engineering Sciences can be found at http://www.ewu.edu/newtech/.

**Collaboration with Industry**

Whenever the word collaboration is mentioned, pictures of industrial partnerships and alliances appear. This is simply because the most widely used form of collaboration is between industrial organizations. Typical partners have included suppliers, customers, peripherally related firms, totally unrelated firms, and even competitors. The scope of these collaborative efforts continues to expand including many additional types of organizations.

Industrial collaborations between business organizations are established to create research and development alliances, marketing alliances, outsourcing arrangements, and agreements between large and small firms. Many of these same reasons are applicable for forming bonds between nontraditional groups. One of the fastest growing trends is to create partnership agreements between industrial and educational institutions. This has been occurring for many years with the very large research universities. However, only in the recent past has this filtered down to the regional and smaller universities.
“Collaborative arrangements involve two or more firms in which the partners hope to learn and acquire from each other the technologies, products, skills, and knowledge that are not otherwise available” (Narayanan, 2001, p. 269). This is precisely why the Engineering & Design Department aggressively pursued industrial alliances. Computers, test instruments, and other products were urgently needed for all of the new engineering laboratories to enable the students to learn using the latest state-of-the-art equipment. However, this is not just a one way street. The industrial partners will soon be able to share in the rewards as well trained highly skilled engineers’ graduate from EWU and search for challenging careers.

The relationship becomes a wonderful opportunity for sharing technology, products, and experiences. Many industrial partners are willing to donate equipment or offer it at greatly reduced prices to colleges and universities. This collaboration allows additional equipment to be available for student use and at the same time alleviating possible budgetary issues. An interesting side benefit occurs as students become familiar with this equipment and its capabilities; after graduation they are likely to specify and recommend its purchase by their new employer. Thus aiding the industrial partner and completing the collaborative cycle.

Collaboration with Professional Societies

One overlooked area of collaboration is with professional societies. Most faculty members belong to a number of societies related to their major field of study. However, few actually apply for grants and other types of funding from them. The Department of Engineering & Design decided to do something about that.

An aggressive campaign was instituted to locate and apply for a number of these opportunities that were potentially a good fit for the Department. Once again, the application process required a great deal of hard work and dedication from the faculty involved. The hope was to acquire additional funding and equipment through the awarding of these grants. It is basically like the lottery. Without an application there is no way to be awarded a grant. But with an application, everything is possible.

A number of professional societies were investigated to determine if they offered any grant opportunities that might be applicable. After considerable research a number of suitable prospects were discovered. Then the real work began. Writing the proposal is a very difficult and time consuming process. The wording must express exactly what activities are planned and how they will be accomplished. Details had to be included for everything, further complicating the process. Finally after considerable effort and multiple iterations the grant proposals were completed and submitted.

Collaboration with Charitable Foundations

Another area of opportunity for funding involves charitable foundations and trusts. Many of these types of organizations are willing to donate funds that can be allocated for equipment or other necessities. Some foundations also require the collection of matching funds after the award
has been announced. This results in the creation of a fund raising campaign that in itself may lead to additional financial support for the engineering program.

The application process also requires the writing of a detailed and specific proposal typically followed by site visits and interviews. It is a tedious process that many institutions simply avoid. Since there are few awards and few possibilities for success additional institutions are discouraged and simply don’t apply. With this in mind the faculty of the Engineering & Design Department wasn’t discouraged and actually considered their chances quite good.

Once again an investigation was undertaken seeking a match between the Department’s needs and the prospect for support. The search revealed a number of potential partners meeting both criteria. Then the specifics of the proposal had to be established. Through planning sessions all of the details were discussed and finalized. Proposals were then drafted, revised, and lastly submitted. Throughout this entire process the EWU Foundation was a valuable source of information and assistance. Without their dedicated assistance and guidance the tasks would have been insurmountable.

Collaboration with Other Governmental Agencies

Many Agencies of the United States Government offer grants for research and program development purposes. These grant applications require formal proposals outlining exactly what work will be accomplished with the funds received. It is a very rigorous time consuming and labor intensive process with no guarantee that the described effort will be even awarded a grant. The competition is keen with many excellent applicants and few awards. However, winning an award can bring needed funds and equipment into the department and university.

One of the most well known agencies is the National Science Foundation (NSF). They offer many opportunities for collaboration in the form of grants. A large number of these involve pure research into areas of interest including medical, chemical, biological, and technical. However, other areas of a more applied nature are also available. The E&D Department decided to focus its efforts on grants of that nature.

Specifically the areas of Planning and Implementation Grants were investigated. Proposals for new academic programs could be submitted for funds to aid first in the planning process and later even in the start up phase. Competition is once again very stringent and a limited number of grants are awarded. With the assistance and direction of the EWU Grants Office excellent proposals were written, modified, and turned in. It was truly a team effort with everyone contributing.

