

AC 2009-690: BAJA SAE COMPETITIONS: MEETING AND INTERACTING WITH INTERNATIONAL STUDENTS – EXPERIENCES OF STUDENT AND UNIVERSITY PARTICIPANTS

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Baja SAE Competitions: Meeting and Interacting with International Students – Experiences of Student and University Participants

Abstract

In today's global economy, engineers must collaborate with their international colleagues.¹¹ Study Abroad is an excellent preparation for this collaboration. Unfortunately, less than 3% of United States (U.S.) engineering students take advantage of such programs.¹ Baja SAE competitions may be a good alternative for students to achieve exposure to the culture of their international peers.

Baja SAE student competitions were started in the 1970's in the U.S. and involve the design, analysis, and manufacture of a single-seat, 10 horsepower off-road vehicle. Initially, only teams from the U.S. and Canada competed. Today, teams from five continents compete in events around the world. At the 2007 Baja SAE Rochester World Challenge, hosted by the Rochester Institute of Technology (RIT), students representing 35 international teams from 9 countries competed alongside 106 U.S. based teams. The eventual winner of the event was a Brazilian team from Sao Paulo, Centro Universitário da FEL.

Baja SAE events can provide the following benefits to participating students:

- Interaction with students from different backgrounds.
- Travel to experience cultures.
- Witness the capabilities and alternative thought processes of their international peers.
- Establish personal contacts within their international peer group.
- Recognize working challenges between international groups.

Universities are also affected by the experience of hosting or competing in an international Baja SAE event. RIT will be used as a model school to show how visibility and prominence were affected by the school's participation in and hosting of international events. The RIT campus has hosted two International Baja SAE events. The RIT team competes in three North American events per year, and has traveled to a number of competitions in South America and Africa.

Participating in or hosting Baja SAE events may provide the following benefits to universities:

- Increased visibility in the local, academic, and business communities.
- Increased prominence within the academic community.
- Aids in freshman, transfer and graduate student recruiting.
- Associated job fairs for students.
- Enhanced alumni relations.

This paper offers the experiences of both student and university participants of Baja SAE. Surveys and interviews were used to gather fact.^{7,10} Follow-up research will include further surveys and interviews; and focus groups to be held in conjunction with future Baja SAE events.

Introduction

In most of today's industries there is an increasing need to work with people from other cultures.¹² Failure to understand international business culture has been shown to be a major factor in the failure of overseas commercial endeavours.¹¹ Because of these two facts it appears that one of the best ways to succeed in today's global economy is to have some cultural sensitivity and possess a firsthand knowledge of the way our international peers operate.

Cultural sensitivity seems to have gained importance at many schools and businesses as the workplace becomes more and more diversified. U.S. schools with engineering programs have been searching for ways to incorporate an international component into their curriculum.² It's important to understand not only how our peers think and work but we often need to be aware of their culture.¹² There have been many international business people, including engineers, that have accidentally offended an international colleague through an unintentional insult. One personal example relates to tossing an old floppy disk at a Korean teammate in graduate school. The Korean student was extremely offended and after several weeks of brewing explained that in Korea throwing anything at a person is a major insult. Other examples of potential cultural pitfalls exist in other countries as well. For instance, in the Arab world showing the bottom of one's foot is insulting.

One of the best ways to learn appropriate international behavior may be to practice prior to entering the workforce. Once a person enters the workforce "the bottom line" is very important and inappropriate behavior could cost your company real money. Unfortunately, according to the Institute of International Education's Open Door Statistics only about 3% of U.S. engineering students take advantage of "study-abroad" type programs.¹ In other words - most engineering graduates tend to be uneducated when it comes to foreign culture and customs. If these graduates find themselves in an international work environment they might not be as successful as someone who has previously worked in an international setting. In addition, a person who lacks international experience may be passed over for jobs, promotion, or even special projects which require such unique traits. A person's diverse experience with other cultures can make them better rounded; a trait which most modern employers seem to find very appealing.

The Accreditation Board for Engineering and Technology (ABET) recognized the importance of some global education and has expanded its requirements for engineering programs. Criterion 3 of the ABET guidelines was altered to include⁶:

- Ability to function in multidisciplinary teams
- Ability to communicate effectively
- The education necessary to understand the impact of engineering solutions in a global and societal context
- Knowledge of contemporary issues

Similar to the ABET Criterion 3 changes institutions have broadened their mission statements to commit to produce globally competent graduates. These graduates should be able to effectively function in the global marketplace while providing enhanced leadership in the international arena.²

So the question is: If only 3% of engineering graduates are getting exposed to study abroad how can we expect these engineers to be successful in today's global marketplace? Is there another way to expose students to their international peers without bankrupting the college or student? Fortunately, a program already exists and can trace its roots back nearly four decades.

