



Using Baja SAE for International Student Outreach

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122nd ASEE Annual
Conference & Exposition

June 14 - 17, 2015
Seattle, WA

Making Value for Society

Paper ID #14154

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Abstract:

Baja SAE Collegiate Design Series is a competition that simulates real-world engineering design projects. Engineering students are tasked to design and build a single seat, off-road vehicle that will survive a challenging environment. The student teams must design, plan, manufacture, and race a vehicle within the limits of the rules. SAEINDIA recognized the value of this hands-on learning experience and initiated a similar program in 2006. In an effort to accelerate the level of competition and safety, a decision was made to benchmark their program against the program of a historically successful team. This provided an outstanding outreach opportunity for an American team from this international competition.

Nine Baja SAE team members and two faculty sponsors from Tennessee Tech University traveled to India to conduct workshops by sharing their expertise in Baja competition and safety. Both faculty and students concluded that the opportunities of this experience far outweighed the challenges and risks. There is often reluctance to undertake foreign travel with students due to the inherent challenges. These may include jet lag, health issues, scheduling, being in a minority, and differences in food, language, and cultural expectations. Although students on this journey experienced all of these challenges, the challenges paled when compared with the amazing opportunities.

In their first encounter, all of the students discovered that their shared passion for Baja created an immediate bond. These Baja-related conversations were heart-felt and intense. Students quickly realized how much they had in common. In the more formal workshop setting, the outreach team became more confident as they realized their robust knowledge of this subject area, and that they could make a significant contribution to their Indian counterparts.

In the available time between the three workshops conducted, travel and cultural immersion provided many educational opportunities. Students also had the opportunity to visit the Automotive Research Association of India (ARAI) and several manufacturing facilities. This provided the opportunity for the students to observe both similarities and differences in manufacturing and research between the two countries. Although this specific program may not be replicated in detail, this type of learning experience should be embraced by all engineering programs when opportunities present themselves.

Introduction

Lately, there has been a lot of discussion in academic circles regarding the value of shared learning, and experiential (hands-on) learning. The mechanical engineering department at Tennessee Tech University (TTU) has adopted this model in many areas including student-led design competitions sponsored by SAE, ASME, ASHRE, etc. Exposing students to case studies and engineering design projects at an early stage in their engineering education is an excellent means of bringing about the needed transformations. Such approaches provide an opportunity for students to experience the creative nature of the engineering design process while simultaneously developing professional skills, such as project management, teamwork, time management, and communication, along with a recognition of the need for, and ability to engage in, life-long learning. In addition, to function in today's global economy, students should have a broad education necessary to understand different cultures and societies, travel abroad, and learn to collaborate with their international counterparts. Study abroad programs, international internships, and participation in international conferences and design competitions are some of the ways for students to acquire these skill sets. One area in which TTU has been especially successful is in the recent partnerships formed between TTU's SAE Baja team and SAEINDIA through the Automotive Research Association of India (ARAI). Through these partnerships, TTU has managed to provide a memorable international experience of team learning to nine TTU students, and nearly one thousand students in India.

This paper presents a brief summary of student-led education outreach by a group of nine students and two faculty members from TTU, as shown in Figure 1 who traveled to India for a period of sixteen days to conduct workshops and demonstrations on how to design, build, and race a winning Baja SAE vehicle. The TTU team has long been affiliated with the Baja SAE competition. Since 1977, TTU has hosted the event five times and the team has placed in the top 10 in over 80% of the competitions entered. In fact, it has won championships at twelve competitions to date, a feat no other team in the world has achieved.

Baja Competition

The Baja SAE Competition originated at the University of South Carolina in 1976, under the supervision of Dr. J. F. Stevens. Since that time, the competition has grown to become a premier engineering design series for university teams. It is currently an intercollegiate design competition run by the SAE [1] for undergraduate and graduate engineering students. Teams of students from universities all over the world design and build single seat, off-road vehicles. The vehicles all have engines of the same specifications. As of 2009, the engine has been an unmodified Briggs and Stratton Intek 20 single-cylinder with a displacement of 305cc and power output of approximately 10 bhp (7.5 kW).