Success Stories

Eastern Washington University recognized that the old model of asking the state government to fund the entire needs of its engineering programs was not practical in today’s economy. It was immediately realized that the opportunities for successful funding using this outdated model were very slim if at all. As a result other sources of financial support were actively pursued with great success.
The biggest need was a new building to house the E&D Department. The bold step was taken to ask the State of Washington to fund only the building and that EWU would then seek financial support from other sources to equip the building’s laboratories. This fresh partnership approach allowing for numerous synergistic arrangements with industry, professional societies, foundations, and other government agencies was well received by the Governor and State Legislature. The State no longer felt it was being required to “go it alone” and that all the stakeholders would have an active role in securing the needed resources required to educate the engineering students. Many successful partnerships were formed to make the new building and laboratory equipment come to fruition.

Members of the faculty along with the EWU Foundation were very aggressive and active in contacting various industrial stakeholders and possible partners for the new building. Generous donations of equipment to furnish the new laboratories were received from Agilent, Hewlett Packard, Tektronix, Fluke, XN Technologies, CenturyTel, and other high technology companies. Additional new equipment was purchased utilizing money from university funds and grants to furnish extra laboratory apparatus. Most of this equipment was purchased from industrial partners at very large discounts realizing that it was going to be utilized in an educational laboratory environment. In addition, software donations were received from FANUC Robotics, Microsoft, and Mentor Graphics. This allowed a number of laboratories to be fully configured with entirely new state-of-the-art equipment that is absolutely required for a real world engineering education.

The E&D Department along with several local industrial partners collaborated, applied for, and received a grant from the Society of Manufacturing Engineers (SME) for over $200,000 to support new laboratories and curriculum revisions. The reviewers stated that one of the most important factors contributing to the awarding of the grant was the extensive support from local industry. They were also impressed with the commitment exhibited by the local industrial partners to lead, guide, and direct the efforts of the E&D Department to address the national competence gaps identified by the SME. The success of the grant was further enhanced by the large turnout of industrial partners during the SME Grant Committee’s onsite visit and inspection.

An NSF Planning Grant was also awarded to faculty members in the E&D Department for investigating and developing a Dual-Site Electrical Engineering Program. Further governmental funding of over $1.5 million was obtained through a Congressional Appropriation for the School of Computing and Engineering Sciences (SCEC). This was made possible by collaboration with the Computer Science and Physics Departments to address the growing national concerns for cyber security.

In addition grants from the Murdock Charitable Trust along with the Kresge Foundation allowed other pieces of significant equipment to be purchased filling other critical needs. The Kresge Grant further required the forming of a fund raising effort to obtain matching money for a continuation of the grant. This led to an additional input of funds into the Department. These avenues for extra financial support greatly enhanced the equipment available to offer an extraordinary educational experience for engineering students at EWU.
The results demonstrate that it is possible to obtain participation from a variety of stakeholders interested in improving engineering education. In order to get this type of response a joint university wide effort must be established to contact and coordinate activities. At EWU a consortium called the Technology Initiative for the New Economy (TINE) was established with this purpose in mind. Figure 1 indicates the percentage of participation in terms funds received from each category of collaborator.

![Partnership Collaboration](image)

Figure 1. Partnership Collaboration

The resulting facilities in the new building are among the best equipped engineering laboratories not only in the State of Washington but also in the entire Northwest Regional area. Together they present the student with an exceptional opportunity to study engineering and engineering technology whether it is electrical, computer, or mechanical. It would have been impossible to accomplish this goal of offering a real world engineering education without the generous assistance of many organizations through a series of collaborative efforts.

**Conclusions, Reflections, and the Future**

The success of Eastern Washington University’s program to build and furnish a new building shows that the new paradigm of forming collaborative partnerships with all of the stakeholders in engineering and engineering technology has great merit. By utilizing this new approach to the reoccurring problem of funding engineering education Eastern Washington University was able to build a new state-of-the-art facility for its programs. This new model simulates and requires that faculty members become intimately involved as an integral part of the development of synergistic partnerships. These were established among fellow Department members, members of other departments, local industry, professional societies, charitable foundations, and various
government agencies at all levels. This has resulted in substantial benefits for the engineering programs far beyond that from the initial funding campaign.

A standing committee (TINE) has also been established at the college level to continue the search for ways to fund new initiatives. The committee has as its member’s representatives from the faculty, the university foundation, university grants and research area, department chairs, and the Deans office. The group meets every two weeks and is focused on the needs of the unit. In this way the lessons learned and synergism will continue and not die off once this initial project is completed. Another very important byproduct of this process are the now active ongoing relationships and steering committees composed of industrial partners. Their charter is to mold and keep the engineering programs current and relative to the local industry. This merges local and regional industry into a partnership with the E&D Department and facilitates the process of preparing students for their future careers.

Eastern Washington University is committed to continue these efforts. It is suggested that other institutions examine this model and adopt it as an approach to open new funding avenues while improving their relationship with community and professional organizations. The advantages from these collaborations with industry, professional societies, charitable foundations, and government agencies have already yielded results that will positively affect students for years to come. This process will also allow for greater faculty involvement with industry resulting in curricular improvements that greatly benefit the students as they are preparing for real world engineering careers.

Bibliography