Baja SAE Competitions

SAE has been sponsoring Baja SAE, formerly known as "Mini-Baja" competitions since the early 1970s. In the early competitions a few dozen U.S. schools would design, build, test and compete their one-person off-road vehicles against each other. All teams were given a low horsepower "lawnmower" engine as their energy source. Dynamic events included acceleration, maneuverability, suspension and traction, hill climb, mud bog, water maneuverability and a several hour endurance race across both land and water. Prior to the dynamic events all vehicles were subjected to design judging. During design judging cars were looked over from top to bottom to make sure that they met all of the design requirements set by SAE. Students often gave design presentations and submitted detailed cost reports outlining everything from the nuts and bolts to the imported high strength German steel tubing used for the frame of the car.



Figure 1: An Example of a circa 1970's Baja Vehicle

During these early events camaraderie was observed to be very high. Teams from different schools would help each other with both parts and manpower. There was a sense of competition but also of community. Engineering students were learning to function as part of a technical team. Education was not administered in the classroom but in the field. These students probably didn't even think about the valuable life-lessons they were acquiring.

As the events matured, non-U.S. schools started to participate. Initially, most of these non-U.S. schools were from Canada or Mexico. So now, when students on different teams assisted or

competed against each other a language barrier may have existed - Spanish to English or French to English or French to Spanish. Students might have looked, smelled and dressed differently. The way that the international teams functioned might have been a bit different from their US counterparts.

As the international teams gained experience they began winning competitions.⁸ The U.S. teams no longer won every event. Intense international competition had begun. The similarity to current global conditions is hard to miss. According to Global Competitiveness Report the U.S. has been able to maintain its global competitiveness as other countries have slipped slightly.³ At Baja SAE competitions the U.S. has been challenged for over 25 years and counting. A possible result of this international challenge is that most designs and teams have become more advanced with new technologies implemented at every event.

Most recently, Baja SAE competitions have been held in other countries including India, Brazil, South Korea and South Africa. Teams from these countries have been attending some of the U.S.-based competitions. Conversely, a few U.S. teams have traveled overseas to compete in events in Brazil and South Africa.

At an event held at the Rochester Institute of Technology in 2007 there were 35 international teams from nine countries registered to compete alongside 106 U.S. teams. The eventual overall winner of the competition was a team from Brazil. The same team went on to a repeat victory in 2008 at an event held in Quebec, Canada.⁸



Figure 2: United States Military Academy and University of Buffalo at a 2005 North American Baja Event.

Some of today's North American Baja SAE events have close to 30% representation from international teams. Today, teams still help and compete against each other. The difference now is that there is a literal melting pot of student engineers working together towards a common goal. Let it be known that not all U.S. or international teams work well together. Observation at Baja SAE events shows that some teams view winning as more important to helping each other,

especially rookie or less-experienced teams. Interestingly, it is the teams that appear to help each other the most that seem to be more widely respected and successful.⁸

In industry, the establishment of international economic alliances requires that engineers be prepared to work in settings international in nature. Most major corporations are operating globally with engineers constantly being challenged to design products for a new global market. To be most successful, an engineer of the future might have to embrace diversity and excel in a multi-national atmosphere. It is imperative that engineers be able to communicate and socialize as well as use technology to exchange ideas, solve problems, and present solutions.⁴ Baja SAE teams have been following this model and appear to be paving the way towards a culturally diverse yet unified future in business and engineering.

The fact that not all U.S. teams work well with their international peers is a microcosm of the engineering society in general. Some of the Indian teams have found it exceptionally difficult to get their vehicle to U.S. competitions on time and fully completed. Once here the same Indian teams have transportation issues – they are not familiar with the U.S. transportation systems. Other teams have had to “rescue” their Indian counterparts by chipping in both manpower and transportation assistance.

Participation Benefits for Students

Students that participate in Baja SAE events are afforded the opportunity to:

- Interact with students from different backgrounds.
- Travel to experience cultures.
- Witness the capabilities and weaknesses of their international peers.
- Establish personal contacts within their international peer group.
- Recognize working challenges between international groups.



