

Overcoming Problems in Mechanical Engineering Technology Education through Innovative Projects

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Abstract

Two of the biggest problems facing mechanical engineering technology programs are retaining freshmen students and adequately preparing graduating seniors for the real world. The reasons for these problems are simple. Freshmen students often become frustrated early in their college careers because they have to take so many classes yet not really know how they fit into the big scheme of things. Unless they have a family member or friend that is an engineer, many of them may not actually know exactly what exactly an engineer does. On the other hand, the biggest dilemma facing recent graduates is that although they may be proficient subject wise, they often lack real world experience.

Acknowledging these problems is only the first step, but the difficult task is coming up with solutions. Faculty members at Middle Tennessee State University feel that creating enthusiasm in the first year of college and properly training students for careers in engineering are two important ingredients to making a successful mechanical engineering technology program. MTSU has accomplished both of these goals by implementing multidimensional projects such as the solarbike, moonbuggy, and SAE formula one with the final goal of competing in national competitions. It is through these projects that students are able to see the big picture.

Freshmen students are paired with a senior mentor and together, these teams are required to complete all aspects of the project from the initial research and the design process to budgeting and manufacturing nearly everything from within the laboratory. In the end, the students are able to see the outcome of their projects by competing against top-notch universities in a national competition. Freshmen students complete the project as part of their fulfillments for the Introduction to Engineering Fundamentals course while seniors complete it for the design and capstone requirement. Nevertheless, these projects carry out a bigger purpose than meeting program requirements; they create enthusiasm in freshmen thus improving retention and simultaneously giving seniors real world experience that will give them an edge in their professions.

Introduction

Many universities are finding themselves in a familiar crisis. They are uncertain how to retain new recruits through maintaining their excitement and enthusiasm, yet still make the college experience one that teaches them what they need to know by the time they take their senior exit exams and enter the real world. Until recently, the faculty members at Middle Tennessee State University (MTSU) were still baffled by this mystery. In fact, a major piece to the puzzle was practically stumbled upon by one mechanical engineering professor.

The project

A professor at MTSU happened upon a brochure that described a national competition known as The Great Moonbuggy Race. He thought that designing and constructing a moonbuggy that is capable of traversing various terrains ranging from sand to rock would be an exciting opportunity for the students. A tape of a previous year's competition was available, which he showed his Introduction to Engineering Fundamentals class. The students, excited about simulating what the original NASA moonbuggy team accomplished in the 1960's (and eager to do something outside of the everyday class lecture), agreed with their professor that this would be a great opportunity.



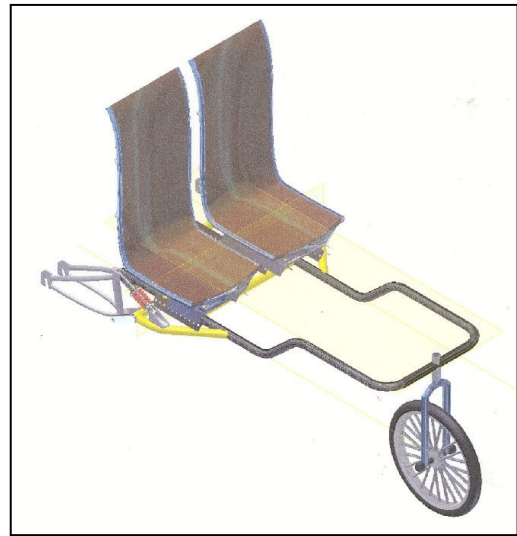
Project responsibilities

The creation of a moonbuggy is a multi-dimensional task that allows the students to complete the cost analysis, design the product, fabricate almost everything from within the laboratory, and communicate with industry for advice. In MTSU's case, if a specific part cannot be created within the laboratory, the student may contact a particular industry to do it at their facility¹. Although the students are responsible for more than ninety

percent of the project, faculty and industry provide minimal assistance. For example, the faculty advisor raises essential funds and ensures proper shop procedures. MTSU's resident machinist Rick Taylor assists in the machining of the sprockets. As stated, if a particular part cannot be fabricated within the laboratory, industry may be contracted to do so. Other than this assistance, the students are responsible for completing the project entirely on their own.

