

Implementing a National Competition Design Project as a Capstone Course at Middle Tennessee State University

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Abstract – The Engineering Technology and Industrial Studies department at Middle Tennessee State University offers the chance to participate in a national design competition as a choice for the senior level capstone course. The latest addition to the choice of projects was the Society of Automotive Engineers Mini Baja Series. For this project, seniors were given course credit for leading teams of freshmen and sophomores in the design and construction of a Mini Baja off-road vehicle. The seniors learn leadership and project management skills, and exercise their engineering creativity. The freshmen and sophomores gain lots of hands-on experience and can see the engineering principles they are being taught in the classroom put into practice. When they become seniors they will assume the leadership roles and lead teams of their own to build even better vehicles.

Keywords: Capstone, Mini Baja, Teams, Leadership, Creativity

INTRODUCTION

The questions are well known: how do you test the skills and knowledge of graduating seniors, how do you prepare seniors for the “real-world” work environment, and how do you stimulate the interest of freshman and sophomores to learn the fundamentals of engineering, the value of such knowledge, and stay in the Engineering Technology and Industrial Studies (ETIS) department? The answer to all these questions for the ETIS department was to offer seniors who needed to fulfill their capstone course requirement the opportunity to lead a team of freshman, sophomores, and juniors in a national design competition. Usually, a senior fulfilling the capstone requirement would work alone, under the direction of his/her advisor, on a project that suitably demonstrates competency in the senior’s area of concentration in the major. This method, while acceptable, is somewhat limited in the benefits it provides. The other option, the national design competition, affords many more benefits. The students work together as a team; the seniors get extensive experience in leadership roles, project management, personal communication skills, and the application of “real-world” engineering principles, while the freshman, sophomores, and juniors gain a better understanding and appreciation for the engineering fundamentals being introduced within the classroom, and as a team share in the exciting dynamics of a national competition. When they become seniors themselves, they will seek to raise the bar to a new level with their own team of freshman, sophomores, and juniors. Competition is a powerful force, igniting a spark in young engineers that will drive a quest for knowledge and excellence.

Society of Automotive Engineers Mini Baja Series

For the Society of Automotive Engineers Mini Baja Series, engineering students are “tasked to design and build an off-road vehicle that will survive the severe punishment of rough terrain and in the East competition—deep water [SAE, 5].” This involves the “planning and manufacturing tasks found when introducing a new product to the

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consumer industrial market. Teams compete against one another to have their design accepted for manufacture by a fictitious firm. Students must function as a team to not only design, build, test, promote, and race a vehicle within the limits of the rules, but also to generate financial support for their project and manage their educational priorities [SAE, 4].” Outside of the strict rules about certain structural and safety issues, the design of the vehicle is open to the creative imagination and knowledge of the student team. There are three national SAE Mini Baja races, East, West, and Midwest, and several international races. In 2005 the MTSU Mini Baja Team competed only in the Midwest, where they received 2nd Place Rookie, and placed in the top 50% out of 147 teams.



Figure 1 Team at Midwest Competition

The Challenge

For the 2006 competition series, MTSU is building two new vehicles, and will race in all three national events. Teams that compete in all three events are qualified to be ranked nationally and eligible to win Mini Baja of the Year. At each race every vehicle is taken through a series of static and dynamic events. The static events consist of Design Judging and Safety Inspection. If a vehicle doesn't pass, it is up to the student team, no help from any faculty or staff, to make the necessary changes on site and repeat the inspection. After passing inspection each vehicle competes in several dynamic events: the Incline Test, Acceleration, Log Pull, Water Maneuverability, Land Maneuverability, Suspension and Traction, and a 4 hour Endurance Race. Each team accumulates points for each event, and the team with the most points wins. Individual awards are also given for each event and special category. So, what does it take to build a Mini Baja, or two of them for that matter?



Figure 2 Mini Baja Team Current Construction

Project Requirements

The students are responsible for all aspects of the project: design, cost analysis, budgeting, purchases, fabrication, repairs, and safety. All of which would fall under the category of project management. A survey of local industry conducted by the Russell Chair of Manufacturing Excellence at MTSU found that project management and soft skills were the most sought after qualities in a potential employee [Perry, 4]. In other words, knowledge and ability will potentially get the interview, but leadership, management skills, and people skills will get the job.

Leadership

A senior team leader must be able to organize his/her team to make the most of valuable resources including: talent, time, knowledge, ability, and training. The team leader must assess his team members and assign responsibilities and duties effectively and efficiently. An effective leader can manage conflicting personalities and differences of opinion without losing team members; an ineffective leader will be doing a lot of work by himself/herself.

