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Weaving Green Engineering into Campus Construction

A Professor's and a Student's Perspective

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Abstract

Students and faculty rarely have the opportunity to work together on the design of a major facility that both are going to use. Funds were appropriated to design and build an engineering annex at the University of Texas at El Paso (UTEP). A Green Engineering Building Design Contest (GEBDC) was proposed and approved by the faculty and administration. These groups enthusiastically endorsed the undertaking largely because it would serve as a great learning experience. As a product, the faculty, students and architect worked together through a series of meetings to develop and incorporate sustainable design options into the structure. The goal was to demonstrate UTEP's leadership in engineering design and sustainability concepts for the El Paso/Ciudad Juarez region. This paper describes and analyzes the GEBDC process and its impact on the sustainable engineering initiative and engineering education at UTEP as well the impact on building design. The authors, one a civil engineering professor and the other, a Ph. D. candidate in the Environmental Science and Engineering program provide two perspectives on the challenges and outcomes of this effort. This paper is of interest to faculty members involved in the integration of sustainable design concepts into the curriculum. The contest provided a cooperative learning experience for both students and faculty, and consequently, made significant contributions to the student's engineering education.

Background

UTEP initiated green engineering and science efforts in 1997. UTEP joined forces with Virginia Tech (VT) to submit a proposal to a large energy corporation for the development of a student and faculty exchange that would initiate a greening program in the Colleges of Engineering and Science at UTEP. UTEP would build on Virginia Tech's existing green program and Virginia Tech students and faculty would have an experience at a culturally diverse institution that has been shaped by environmental challenges and opportunities along the U.S.-Mexico border. The proposal was not funded but it sparked an interest in moving ahead with sustainable/green academic initiatives at UTEP. Funding for these initiatives was secured in the 1999 proposal to the National Science Foundation (NSF) for the second phase of UTEP's Model Institution of

Excellence (MIE) program. Participants in the MIE program serve as models for improving the quantity and quality of science, engineering and mathematics (SEM) graduates and doctoral degree recipients.[1] MIE is intended to be a catalyst for developing new approaches to higher education. The College of Engineering at the University of Texas at El Paso (UTEP) developed a program for the teaching and learning of sustainable engineering concepts in each and every engineering program. The departments impacted are Civil, Electrical, and Mechanical & Industrial Engineering, Materials & Metallurgy Engineering and Computer Science. The program was the result of self-assessment at UTEP and had the support of a National Science Foundation initiative for Model Institutions of Excellence. The program introduced sustainable engineering concepts into the teaching of required courses in each year of the curriculum. As a result, the College of Engineering developed a college-wide Sustainable/Green Engineering Initiative that involved all five departments in each year of their four-year degree programs.[2]

New Building

Back in 1989, the Dean of the College of Engineering, the current provost, submitted a request to the legislature for six million dollars in funding to construct a research facility for the College of Engineering. The current facilities were designed for teaching and made little provision for research. The dean was hopeful that the funds would be appropriated within two or three years. Finally, in 2001 the legislature appropriated the six million for construction of the new building. After twelve years six million will not build the same structure. Assuming a 6 percent annual rate of inflation in construction costs, the cost to build the structure doubled in twelve years and the college needed twelve million in 2001 to construct that same six million dollar building.

The short fall in funding left the dean open to new ideas on what the six million dollar building should be designed to accomplish. The current engineering building was designed during the 1973 OPEC oil embargo. The design concept was to place all office space in the core of the building to make heating and cooling efficient thereby conserving energy. Lighting costs, life cycle analysis and the impact on human productivity were not taken into account. Sixty plus faculty offices are windowless and located in the core. One of the key concepts of sustainable building systems is the use of locally available renewable resources. El Paso has the most sunshine of any major city in the nation. Today building lighting system designers follow the principle that "sustainable lighting design meets the qualitative needs of the visual environment with the least impact on the physical environment".[3] Faculty instinctually recognized the need for natural light in offices and requested that the new engineering lab building be designed for faculty offices with windows and the windowless office space be converted into research facilities. This instinctively sustainable approach is backed up in the literature.[4] Perhaps part of the faulty enthusiasm for a naturally lighted building can be attributed to work by individual members of the sustainable engineering committee during the previous year on the Sustainable Engineering Committee (SEC). The SEC committee was responsible for the Sustainable Engineering Initiative and has representatives from each of the departments in the College of Engineering. Since this is a college wide committee, the challenge of obtaining support from the other engineering departments was made much easier.

