

International Education Outreach: A Report on the SAE Baja Workshops in India

by

Dr. Mohan D. Rao

Chair, Mechanical Engineering

Dr. Dale Wilson, Professor, Mechanical Engineering and Dr. Satish Mahajan, Professor,
Electrical and Computer Engineering

Tennessee Tech University, Cookeville, TN 38501, USA

mrao@tntech.edu, dwilson@tntech.edu, smahajan@tntech.edu

Abstract:

The Baja Collegiate Design Series is a competition that presents engineering educators with an opportunity to offer students a meaningful, hands-on, team learning experience. Each year as many as 140 Baja cars are entered in the Baja SAE events across the US and around the world. 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 teams are judged on ergonomics, functionality, and producibility of their cars in addition to a combination of static and dynamic race events. The Mechanical Engineering department at Tennessee Technological University (TTU) has long been affiliated with the Baja SAE competition, having hosted the event 5 times and placed in the top 10 over 80% of the time since 1977. SAE India recognized the value of this hands-on experience and initiated a similar program for universities in India in 2006. In order to provide the required experience and expertise for the Indian teams to compete in the international competitions, SAE-India partnered with

TTU to conduct workshops and advise Indian college students on building and racing a competitive SAE Baja vehicle.

This paper presents a report on a recent trip over a period of 16 days by a group of nine students and two professors from TTU to conduct workshops and interact with about 1000 Indian college students at three different sites. They held demonstrations using TTU's 2011 winning vehicle and gave technical presentations on various aspects of designing, building and racing a winning vehicle. In addition to visiting some industries in Pune, India, the team toured the Jaipur foot factory (jaipurfoot.org) and enjoyed some cultural immersions, visiting the Taj Mahal, Golden Temple and Jaipur Palace along the way. Overall, it was an extremely beneficial experience to students from both countries as summarized in one student's journal entry:

"We brought home a ton of pictures, stories, and experiences to share with everyone here. I think we learned as much, if not more, than everyone we were teaching at the workshops. I think we made a great impact going over there, and we formed a lot of strong partnerships and relationships that will hopefully carry on into the future. I

know I am more culturally connected than when I left, and I think I will have a better time understanding our international students here as well. I'm so grateful that I got to be a part of this amazing journey."

1. 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 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 for 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, team-work, 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 SAE-India through the Automotive Research Association of India (ARAI). Through these partnerships, TTU has managed to provide a memorable international experience of team learning to a handful of TTU students, and several hundred students in India.

This paper presents a brief summary on student-led education outreach by a group of nine students and two faculty members from Tennessee Tech University traveling to India for a period of sixteen days to conduct workshops and demonstrations on how to design, build, and race a winning Baja vehicle. The TTU team has long been affiliated with the Baja SAE competition—having hosted the event 5 times, the team has been placed in the top 10 over 80% of the time since 1977. In fact, it has come in at 1st place twelve times to date, the feat no other team in the world has achieved. The second most winning team has won the competition only six times.

2. 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 for undergraduate and graduate engineering students. Teams of students from universities all over the world design and build small off-road cars. The cars 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).

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 140 Baja cars are entered in the Baja SAE events across the US and around the world where events are held including India, Brazil, South Africa and Korea. In India, this event is run by SAE India. All cars must adhere to SAE's rules and pass SAE's technical inspection and judging; a car may not race until all safety inspections are passed.

There are multiple dynamic events, usually four per event, as well as a single four-hour endurance race. Static events, such as written reports, presentations and design evaluations are provided by participating teams. This is when the teams are judged on ergonomics, functionality, and producibility

of their cars, 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 for production. SAE-India in cooperation with ARAI recognized the value of this hands-on experience and initiated a similar program in 2007. Mahindra & Mahindra Ltd., the leading Automobile Manufacturing Company of India, has been the co-sponsor for the event since inception and the title and principal sponsor for last four consecutive years.