The process

After the students develop and draw the initial design, a budget is created based on the materials that will be needed. The budget is approved by the faculty advisor and is based on the availability of funds that are raised. The teams are then divided to work on various aspects of the project based on their interests and skills. Most of the parts are manufactured in the machine shop metals lab. As mentioned previously, the students are responsible for knowing their own limitations and must determine when it is necessary to contact appropriate industrial facilities for assistance. The students keep detailed journals of any problems they run into so as to prevent future teams from colliding with the same obstacles. In the end, the final product is put to the test in a national competition involving the top universities across the United States. However, crossing the finish line is not the only goal of the students. They must also participate in the written and oral sections of the final competition, which requires the teams to defend their choices both on paper and on stage.



One project: two solutions

Of course the first time an engineering department at any university embarks upon such a competition, there will naturally be issues to smooth out. For MTSU, the problem initially was not how many students were available for the task, rather it was how to organize them into productive teams. There were so many interested freshmen who possessed the enthusiasm and work ethic for such a project, yet lacked pertinent knowledge and experience. On the other hand, there were many seniors who were interested in working on the project as a senior capstone design project, but due to the complexity of the project were in need of assistance. After careful observation and direction by the faculty member, a unique collaboration emerged. "Mini teams" were formed that consisted of freshmen being paired with senior student mentors. The benefits



of this system for each group of students will be discussed in the next two sections of this paper.

Benefits for freshmen students

The objective of educators is to create interest for freshmen students about engineering programs, and in doing so, help retention issues². Students today are growing up in an increasingly “high-tech” world. As a result, today’s freshmen are different than incoming freshmen of the past and require a different approach. The interest of new engineering students must be stimulated or they will be lost to other departments. Engineering educators should not only emphasize knowledge, but also the practical application of knowledge in ways that are fascinating to the learner. Freshmen students seek hands-on applications or problem solving challenges in an environment that fosters learning³.



The moonbuggy is a suitable project for freshmen students because it offers them experimentation in the areas of statics, dynamics, electricity, strength of materials, energy, computer aided drafting, and project development. This of course encompasses the knowledge component of a fitting project for freshman. In addition to this however, the moonbuggy provides an opportunity of educational growth that encourages peer interaction and teamwork, positive and comprehensive educational experiences, and interest in engineering and engineering technology⁴. The written and oral presentations required on race day allow the freshmen students to exercise their communication skills that they will inevitably need in their upper division courses¹. Most importantly, this type of project can be a persuasive tool to convince freshmen to continue in the engineering technology field⁵.

In fact, one-hundred percent of the freshman students who have participated in this project (as well as other projects) have stayed in the program. Moreover, before integrating these projects, the department would lose between thirty and thirty-five percent of its incoming freshman. That number has been decreased to around ten percent. Furthermore, enrollment has actually increased by twenty percent. The Chair of the department assesses that much of this increased enrollment is due to the exposure the department has received from doing so well in competitions involving projects such as the moonbuggy.

One previous problem with losing freshman was also because some students would transfer after the first year to more well known engineering technology departments. Now that MTSU is competing (and winning) against top-notch universities, freshman are realizing that the quality of education they can receive at MTSU is comparable with other universities. One graduate student in the ETIS department is on a student advisory committee that meets at the Dean’s house along with other students in the college to

make suggestions to improve individual departments and the college as a whole. At the last meeting, this student said that all of the students from the other departments were very excited about the recent successes of the ETIS department. Some of these students even expressed interest in wanting to help with the current projects. This is why many undecided students are choosing their majors as ETIS. At the last ETIS open house, fourteen undecided students signed up with the department and all of them had heard previously about the exciting opportunities that were in store for them.