Knowledge

The amount of research, design, and fabrication would make this an impossible task without dedicated team members. The scope of the project encompasses: drafting, CAD, 3-D modeling, strength of materials, statics, dynamics, thermodynamics, energy, mechanical and electromechanical engineering. The team members draw on their knowledge of these subjects which they acquired in the classroom, and apply it in a hands-on approach. Any area with which the student is unfamiliar will require the student to carry the learning process outside of the classroom and seek out answers to questions he/she does not know the answer. “How do I do that?” “How does that work?” “What if I do this?” And the very popular: “Why didn’t that work the way I thought it would?” The whole process of designing and building anything from scratch is a valuable learning tool to exercise the mind of a budding engineer to consider all the variables he/she can imagine, and experience all the ones he/she didn’t imagine; “I didn’t think of that!”

Teamwork

This is why a good team is so important. Every member brings a different set of eyes, ideals, opinions, and experiences to the team, which a good team will utilize to its advantage. A new student has not yet been told, "You can't do that, it's not possible." He/She might just be creative enough to make it possible. Isn't it engineers who like say, "We can build anything!"

During the process of working together building a Mini Baja, the team leader shares his experience and knowledge by mentoring the freshmen and sophomores. He/She not only assists them with their questions about the project, but also their current classroom studies. This benefits all members of the team. It reinforces the knowledge in the senior, and improves his/her communication skills. The freshman and sophomore benefits with better grades, raised confidence, and improved engineering skills. This arrangement additionally builds team unity; a discouraged freshman or sophomore has another place he/she can turn for help, and the senior earns more respect from the other members. No one will follow a leader they don't respect for very long.

A Beneficial Cycle

There is an inherent, and planned for, beneficial cycle to implementing the system described above. With seniors mentoring and leading groups of freshman, sophomores and juniors, there is a continuing supply of new leaders as the seniors graduate and move on, and new freshman enter the department. To ensure this cycle, the ETIS department is proactively working on ways to improve retention and recruitment.

Retention

The problem experienced with many first and second year students is that "many become bored in their introductory courses, not seeing the need to study and gain the knowledge of the fundamentals [Foroudastan, 3]." Today's students "seek hands-on applications or problem solving challenges in an environment that fosters learning and provides them extra incentive, [and] added involvement [Foroudastan, 2]." The Mini Baja project provides this opportunity to these students. They get the hands-on learning experience and application of the fundamentals combined with the excitement of competition that will keep their interest. Getting capstone course credit for working on such an exciting project is a big enticement to the students at all levels.

Recruitment

The Mini Baja project is an excellent recruitment tool to bring in graduating high school students. American Chopper on the Learning Channel is a hugely popular television show where custom motorcycles are built from scratch. There are many other shows in a very similar format that have sprung up following the success of American Chopper. The Mini Baja project is a perfect fit to recruit new high school students who would like to learn to do the things they see on American Chopper and other similar shows. Buying advertising that highlights the Mini Baja and other engineering projects at MTSU during those shows could bring a large number of new students to consider MTSU as their university of choice, if the department or university could ever be convinced to pay the high advertising cost. "The special projects at MTSU peak the interest of students who ordinarily would not want to attend college. Additionally, they offer something for everyone who has entertained the thought of engineering as a profession [Foroudastan, 1]."

Conclusion

The daunting task of building an off road vehicle that adheres to the strict rules set forth by SAE, that can survive the brutal punishment of the race, and keep its driver safe to the finish line is a challenge the Engineering Technology & Industrial Studies students at Middle Tennessee State University have met and will continue to push to new levels of excellence. Seniors receiving capstone course credit for leading freshman, sophomores, and juniors is a very successful arrangement that benefit the students, the department, and the University. It provides educational opportunities for all the students in many different ways and areas. It also benefits the department by increasing retention and recruitment. The SAE Mini Baja Series has been, and will continue to be, a successful addition to the other national design competitions participated in by the Engineering Technology & Industrial Studies students at Middle Tennessee State University.



Figure 3 Mini Baja in Action

REFERENCES

- [1] Foroudastan, Saeed D., Saxby, Dyani, "Engineering Technology Students: Getting Them Here to Stay", CIEC Conference, Savanna, Georgia, 2005, pg. 2.
- [2] Foroudastan, Saeed D., Hardymon, Linda, "How to Stimulate Interest in Freshman Students Through Project Innovation", Proceedings of the ASEE Annual Conference and Exposition, 2005, pg. 1.
- [3] Foroudastan, Saeed D., Hardymon, Linda, "The Positive Impacts of Design Projects in Freshman Courses", Proceedings of the ASEE Annual Conference and Exposition, 2003, pg. 2.
- [4] SAE Mini Baja East. <<http://students.sae.org/competitions/minibaja/east/>> 2006.
- [5] Perry, Charles. Inaugural Manufacturing Excellence Conference. March 16, 2006 - Murfreesboro, TN.

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