In an effort to speed up the progress in their level of competition and safety, SAE India 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 SAE India. 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 Baja vehicle competition at different locations in India to benefit a large body of students. The students held three one-day workshops at the College of Engineering Pune, Vellore Institute of

Technology, Vellore and JECRC, Jaipur. It took almost one full year to plan and execute this event with support and assistance from a lot of people in both countries. The funding for this program was provided by the TTU study abroad program, SAE India and the three host institutions. One of the biggest challenges was to transport the TTU winning car to India for a show-and-tell demonstration. 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 the logistics of transporting the vehicle throughout India for all the three workshops.

3. Workshops

A total of three centers all over India were chosen strategically for the TTU workshops in order to reach the maximum number of 2015 Baja SAE-India participants. These were Pune (W. India), Vellore (S. India) and Jaipur (North & Central India). The schedule was as follows – 10th Aug'14: College of Engineering, Pune; 16th Aug'14: Vellore Institute of Technology, Vellore, and 21st Aug'14: Jaipur Engineering College and Research Center, Jaipur. The workshops were totally free-of-charge for the 2015 Baja SAEINDIA participants. Some pictures from these workshops can be seen at the end of the paper. 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.

In the Pune workshop, a total of 327 students from 39 teams participating in 2015 Baja SAE-India from the states of Maharashtra, Gujarat, Odisha, Goa, Diu & Daman participated. Teams from Tamil Nadu, Karnataka, Kerala, Andhra Pradesh and Telangana participated at VIT, Vellore. A total of 367 participants from 31 teams attended the Vellore workshop. Teams from Rajasthan, MP, UP, HP, Bihar, Punjab, Haryana, J&K, and New Delhi participated at JECRC, Jaipur. A total of 287 participants from 34 teams attended the Jaipur workshop.

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. The TTU vehicle demonstration was an added advantage for all the participating students. The workshop at all three locations was well organized. Teams were quite satisfied with one-to-one interactions with their iconic team. The presentation content and TTU team's competency boosted the Indian teams' energy as reflected in the written student feed-back shown below in Table 1.

The results from Table 1 show that students gave high scores—8 or higher out of 10-- to the TTU team's presentation style, competency, and with the Q & A session.

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

4. Some Observations and Final Remarks

With the true immersion that the TTU Baja team members had in the Indian cultural and educational spheres, we managed to facilitate the creation of strong bonds. This allowed the group to learn together, and from each other. 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 that case.

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 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 experiential, multicultural learning experience should be embraced by all engineering programs when opportunities present themselves.

We had some experiences during the course of the trip that caused our students to re-examine their previously held beliefs about working in the global marketplace. The teams had communicated through emails and technical reports, and the TTU students were certain that there would definitely be no language barrier between them and students in the Indian teams. However, the question and answer sessions at the workshops highlighted the difference in the accent that initially proved to be a challenge.

In designing similar workshops in the future, we may incorporate additional steps that we did not anticipate with our first trip.

The TTU Baja team had to deal with some issues related to international travel that were out of their control. They had to learn to handle these issues and think on their feet and adapt to the situation. On one occasion, their Baja vehicle was delayed by a day in reaching the destination. There was a time when the electricity got cut off during one of their sessions. They had to adjust to the host country's cultural norms, one of which was the lack of punctuality that occurred at each of their locations. Another important issue was the Indian diet. Even though the students on the outreach team did not dislike Indian food, they quickly got tired of it started to crave good old American fast food. This problem was addressed by an emergency trip to the local McDonalds.

Though these may seem like several negative events, it was not all experienced by one individual. The team experienced these things together and learned from them in a group setting. Furthermore, going through these hardships together strengthened their closeness with others on their team. It created a sort of common bond. In addition to those experiences, there were other, very positive experiences as well. They were looked up-to by their Indian peers as being experts in their field, which really helped to make them feel empowered and confident.

In their first encounter, all of the students 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.

They also felt validated, knowing that they have impacted individuals all the way on the other side of the world in such a real and meaningful way. They have come to understand another culture from an insider's perspective, in a way that very few people get to do. There were nine students and two faculty sponsors in the 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.

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Some Pictures from the Workshops