Figure 1. TTU team departing for India

The objective of the competition is to simulate real-world engineering design projects and their related challenges. Each team competes to have its design accepted for manufacture by a fictitious firm. The students must function as a team to design, build, test, promote and race a vehicle within the limits of the rules. They also need to generate financial support for their project and manage their educational priorities. Each team's goal is to design and build a prototype of a rugged, single seat, off-road recreational vehicle intended for sale to the non-professional weekend off-road enthusiast. The vehicle must be safe, easily transported, easily maintained and fun to drive. It should be able to negotiate rough terrain without damage.

Each year as many as 100 Baja vehicles are entered into each of the three Baja SAE events across the US and many more around the world where events are held including India, Brazil, South Africa and Korea. In India, this event is run by SAEINDIA. All vehicles must adhere to the SAE rules and pass the SAE technical inspection and judging; a car may not compete in any dynamic events until all safety inspections are passed.

There are typically four dynamic events, such as acceleration, pull, hill climb, rock crawl, land maneuverability, and suspension/traction, as well as a four-hour endurance race. Static events, such as design and cost reports, sales presentations and design judging are an integral part of the competition for the teams. During the static events the teams are judged on ergonomics, functionality, and producibility of their vehicle, ensuring that the final placement of the team does not rest solely on the vehicle's performance but rather on a combination of static and dynamic events. Required reports detail the engineering and design process that was used in developing each system of the team's vehicle, supported with sound engineering principles. Also, a cost report that provides all the background information necessary to verify the vehicle's

actual cost is used to rate the most economically feasible vehicle for production. SAEINDIA in cooperation with ARAI recognized the value of this hands-on experience and initiated a similar program in 2006. Mahindra & Mahindra Ltd., the leading Automobile Manufacturing Company of India, has been the co-sponsor for the event since its inception and the title and principle sponsor for the last four consecutive years.

In an effort to speed up the progress in their level of competition and safety, SAEINDIA approached TTU for assistance in engaging students through outreach. A memorandum of understanding (MoU) was signed between TTU, Automotive Research Association of India (ARAI), and SAEINDIA. Among other things, the MoU included development, organization and hosting of joint academic and cultural symposia, conferences, workshops, events, competitions and meetings. A contact person at each institution was chosen and an action plan established to conduct a series of workshops on the Baja vehicle competition at different locations in India to benefit a large body of students. It took almost one full year to plan and execute this event with support and assistance from many people in both countries. The funding for this program was provided by the TTU study abroad program, SAEINDIA and the three host institutions. One of the biggest challenges was to transport the TTU winning car to India for show-and-tell demonstrations. Everyone understood the importance of having the winning vehicle in the workshops. Fortunately, Cummins, Inc., helped to ship the vehicle to India by obtaining export clearance and managing the logistics of transporting the vehicle throughout India for all three workshops.

Workshops

A total of three centers in India were chosen strategically for the TTU workshops in order to reach the maximum number of 2015 Baja SAEINDIA participants. These were Pune (West India), Vellore (South India) and Jaipur (North & Central India). The schedule was as follows: August 10, 2014, College of Engineering-Pune; August 16, 2014, Vellore Institute of Technology, and August 21, 2014, Jaipur Engineering College and Research Center. The workshops were totally free-of-charge for the 2015 Baja SAEINDIA participants. The agenda for the entire day was kept uniform at all the locations. The agenda consisted of the following broad topics having sub topics under each category:

1. Pre-workshop vehicle display,
2. Introduction,
3. Team Hierarchy,
4. Design Process,
5. Prototyping/Testing,
6. Frame Design,

7. Drivetrain Design,
8. Suspension, Steering & Brake Design,
9. Fabrication,
10. Electronic system,
11. Competition Preparation,
12. Technical Inspection Preparation,
13. Design/Sales Presentation Preparation,
14. Race preparation,
15. Feedback session,
16. Demonstration of TTU Baja Vehicle, and
17. Conclusion.

