The WERC Design Contest: Tufts University's Experience

Christopher W. Swan, Linfield C. Brown, and Sean T. DiBartolo
Tufts University

Abstract

Tufts University has participated in the annual environmental design contest of the Waste-management Education and Research Consortium (WERC) for 5 of the last 6 years. Beyond its competitive aspects, the design contest serves as a valuable educational tool in the undergraduate curriculum. For example, students are exposed to "real world" aspects of environmental design, learn the importance of working in multi-disciplinary teams, and have their work evaluated by practitioners rather than faculty. In addition, they are encouraged to confront the interplay between various technical and non-technical factors that must be considered to achieve a feasible and successful design.

The WERC contest has been incorporated into the senior capstone design experience for students in the Tufts ABET-accredited BSCE and BSEvE programs. The contest has also provided a venue for non-engineering students from the liberal arts college to participate in and contribute to an upper level engineering course (for academic credit). We have found this to be an enriching experience for both the engineering and non-engineering students participating in the contest.

In this paper we reflect upon the involvement of Tufts University in the WERC design contest from 1995 through 2000. First, we present a review of the Tufts' student teams and their participation. We then focus on the influence the contest had (and continues to have) on participating students, faculty advisors, and the university. Information in this paper was gathered from reflections by the authors and former student team members. These reflections indicate that the contest had, and in some cases still has, a profound effect on the educational experience of Tufts student participants. Although changes in the contest and how it is managed at Tufts are noted; overall, both students and faculty feel that the contest provides a beneficial educational experience for the students, an experience that is not generally available through traditional course work or laboratory projects.

Introduction

What is WERC? The Waste-management Education and Research Consortium (WERC) is a consortium of academic institutions, industry, and government agencies partnering in educational, research and outreach initiatives in the environmental field. Academic institutions involved with the consortium are New Mexico Institute of Mining and Technology (NMIMT), University of New Mexico (UNM), New Mexico State University (NMSU) and Diné College. The consortium offices reside at NMSU. Major industrial partners have included Westinghouse, Fluor Daniels, Atlantic Richfield (ARCO), Rust Geotech, Inc., and Phillips Petroleum. Major government contributors include the U.S. Environmental Protection Agency, Department of Energy, and Department of Agriculture as well as the Los Alamos and Sandia National Laboratories.

Since its inception, WERC has offered a number of events, lectures, and affiliated courses for the communities in New Mexico. To enhance its outreach efforts, WERC has sponsored an environmental design contest open to all colleges and universities in the United States and abroad. The contest allows student groups to develop innovative concepts, methodologies and techniques for the remediation of complex/unique environmental problems. Typically, students choose to address one or more tasks from a field of up to 12. Deliverables in the contest include a written report, an oral presentation, a poster presentation, and working bench-scale model demonstrating their final solution.

The contest promotes that the teams of students be assembled from a variety of disciplines (i.e. majors). These areas not only include appropriate technical expertise, assessment and design but an economic analysis of the proposed remediation scheme in addition to an accompanying business plan. Teams must consider legal and regulatory issues, health considerations (both to on-site workers and off-site abutters), and community relations. The project also requires the teams to obtain audits by professional and/or experts in each of these areas. All solutions and recommendations must be defensible.

The contest opens at the start of the academic year and culminates in a four-day “conference” at the NMSU campus in April. Tufts University has participated in the WERC design contest for 5 of the last 6 years. Beyond its competitive aspects, the design contest serves as a valuable educational tool in the undergraduate curriculum. For example, students are exposed to "real world" aspects of environmental design, and learn the importance of working in multi-disciplinary teams. In addition, they are encouraged to confront the interplay between various technical and non-technical factors that must be considered to achieve a feasible and successful design. They must defend their designs under the scrutiny of practitioners not affiliated with their university setting.

In this paper we summarize upon the involvement of Tufts University in the WERC design contest from 1995 through 2000. First, we present a review of the Tufts’ student teams and their participation. We then focus on the influence the contest had (and continues to have) on participating students, faculty advisors, and the university. Although changes in the contest and how it is managed at Tufts are noted; overall, both students and faculty feel that the contest provides a beneficial educational experience for the students, an experience that is not generally available through traditional course work or laboratory projects.