The UTEP Sustainable Engineering Initiative sponsored the GEBDC during the fall semester of 2001 and the spring semester of 2002 in order to promote the integration of sustainable design elements into the construction plan of the new Engineering Building Annex. The new engineering building must be seen as a sustainable engineering icon and thus, its design should incorporate state-of-the-art technology and at the same time, it must contemplate the sustainable use of resources to the maximum extent possible.

Goals

- Create an opportunity for students and faculty to contribute to the design of the new building that will serve as a learning experience for all.
- Create a model building that illustrates UTEP's leadership in engineering design and sustainability concepts for the El Paso-Ciudad Juarez region.
- Provide solutions to today's problems so that future generations will have at least the same opportunities to live and prosper that the present generation enjoys.

Contest Rules

All contests must have rules and prizes. The prizes generate student and faculty enthusiasm – especially since the contest was initiated mid semester when both students and faculty are thinking about midterms. The rules and prizes are listed below:

- The design should include sustainable engineering concepts
- The design must be representative of multiple College of Engineering disciplines.
- Groups should number 3 to 5 students with members representing at least two departments within the College of Engineering.
- Groups must include at least one lower division student (i.e., freshman/sophomore).
- Each group must have a faculty advisor.
- The first place winners each received a laptop computer.
- Second place winners each received a $1,000 stipend.
- Third place winners will each received a $750 stipend.
- Faculty advisors for the wining teams received equivalent awards.

A team of professionals from outside the College of Engineering conducted the judging.

Design Contest Criteria

The GEBDC provided a great learning opportunity for students by exposing them to the process of the building's design and the incorporation of sustainable design concepts as well as understanding the role of engineers in contributing to a sustainable future. Additionally, this design competition was of great importance because it promoted a closer interaction among faculty members and students outside the classroom.

Multi-disciplinary participation was one of the key aspects of the GEBDC. Students from all disciplines were invited to participate. Involvement of Civil, Electrical, Industrial and

Mechanical engineering as well as Materials & Metallurgy, and Computer Science students was highly encouraged. Groups participating in the competition should consist of three to five students with members representing at least two departments within the College of Engineering. In addition, each group was required to have a faculty advisor. As stated earlier, the objective of this competition was to motivate students to think how they, as engineering students, could integrate sustainable engineering concepts into the design of the Annex.

Meetings were held in order to coordinate groups and meet with the architects in charge of the building's design. Support material was also provided by the GEBDC organization committee. Resources such as journal articles and sustainable design texts were available for students to check out. A website (www.utep.edu/green/greencontest.htm) was built to be used as a communication tool (i.e. message board, updates). This site also contained a compilation of web resources that provided web links to useful and related websites.[5,6,7]

Ten minute progress report presentations were given by each of the nine teams at the end of the fall semester of 2001. The architect, faculty advisors and the Vice President for Facility Services were present during these presentations and feedback was provided to students at the end of each presentation. Other than the students from the presenting team, students were not allowed to attend the presentation session for each individual team. The teams requested this format so that their ideas could not be "stolen" by another team. Final presentations were held during the spring semester of 2002. Six teams made presentations at the final session. By this time five of the original nine teams and their faculty advisors remained. Each team had between three and five students. Judging was conducted by four professionals with more than 25 years of experience in engineering and architecture from outside the College of Engineering.

Faculty/Architect/Administration Involvement

Valuable was the participation of the faculty/administration/architects in the completion of this design contest. Faculty members from all College of Engineering disciplines were involved as part of the organization committee and/or as faculty advisors. Architects in charge of the design and construction of the New Engineering Building Annex took also part throughout the progress of the contest by making information available and participating in meetings with the student teams to discuss design and construction planning. Facility Services was also supportive and supported limited access to architect.