After an introduction by the faculty sponsors, the entire workshop and the question and answer session that followed was conducted by the TTU students. Each student presented material and responded to questions that corresponded to their areas of expertise and responsibility.

In the Pune workshop, a total of 327 students from 39 teams participating in Baja SAEINDIA 2015 attended. In the Vellore workshop a total of 367 students from 31 teams attended, as shown in Figure 2. In the Jaipur workshop a total of 287 participants from 34 teams attended. The workshops provided an outstanding outreach opportunity for 971 students from 104 Baja teams! The learning outcomes for both the outreach team and the Indian teams were significant and memorable. The participants learned how to prepare and win the Baja event. Indian students do not grow up in a car culture that students in the United States may experience. The TTU vehicle demonstration was an added advantage for all the participating students. This vehicle weighed 171 kg when it arrived for the workshop, while traditionally, the vehicles at the Baja SAEINDIA competitions have weighed between 300 and 500 kg. Seeing a championship vehicle perform, as shown in Figure 3, made a step change in the understanding of what it takes to design a competitive vehicle. The workshop at all three locations was well-organized. The students attending these workshops were enthralled with the one-on-one interactions with this iconic team as seen in Figure 4. The presentation content and TTU team's competency boosted the Indian teams' energy as reflected in the written student feedback shown below in Table 1. The results show that students gave high scores (8.26 or higher out of 10) to the TTU team's presentation style, competency, and with the Q & A session.



Figure 2. Vellore workshop



Figure 3. Demonstration by the 2011 championship vehicle



Figure 4. One-on-one interactions with TTU Baja team members and Indian students

Table 1: Results of Student Feedback

Fields	COEP	VIT, Vellore	JECRC, Jaipur
Hospitality	8.00	7.79	7.53
Presentation content	8.8	8.66	8.26
Food	7.8	7.76	8.32
Communication clarity	8.5	8.76	9.85
Volunteer's coordination	8.6	8.66	8.01
Event flow	8.7	8.69	7.69
Venue	9.2	9.31	7.03
Competency of TTU team	9.5	9.24	8.97
Q & A with TTU	8.9	9.00	8.68
Overall Summary	8.67	8.65	8.26

Opportunities

This trip was filled with opportunities for the students to see new things and to have experiences that were completely unfamiliar to them. Some members of the group had limited travel experience prior to this trip, so even train and airplane travel were an adventure. Students were able to do some sightseeing in the various cities, and they encountered working camels and herds of peacocks.

The students were often treated as VIPs, and they were befriended by the chancellor of one of the universities. At each workshop location, there were numerous reporters to provide press coverage of the events. Each workshop was opened with a ceremony that included elements of Indian culture, and the students were included in the 68th Independence Day celebration which occurred while they were in Vellore. They visited Jaipur Foot – a world renowned charitable organization which builds low cost prosthetic limbs. This was considered an engineering marvel by some students as they witnessed engineering with goals that were based on low cost and not on the latest technology. Another unique visit was to Akshaya Parta, a facility which provides 1.5 million hot meals to be served daily at schools across India.

Visits to industry were arranged, and the students toured Automotive Research Association of India (ARAI) and the manufacturing facilities of Deere & Company (John Deere), Cummins Inc., and Mahindra & Mahindra Limited, where they were privileged to meet with the CEO. They observed both similarities and differences in the approaches to engineering in India and the United States.

Between workshops, the students also had the opportunity to visit many historical and cultural places in India, including the Taj Mahal as shown in Figure 5, Gateway to India in Mumbai,



Figure 5. TTU team and hosts at the Taj Mahal

Victoria Station, the Golden Temple near Vellore, the Pink City in Jaipur, and Aga Khan Palace, where they learned about Gandhi's time there while under house arrest.