Previous Tufts Team in WERC Contest

Tufts’ first year of participation was in the fifth annual WERC contest during the 1994-95 academic year. Our six-student team consisted of five graduate students (La-Verne Parris, Mark Gambrel, Patricia Reed, Ian Ewusi-Wilson, and Dan Peña) and one undergraduate (senior Yvette Johnson); all from the Civil and Environmental Engineering department (CEE). The academic advisor of the team is the lead author who was in the first year of his tenure-track appointment in the department. After numerous false starts, the team chose to focus on the removal of cemented sludge in underground storage tanks. Tufts inexperience with the contest resulted in a poor performance by the team. However, the team was cited for their spirit and awarded a trophy and $1000 cash.

In the sixth WERC contest, Tufts fielded a completely new but more diverse team of ten students. Team members were students from CEE (juniors J. Paulo Silva and Geoff Schwartz; senior Nat Woodruff; and graduate students Bob Hauser, Ola Holmstrom, and Stu Saffer), chemistry (graduate student Bob Simpson) and biology (juniors John Adornato, Jon Arnason, and Marcus Rosencrantz). Again, the lead author served as the lone adviser. The chosen task consisted the remediation of vegetation containing radioactive isotopes cesium (Cs) and strontium (Sr). The team developed an innovative solution using crown ethers, an organic compound, to remove the Cs and Sr from the vegetation and recycle them for later use. While the process was not perfect, the team garnered third place in this task ($2000 cash prize) as well as an award for their innovative processes ($1000 cash prize).

Tufts entered the WERC design contest for a third time in the 1996-1997 academic year with another completely new team of seven students. Member from the CEE department included two graduate students (Derek Yimoyines and Tatiana Ivuskina), two juniors, (Erik Rushton and Rachel Schainker), and two sophomores (Mark Wong and Sean DiBartolo). One team member was a sophomore from biology (Robert Wu). The project chosen was similar to the previous year, the removal of radioactive isotopes Cs and Sr, however the contaminated medium was groundwater. The team used a similar process as the previous year but with less success. However, the team did win an award for team spirit that brought with it a $500 cash prize.

Tufts did not participate for the 1997-1998 academic year but fielded a nine-member team in 1998-1999. Three seniors were repeat members from the 1996-1997 team (the three sophomores). The six other members were from CEE (seniors Kelly Armitage, Craig Browne, and Katherine Friend; and juniors Chen-I Lin and Frances Switkes) and the final member from Economics (senior Doug Ostrov). The chosen task involved the biological (anaerobic) remediation of soil contaminated with high explosive compounds. This team was the first team to have its senior members receive course credit and benefit from a more formal course structure throughout the project duration. Another faculty advisor, the second author, also came on board to provide more guidance to the team. However, the competition for this task was substantial (21 competitors) and the team did not win any awards.

The 1999-2000 team consisted of five team members (two repeaters), all from the CEE department (seniors Isuara Vergucht, Leesa Jones, Chen-I Lin and Frances Switkes, and junior Christina Correa). The chosen task involved the remediation of acid mine drainage and the reuse of treated water for irrigation. Again, the seniors received course credit via the senior capstone course and two academic advisors were available to the team. However, once again the competition for this task was substantial and the team, while doing well, did not place at the award level.

Student Perspective and Reflection

In interviews with past team members, the general consensus is that most students who participated in a WERC design contest had very positive experiences regardless of whether the team won any cash award. Their comments can be summarized as follows.

Project workload: All students felt that the project was intense and exhausting. Many feel that the project pushed them both mentally and physically.

Teamwork: During and just after completion of the contest, many students commented that they felt their teams functioned well. However, the 1994-1995 team was a notable exception during preparation when the team was on the verge of collapse prior to the NMSU phase of the competition. However, the desire to represent Tufts in the best way possible led to better cooperation and teamwork at the competition. In addition, the adversity this team had during the bench scale model demonstration (their model failed to work) only brought them closer together.

Reason for being on the team: Many of students chose to work on the project because of a need for a different, and hopefully more fulfilling, challenge in their education. All of these students felt that the project provided this necessary element to their education. Years after participation on a WERC team, many still feel that even given what they know now, they would do it again.