Outcomes

Ideas generated from the contest were innovative, and directed toward the integration of sustainable engineering concepts into the building's design. Students brought about attractive ideas including the implementation of a rain water capture system for irrigation, motion sensor climate/lighting control offices, day lighting throughout building, waterless urinals, and incorporation of Foucault pendulum, among others.

Concepts suggested by students in their design proposal were to be incorporated into the building's design. Architects agreed to consider ideas exposed by students in order to integrate

the more tangible ones, but without compromising the basis of the design and the budget. Unfortunately, none of the proposed ideas were incorporated in the New Engineering Building Annex due to budget constrains.

Nonetheless, "What Students Learned" is considered an achievement itself. Students involved in the GEBDC faced a one-of-a-kind learning experience. They were exposed to a 'real life' scenario. At the same time, students were able to put to test their knowledge and abilities to deal with a tangible project. They were exposed to all the aspects involved in the design and construction of a facility of this kind. Such experience made them to understand how interdependent the engineering profession is. Consequently, students when 'thinking as engineers' must contemplate that interdependency sometimes limits and restraints a design project. Many aspects are involved while designing in this case, designing a sustainable engineering building, and consequently, things may be out of engineers' hands since funds availability and administration play important roles in the design process. Independently of the fact students were or were not among the winners, understanding that integration and interaction within engineering disciplines are key aspects in the real world is the most valuable reward for each student.

Currently, the Engineering Building Annex is under construction. The administration added one million dollars to the legislative appropriation of $6 million to bring the total to$7 million for the building's construction. Still, the funding is not sufficient and the first and second floor interiors of the structure will remain unfinished until additional funding obtained. Construction started in late spring 2003 and is scheduled for completion by the end of the fall semester of 2004.

Graduate Student's End Perspective and how to do it right.

The GEBDC was a useful tool for both students and faculty that led to the understanding and integration of sustainable engineering concepts in the design process. A design competition of this kind is a valuable learning experience for students since they are exposed to the real life world. Even though the prizes were very attractive and this fact caught the attention of some students, all participants were very enthusiastic about the design aspect of the contest with greater emphasis on the integration of green engineering elements into their lives and professional careers as future engineers.

During the contest students came to understand that team organization and time were important management issues. Organization was strategic if a team was to be successful. For instance, at scheduled meetings and progress report presentations there were significant differences in the quality of team performance based on the use of the printed resources that were available. Involvement of faculty from disciplines other than engineering would have provided a broader view and coverage about other fundamental aspects involved in the design process; that is to say finance and administration. Time constraints played an important role in the evolution of this competition. Time was very limited since construction of the new facility was scheduled to begin the fall semester of 2002. Consequently, an earlier start would have enabled teams to develop more detailed plans and allowed students additional time to add implementable concepts to their visions and develop cost-benefit and life-cycle analyses to present to the administration.

The GEBDC was a learning experience for both students and faculty members and it is an effective learning approach on the way to the integration of sustainable concepts into the design process and more specifically, in academia.

Professor's End Perspective and how to do it right.

Time and money are always end points. The professor had a vision of the Engineering Annex as a regional showplace for the implementation of sustainable engineering design. Support from students and faculty was superb. Administrative support was adequate. The point of failure is the lack of financial resources to construct anything more than a basic structure without the infusion of additional millions in funding. Critical for this project was the time frame. The search for funding to implement this type of non-traditional facility should begin at least two years prior to design. The University of Texas System administrative regulations do not make provision for innovative structures unless the funding for innovative features and concepts is independent of legislative appropriations, i.e., outside funding from alumni or corporate sponsors.

The design experience and contest generated tremendous enthusiasm and provided a design experience rooted in the real world constraints for the students. The architect was supportive and excited about the possibilities. The end product is just another structure that uses conventional materials and design. For the professor the building is a disappointment. For him, the students are the inspiration and the promise for future successes.

Biographical Information

Charles D. Turner has been at UTEP for fourteen years. His areas of research are water resources of the Rio Grande and water treatment and desalination. He is an advocate of sustainability in all aspects of engineering and has worked to implement these concepts at UTEP and in his research.

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