AC 2012-4358: COLLEGIATE SOLAR BOAT PROJECT PREPARES TODAY'S ENGINEERING STUDENTS FOR TOMORROW'S ENERGY CHALLENGES

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Collegiate Solar Boat Project Prepares Today's Engineering Students for Tomorrow's Energy Challenges

Abstract

The rising demand for green energy and environmental responsibility has had a strong influence in modern American engineering curricula. Competent, innovative engineers are needed now more than ever to help solve some of the most complicated problems in the alternative fuel industry. Solar power is one of the most promising and challenging green technologies, and the collective efforts of inventive engineers will be needed to bring it into the mainstream. However, the numbers of engineering graduates in the U.S. continues to dwindle, even with the projected market demands.

In order to overcome the impending energy crisis, the nation must invest in and support innovative approaches to engineering education which will in turn target many of the issues that deter individuals from pursuing critically important career paths. The solar boat project discussed in this paper is an introduction to how novel hands-on engineering opportunities for students can inspire them to pursue challenging careers within the energy industry. By fostering a nurturing, creative atmosphere not typically found among engineering curricula, more students can be attracted to engineering and engineering technology and graduate ready to face enormous challenges.

Introduction

Green energy and environmental consciousness have become central themes in American politics and culture in recent years. The worldwide energy crisis has encouraged a revolution in energy use and conservation. The paradigm shift from fossil fuels to "green" energy has also begun to have a major impact on college science and engineering curricula. While the nation battles to loosen the grip of fossil fuels on the economic infrastructure, institutes of higher education struggle to attract, retrain, and graduate innovative young minds for future careers in an increasingly demanding and complex energy industry.

The difficulty in preparing a sufficient number of quality scientists and engineers reflects a long-standing national trend. The number of students obtaining post-secondary engineering or engineering technology degree continues to stagnate while overall graduation rates are on the rise. Without a technologically savvy workforce to act as a new generation of energy innovators, the country will continue to experience a worsening crisis situation. The key to solving the problem may lie in the ability of higher-education institutes to inspire and excite a new generation of scientists and engineers who are willing and able to tackle the tremendous challenges laid out before them.

To begin to understand how to recruit and retain a higher number of engineering and engineering technology students for the energy industry, it is vital to understand what discourages students from entering the engineering discipline in the first place. Several issues may be blame for the low numbers of engineering graduates, while many more problems are unique to individual

students. However, there are several general problem areas that may be targeted by engineering educators, including the lack of defined student-support systems, creativity-stifling environments, and low-confidence levels, among others. This paper seeks to introduce one novel approach to engineering education which can help to target the aforementioned problem areas while encouraging students to enter the solar-energy or other alternative-energy sectors where their skills and expertise are in high demand.

Middle Tennessee State University's Solar Boat Project Targets Enrollment and Retention Issues

The introduction of hands-on, experiential learning projects aimed towards engineering and engineering technology students can provide them with a solid environment in which to build confidence as they hone their skills. Projects which focus on a major aspect such as solar energy can further encourage the students to explore a novel and critically important field of technology. The benefits of such solar-focused engineering projects are two-fold: students are encouraged to study engineering, and they become intimately involved with the specialized technology, making them more likely to enter the solar-energy field upon graduation.

Numerous solar-centric engineering projects have been a part of engineering curricula since the late 1970s, while "green vehicle" competitions have become increasingly popular in later decades[1]. Numerous national and international collegiate competitions focusing on solar power have become extremely well-known among professional societies, industrial partners, and government institutions including the Innovators Educational Foundation, the U.S. Department of Energy, and many others[1]. The large amount of interest generated by these projects is reflective of the enormous importance and potential of alternative energy. The National Academy of Engineering announced the efforts to make solar energy economical one of the "Grand Challenges of Engineering," citing specifically the need for engineers to improve efficiency by lower manufacturing costs and targeting numerous other aspects necessary to make solar power competitive.[2]

MTSU Solar Boat at the 2010 Solar Splash Competition

Middle Tennessee State University offers several nationally competitive experimental vehicle projects as extracurricular activities for undergraduate engineering technology students[3], including a solar boat project. The solar boat project was founded following the inception of the Institute of Electrical and Electronics Engineers Power Electronics Society's Solar Splash Competition, an international collegiate competition showcasing solar/electric boating[4]. The solar boat project focuses on the capture, utilization, and storage of solar energy to power a special-purpose boat. The boat design must follow a set of regulations to accomplish numerous pre-determined outcomes[5]. Nevertheless, the students are given a large amount of freedom in the design and operation of their solar boat. The project culminates at the annual five-day competition where the students showcase their efforts and compete against other student design teams in various categories[4].

MTSU Solar Boat at the 2007 Solar Splash Competition

The Solar Splash Competition may be classified as a "brain sport," an activity giving engineering students an opportunity to experience real-world design and engineering problems[1]. Students utilize their classroom knowledge of engineering principles while simultaneously developing valuable soft-skills such as teamwork and communication[3]. The overall effect of the project is an enjoyable, educational, and engrossing experience for the students, which encourages the exploration and pursuit of engineering and solar technology.

Current estimates report that less than five percent of college-bound high school seniors are interested in pursuing a degree in engineering[6]. Of the relatively few students who begin their college career in engineering, many will abandon the field of study. While it is difficult to pinpoint exactly what motivates a student to leave their engineering studies, it is important to note that engineering disciplines are often regarded as the most difficult category of majors at the collegiate level. Due to the engineering discipline's reputation for being extremely challenging, it is vital for engineering educators to take action towards improving enrollment and retention rates through the implementation of unique student projects and programs. Middle Tennessee State University's solar boat project is just one example of a teaching tool that has been utilized to target enrollment and retention issues with proven success since 2005[7].