Challenges

For many of the students, prior travel experience was limited. They learned the process of acquiring passports, visas, and the required vaccinations. They learned strategies to deal with long flights, jet lag, customs and security. They also learned that the weight limits for baggage were less on flights within India than on the international flights. This led to the need for a quick redistribution of personal belongings within the luggage of the group.

Challenges occurred as the students learned to navigate a new country and culture. They immediately experienced the differences in moving about and walking with intense traffic and right hand drive cars. They learned that wireless internet connections are intermittent, and they were challenged by eating spicy food at every meal. They learned that many things in India are not built for persons with a tall stature.

Many of these new experiences also provided an opportunity for personal growth. The students learned what it was like to be in the minority in a foreign country. They became aware that in their host country, it was customary for service persons to assist with almost every task. This was a big adjustment for college students from a rural area. The students also gained experience in graciously and confidently fielding a flood of questions before, during, and after each workshop. Although the workshops were conducted in English, the differences in accent created a challenge in understanding one another.

Risks

As with any foreign travel, there were genuine risks involved in this trip. There was a need for precise timing in meeting every travel connection over the sixteen days. Much advance education, care, and caution went in to preparing the students and keeping them safe in an environment with different customs and cultural expectations. There was a particular need for vigilance in traveling with a female student in the group. Also of concern were the unsafe drinking water and the many encounters with street beggars and roaming dogs, cows, and monkeys.

Conclusion

With the true immersion that the Baja SAE team members had in the Indian cultural and educational spheres, many strong bonds were created. This allowed the group to learn together and from each other, as seen in Figure 6. It would not have been possible to accomplish this by collaborating remotely. Without travelling to those destinations, the group dynamics would not have been the same.

In their first encounter, all of the students present discovered that their shared passion for Baja created an immediate bond. These Baja-related conversations were heartfelt and intense. Students quickly realized how much they had in common. In the more formal workshop setting, the outreach team became more confident as they realized their robust knowledge of this subject area, and that they could make a significant contribution to their Indian counterparts.

There was a feeling of validation, knowing the workshops had an impact on individuals all the way on the other side of the world in such a real and meaningful way. Now there was an understanding of another culture from an insider's perspective, in a way that very few people get to experience. There were nine students and two faculty sponsors from the TTU Baja SAE team that traveled to India to conduct workshops by sharing their expertise in Baja competition and safety. Both faculty and students concluded that the opportunities of this experience far outweighed the potential challenges and risks.

Although this specific outreach activity is not something that would be duplicated by other institutions, it is meant to be motivating for others to seek opportunities for student-led outreach activities. Each institution should work with its individual strengths. The growth in students' abilities to understand global economics, function in different cultures and societies, and travel abroad will have an impact on students for a lifetime. The increased probability of future collaborations and exposure for the institution will also bear fruit.



Figure 6. TTU Baja members immersed in educational experience

Acknowledgments

Several people contributed in various capacities to the success of the workshops. Support from the TTU President, the Provost, the Study Abroad program, and College of Engineering is acknowledged. The two faculty advisors who traveled with the team were Dr. Dale Wilson and Dr. Satish Mahajan. The transportation and logistics of the vehicle were arranged by Dr. Karen Ramsey-Idem of Cummins. The India operations were conceived and executed by Dr. K.C. Vora of ARAI with support from key leaders at SAEINDIA. The leadership and support from Dr. Anil Sahasrabudhe of COEP, Dr. V. Raju of VIT and Prof. Arpit Agrawal of JECRC is also acknowledged. Finally, a big thank you to the nine TTU students: Sam Keener, Logan Atkins, Kurt Pierchoski, Basil Hall, Kendall Hall, Samantha White, Gage Babb, Daniel Thomas, and David Laxton, who took part in the workshops.

Reference

1. "SAE Collegiate Design Series." *Baja SAE Series*. Web. 6 Apr. 2015. <<http://students.sae.org/cds/bajasae/>>.