Figure 3: A Vehicle from Venezuela Shown After the 2007 RIT Baja Event

During most events it is easy to find teams helping each other. At the 2007 event at RIT the host school opened its shop for use by any visiting school – U.S. or international. Traveling past the shop late one night one could hear conversations in at least five different languages as teams from the U.S., Canada, Venezuela, Brazil, and India worked to ready their cars for the next day's competitions. Upon closer review, it was noted that most teams were communicating with other teams either through necessity or because it was interesting for the students to talk with peers from a far away place. Engineers tend to be curious by nature and if something different is put in front of them they will start to investigate. Some of the U.S. students had probably never before talked to someone from Brazil or Venezuela.

A survey response to the RIT Baja event in 2007 complimented the school and RIT team for "... attention the staff and RIT people had with all the students, specially [sic] the RIT team with the international teams, congratulations."⁷

This type of co-mingling and cultural exchange is much less formal than a "study-abroad" program but the spontaneity and ease in participating seem to be unmatched. Literally, all the students needed to do were to be an active member of their Baja team. No application was necessary and no one was rejected. Best of all, the international exposure is free and the personal connections that are made last a very long time. One student's reply to a survey conducted after the RIT event stated that they enjoyed the event because of the "...environment, with all the different BAJA vehicles from Universities [sic] across the world."⁷

When U.S. students see Brazilian teams compete for the first time they are sometimes amazed at the energy, organization and creativity of their foreign counterparts. Some resources in Brazil are much more limited and students must make do with what they have. Wrapping clear plastic wrap "Saran Wrap" around your universal joints to keep out dirt doesn't occur to many U.S. teams – nor would it be viewed as a particularly wise choice to make. The Brazilians see it another way. Universal joints are very expensive, they often must be imported and import taxes are substantial. By keeping the dirt out the life of the joints is extended and the team can re-use joints from one year to the next.

Brazilian teams will often have one person on the team – usually the smallest, lightest and most agile -- be the sole driver for the vehicle. The other team members recognize the attributes of this one person and relinquish their rights to drive their own vehicle. Not many U.S. teams take this approach – preferring to distribute the right to drive as a reward for working so hard on the car.

Many teams from Mexico have small budgets and must re-use or re-purpose many of the parts on their Baja cars. Some teams have been known to take junk cars and cut out useful suspension and steering parts for use in their Baja Vehicles. Sheet metal might have been an old road sign or body panel from an old car.

By seeing this alternative thinking U.S. students might recognize that what is the "norm" in one country may not be the norm in another. This is a valuable lesson to use after graduation when ideas might come from "off-shore". U.S. students that have been exposed to the intelligence and creativity of foreign engineers might be more willing to accept foreign ideas and incorporate different thinking into making the overall product better.

The small number of U.S. teams that travel to foreign competitions, including RIT, gains an even greater understanding of their international peers. Teams must arrange all details for their trip. Details such as scheduling, international travel, customs, international laws, U.S. export law, and working with non-English speakers all present challenges to the foreign traveling U.S. team. Once the U.S. team is in the foreign country details such as transportation, local customs and laws, and other logistics play a vital role in determining the success of such a visit. Experience has shown that the most effective visits occur when a host school is found in the country where the Baja event is taking place.

The host school normally provides a physical location to re-assemble a car. During the time spent with the host school U.S. students get first hand experience working in a foreign country with foreign workers. Tools and resources that may be different from what the U.S. students have at home. Getting the job done often involves finding creative solutions to even the simplest of problems.

At any Baja event one does not need to look very hard to see some teams that do not work very well or have some other serious problems. Both domestic and international teams fall into this category. The astute participant will try to see what is going wrong and will try to avoid the issues that caused the problems for the other teams.

When a U.S. team and an international team are collectively working together not all may go as planned. As mentioned earlier, one Indian team did not learn how to properly import their car into the U.S. prior to an event. The U.S. host spent days trying to get the car out of customs and finally was successful – only to have the Indian team say they had run out of money and would not be able to participate in the event. One year later several U.S. teams were tasked with helping a different Indian team get its late arriving car ready for a technical inspection. The memories from the previous year were still fresh in the minds of the assisting U.S. teams. They were not sure that their efforts to get the Indian car ready would be fruitful – they were afraid that the Indians might again pull up and leave.



Figure 4: Mexican Baja SAE Team and Their Newly Made American Friends

These real experiences with real problems also provide valuable lessons for the future. Often, the best lessons come not from successes but from failures. As it turns out, the Indian team did stay and compete and the U.S. teams that assisted the Indians were given special recognition. Most importantly to the students – their efforts were not wasted.