Help from faculty advisor(s): All students felt that the faculty advisors could have provided more help. This help could have prevented some of the time consuming mistakes experienced by teams while working on the project. However, not everyone believed that a "controlling" involvement from the advisor is necessarily a good thing. In fact, too much advisor input may stymie the educational process that they wanted to experience or now find beneficial to have experienced.

Overall experience, then and now: Most students felt instant gratification in participating on a WERC design team. However, many feel that the educational benefits of the project go far beyond there acquisition of technical knowledge. For those who were team leaders, the people and time management skills they learned during the project's duration are still applicable today. In addition, some value how the competition forced them to look at problems from "outside the box".

Advice for future teams: Manage your time! Developing a realistic time schedule and adhering to it are key to project success. Team members should be from as many disciplines as possible. In addition, carefully evaluating which task to perform for the contest cannot be understated.

Faculty Advisor Perspective and Reflection

The primary objective in participation in the WERC design contest is educational, not competitive. The contest provides a suite of open-ended problems that do not have singular solutions. The problems, by their very nature, are complex, and require students to go far beyond what is learned in the classroom. Task(s) selection lies in the hands of the students. This requires a critical self-examination of their collective skill sets. In addition, the faculty advisors encourage the students to create a multi-disciplinary team to work on the project. While this diversity is important in developing a solution to the project's problem, it is also important that the students recognize that expertise beyond engineering is needed to solve complex problems in many real world problems.

Beyond these generalities, the Tufts faculty advisor(s) allow the students to control the project. The students develop their own team and chose the task in which they wish to compete. The students perform all research, develop and test the bench scale model, and develop their own oral

and poster presentations. In addition, the students must develop their own organization, task assignments, and leadership structure as well as seek out the expertise available in the Tufts community, professional consultants, and remediation contractors. Initially, the advisors main function was in obtaining financing for the project, including securing the funds necessary for travel to NMSU for the competition. In recent years, this function has also been given to the students; thus, the students control both the internal and external aspects of contest participation. In essence, the students are the drivers in Tufts participation in the WERC design contest with the advisors providing advice, not answers, when asked. By abdicating control, the advisors believe that the students will develop not only better technical skills in research and design of a engineered system but will begin to develop and see the importance of "soft" skills such as time, people, and project management.

This hands-off aspect of advising does have its disadvantages. Advisors are many times left "out of the loop", and often find that students have made critical and/or time-wasting mistakes that may have been avoided if advisors provided day-to-day participation. In addition, students could benefit from the experience that their advisors could apply to the problem. Most importantly, the students do not benefit from a more-regimented schedule that is usually present in a classroom or course setting. This aspect of project management has been partially addressed in that the last two WERC teams have used the CEE senior capstone course to obtain course credit for participation. However, the need to adhere to this schedule of deliverables still needs to be reinforced. We (advisors) believe that the long term benefits of "student initiated" and controlled projects far out weigh the potentially short-lived gains in placing higher (award level) in the competition.

Conclusions

The WERC design contest is an excellent opportunity to expose students to the difficulties in developing solutions to complex environmental problems. Though presented as a competition, the educational value of the contest is enormous. In fact, the educational benefits of the contest should be emphasized. These benefits to the students include problem selection decision; an appreciation of open-ended problems; development and participation in diverse, multi-disciplinary teams; and the value of time, people, and project management skills in a successful professional career. These skills are not often taught in traditional engineering courses or laboratories making participation in the WERC design contest a more valuable educational experience.

Biographical

Christopher W. Swan is an Associate Professor in the Civil and Environmental Engineering department at Tufts University. His teaching and research efforts are in the areas of environmental site remediation, brownfield restoration, and waste reuse. He has been involved with the WERC contest since his employment at Tufts in 1994. He continuously works on incorporating more real world problems in his courses.

Linfield C. Brown is a Professor in the Civil and Environmental Engineering department at Tufts University. His teaching and research activities include water and wastewater treatment operations, water quality modeling, and environmental statistics. In addition to his involvement with the WERC contest, he was a key developer of innovative educational programs in the environmental engineering field, including the development of one of the nations first graduate-level hazardous materials management programs.

Sean DiBartolo is currently a research assistant in the Civil and Environmental Engineering department at Tufts University. He first became involved with the WERC contest in 1996 as a student member and lead the Tufts WERC team of 1998-1999. He is currently pursuing a Masters of Science degree in the area of geotechnical and geoenvironmental engineering.