Benefits for seniors

In one way, the benefits for freshmen students produce a chain of effects that directly impact senior students. Although freshman students learn a vast amount of information on their own, they are still somewhat lost in the experience due to the advanced nature of the project. Even with the careful guidance of faculty advisors, the ratio of these new students to advisors is often disproportionate. This is why MTSU faculty decided that it would be favorable to pair senior students already working on the project for their senior capstone design projects with freshmen students. Thus, the benefits for the senior students multiplied.



First, the moonbuggy project serves as an alternative to the more typical senior capstone design projects, giving them an opportunity to recall the knowledge they have learned in a four year mechanical engineering program and apply it to a real world project. Secondly, this unique project provides them the opportunity to take on a supervisory role while mentoring the freshmen students. Furthermore, as freshmen are able to call upon their senior mentors for advice, the seniors are able to call upon industrial leaders for guidance. As mentioned before, if the students are unable to fabricate a particular part, they have the option of contracting an appropriate industrial facility to do so.

From this arrangement developed a unique relationship between the industrial leaders and the students. The senior students would contact these leaders for advice when they came across a problem they did not know how to handle. It has been MTSU's experience that industries tend to be very receptive to this type of collaboration with students for several reasons. First they make good contacts with potential employees that they get to know through the process of the project. Second, they enjoy the national exposure and credit they receive in the competitions ⁵.

Of course the ultimate benefit for these soon to be graduating seniors participating in such a project is that they are able to work through some of the quirks they will face in a "pseudo" real world before actually having to enter it. The project



selected should have certain elements to it that make it appropriate for engineering students such an advanced level of their education. Project structure, management, electrical and mechanical engineering principles, teamwork, communication, and budgets contribute to a total project package⁶. The written and oral competition are a nice way to wrap up this total package and are especially important for seniors who will inevitably have to present their ideas as professional engineers throughout their careers.

Other projects

The author of the paper would like to make clear that although this paper focuses on the success of the moonbuggy project in retaining freshmen students and adequately preparing graduating seniors for the real world, Middle Tennessee State University has found that similar projects work equally as well. For example, MTSU has expanded its projects to include a variety of different competitions including the Solar BikeRayce, SAE Formula One Collegiate Competition, and Mini Baja Competition. All of these projects are suitable for students in mechanical engineering programs. Students can select which project (or projects) they would like to work on based on their own interests. This also promotes a kind of healthy internal competition since the ultimate goal of all the teams is to enter their final project into a national competition. Based on MTSU's experience, universities experimenting with such projects for the first time should select just one at first and then add more when they feel more prepared to do so.

Conclusion

Two of the biggest challenges faced by today's mechanical engineering programs are retaining freshman by keeping them enthusiastic about their studies while simultaneously providing them with the wealth of information they will need upon graduation. Middle Tennessee State University happened upon an innovative solution to both of these problems when one professor decided to boost excitement in the mechanical engineering technology program through an exciting project. Initially, he thought that entering a moonbuggy in a national competition would provide MTSU with the exposure necessary to recruit new students, which it did. The unanticipated results however, included a way to retain current freshmen students while at the same time providing seniors an exciting alternative to the traditional capstone projects.

The unique partnership that emerged between the inexperienced students and the seniors provides numerous benefits to both groups.

Freshmen students can see the beauty of what mechanical engineers can do when their final product crosses the finish line on race day. Seniors take with them an experience that will hopefully make the real world seem less shocking. It gives them the opportunity to dabble in the real world, which is full of business meetings, complications, and deadlines. All students certainly come away from the experience with an increased amount of



wisdom. Upon returning from a race, one student said, “The most important lesson learned is that putting an idea on paper and communicating it to others is not as easy as it seems. Sometimes even the best ideas are virtually impossible to accomplish due to manufacturing capabilities and budgeting. Those of us who are continuing in the engineering field will find that this experience has greatly increased the respect we have for those technicians and machinists who execute our ideas. We now view our designs not only in terms of a final product, but also in terms of how that design will be executed and built.” These projects are more than a matter of meeting a program requirement; rather they create enthusiasm in freshmen thus improving retention and concurrently give seniors the real world experience that will ultimately give them an edge in their professions.

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Biography

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