The overarching theme of the solar boat project is to encourage students to excel in their studies and to get them excited about solar energy. It has been noted that past solar boat students became so interested in their projects that they actively pursued careers in the solar and other alternative energy fields. The project provides the fundamental knowledge and hands-on experience valued by employers, and serves to fill in any gaps in understanding from the students' classroom education.

The first major retention issue the solar boat project targets is the lack of a well-defined student support system. Numerous studies have shown that students who are involved in small groups retain more than students who work alone[8]. Isolation of a student from his or her peers can cause stress beyond that imposed by an already formidable field of study. At the beginning of each school year, the solar boat project falls under the responsibility of a group of students who opt to become members of the University's Solar Boat Team. Students from any background and major are invited to attend, though historically teams have primarily consisted of students from the Engineering Technology department. The Solar Boat Team is primarily student-led, with assistance provided by the Faculty Advisor and numerous University staff members. Team organization and operation relies on a modified and proven Peer-led, Team-learning (PL-TL) model[7], where students support and mentor each other throughout the course of the project.

The PL-TL model is designed to supplement classroom lectures by requiring students to engage in active group learning. The group environment can prove more conducive to learning than a classroom setting, as the students feel less pressure to provide correct answers or "textbook solutions" to the problem at hand. The benefits of group activities to engineering-student retention have been well-documented. A study conducted by Vincent Tinto reported that student involvement in group learning environments promoted student retention. Tinto writes that "For some students…the collaborative environment of the learning community provided a safe place, a smaller knowable place of belonging, in which they were valued and in which they discovered they could learn."[9]

The Solar Boat Team members collaborate on all decisions throughout the lifetime of their project. Together the students decide how they want to build their boat, conduct all the necessary research, construction, and testing in preparation for the annual competition. As per the PL-TL model, the more senior students lead the inexperienced students[5]. The students often develop strong relationships with their teammates, which in turn encourages them to continue the pursuit of the project and their degree. Such academic and social support networks are crucial components of student retention[10].

Solar Boat Team Members collaborate on all aspects of the project, from design conception to construction and testing.

The second problematic issue the solar boat project seeks to mitigate is the suppression of creativity and ingenuity. In mathematics and engineering, much value is placed on achieving single, correct answers with no additional credit awarded for innovative approaches to problem solving[3]. Students are often discouraged to recognize or explore alternative approaches to problems. The fear of being wrong or labeled as "unusual" can lead to excessive reliance on stilted or rote problem solving skills[3], which may likely discourage some students from remaining in or entering the engineering field. Conventional and uncreative behavior is directly counter to the qualities desired of future

innovators, especially those expected to tackle some of the most important engineering issues ever encountered in modern human history.

The solar boat project provides a creative outlet for engineering students. The peer-led environment provides a congenial and supportive network, while the project itself begs for clever and imaginative approaches. Solar technology provides a plethora of challenges in its capture and utilization, and when applied to its application in a vehicle it gives the students a foundation on which to focus their efforts. Students are often awarded for their creativity at the annual competition, where certain aspects of the solar boat, such as most outstanding hull design, are duly recognized and rewarded. Creativity must be supported and cultivated among students of engineering, as they are not as restrained by conceptual barriers that may cloud the mind of an experienced engineer[3]. The future success of solar energy will no doubt be the product of a collection of unconventional "outside-the-box" ideas generated by a new generation of inventive engineers.

MTSU Solar Boat in Solar Splash competition

The aim of all collegiate engineering programs is to produce sophisticated and talented engineers who are ready to enter the workforce upon graduation. Many students may leave the engineering discipline or choose not to pursue such a career because they lack confidence in their knowledge and abilities, namely in mathematics and science. The solar boat project seeks to encourage students to put their hands on an actual project and gain experience regardless of their opinion of their engineering skills. At the beginning of the project, there is no right or wrong solution, and students of all backgrounds and skill levels combine their ideas as they work towards a common goal. The learning objective of such a project is to test out a variety of theories and methods and to investigate the consequences of each decision. Mistakes are seen as learning opportunities for the future. Even if a student lacked confidence in his or her abilities as an engineer, such hands-on experiences are often the spark that fires the creative imagination that causes the student to become fascinated with solar energy and the future of alternative fuel, making him or her more likely to continue studying engineering and engineering technology.

The solar boat project takes engineering students beyond classroom learning. Though students may amass a large amount of knowledge in the classroom and feel confident in their abilities prior to graduation, they could feel overwhelmed once entering the workforce, deterring them from remaining in an engineering field. Difficult or seemingly esoteric concepts can be made clear through direct application or visualization via a hands-on undergraduate engineering project. Through the active development of the solar boat, students gain appreciation for the development of a design from the concept-phase through final production. The students learn

how to respect both ergonomic and equipment restraints—a fundamental consideration for all practicing engineers. However, they also work in an environment that encourages the freedom to develop alternatives to the given challenges. Solar energy is a field full of potential and unexplored avenues, and students on the Solar Boat Team are given a unique perspective on the issue and are motivated to design something new and different. These students are less likely to form to textbook solutions when exposed to similar challenges upon entering the workforce[3].

Conclusion

The world is facing an energy crisis that is steadily becoming a main theme among national and global politics. In an effort to maintain technological superiority and lead the way in solving one of the biggest challenges of the future, the nation must invest in and support innovative approaches to engineering education which targets the issues that keeps promising minds out of critically important career roles. The solar boat project discussed in this paper is an introduction to how novel hands-on engineering opportunities for students can inspire them to pursue challenging careers within the energy industry. By fostering a nurturing, creative atmosphere not typically found among engineering curricula, more students can be attracted to engineering and engineering technology and graduate ready to face enormous challenges.

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