Many working challenges between international groups involve language barriers. Baja competitions provide a ripe environment for such challenges. During an event several years ago a team from Mexico asked a U.S. team for help. They needed tubing because they had used thick-walled water pipe instead of chromium alloy steel and didn't have equivalency calculations or certifications to back them up. Luckily, a couple of the students on the U.S. team had taken Spanish in high school and were able to do basic translations. By the end of the day the U.S. and Mexican team worked together to complete their vehicle and made it through inspection. The result of this was a new friendship and respect between two very different teams. In fact, the Mexican team was so appreciative that a couple of their members took their customized jumpsuits off their backs and gave them to the U.S. team. The U.S. team took this as a great honor and hung them in their machine shop. The two teams remain very friendly and communicate on a regular basis.

Participation Benefits for Universities

Participating in or hosting Baja SAE events provide the following benefits to universities:

- Increased visibility in the local, academic, and business communities.
- Increased prominence within the academic community.
- Aids in freshman, transfer and graduate student recruiting.
- Associated job fairs for students.
- Enhanced alumni relations.

RIT has hosted two international competitions and regularly competes in three North American events per year. In addition, RIT has traveled to a number of competitions in Brazil and South Africa. The administration of RIT recognizes that the Baja program allows RIT to be seen by a large global audience. By hosting and participating in international events the image – both visibility and prominence - of RIT appears to have been improved. Local and national media seem to be more attracted to a story when there is an international flavor. Articles about RIT's Baja program appearing in the local media tend to boost the local visibility of RIT. Stories appearing in broader media outlets may help improve the image of RIT regionally, nationally and internationally. Becoming an international recognized university has been a goal of the RIT administration and the Baja program is helping them realize this goal.

Many survey responses submitted after one of the RIT International competitions recognized the school for a great event and the fact that “ the host team was very generous with their facilities and resources”.⁷

Currently, RIT is attempting to build international partnerships from some of the connections made through the Baja program. The possibility of establishing partnerships was aided by the greater international visibility afforded by participation in international Baja SAE events both here and abroad.

Some universities have begun to realize that having a Baja SAE team on campus is a valuable recruiting tool. RIT highlights the institute's participation in Baja SAE in recruiting literature to entice prospective engineering and engineering technology students.⁹ RIT gives tours of the machine shops where the teams design and fabricate as well as display previous and new competition vehicles. No tour is complete without first passing by the trophy cases where decades of success are prominently displayed. During interviews with the RIT Baja SAE team several current team members stated that they chose RIT over another school because RIT had a Baja team and the other school did not. Some students added that the team's prior participation in off-shore Baja SAE events was an added attraction.¹⁰

At recent competitions, it has become commonplace for sponsoring companies to use the competition as an opportunity to recruit talented new employees or coops. Companies probably realize that it takes a significant amount of dedication and effort to simply get a car to one of the competitions. Most companies also recognize that the event participants are internationally diverse. Many of the sponsoring companies are large, international corporations such as Toyota, Honda, Caterpillar and General Motors. They recognize the importance of the life-lessons learned and international experience gained at a Baja SAE competition. These Companies expect graduates to come equipped with engineering expertise, problem solving skills, the ability to work alone and in teams. Additionally, their ability to communicate and possess interpersonal skills as well as having foreign language proficiency, and some form of international experience is becoming increasingly important.³

Competitions can not be hosted without the commitment of the hosting organization and many volunteers. Alumni have been used quite successfully as volunteers in both events that RIT has hosted. By bringing alumni in to work on an event connection to the school is maintained. A group of alumni led by former Baja team leader Jason Rounds was instrumental in convincing RIT to host its first international event in 2005. By enhancing alumni relations universities usually can create a large pool of committed individuals. In the future, these individuals may be called upon to aid the university in any number of ways. Possibly best of all, most of these dedicated alumni have experience working in a technical, international setting – who better to help meet the goals of a university striving to build their international reputation.

Conclusions

It has been shown that in today's global marketplace graduating engineers need some international experience to be optimally successful in their careers.^{2,4,11,12} Few engineering students currently participate in study abroad programs.¹ ABET has recognized the importance of international engineering knowledge and has made additions to Criterion 3 that specifically address the "...impact of engineering solutions in a global and societal context".⁶ Experience seems to indicate that Baja SAE does provide an adequate level of international experience to participants. U.S. students compete alongside their international peers. Teams

assist each other and in the process international friendships are sometimes established. Like study abroad, all Baja SAE participants are exposed to a variety of different cultures. Each team arrives at the competitions with their own unique skill sets and talents. Learning from team's successes and failures as well as being original is very important. Teams from Brazil have traveled to international competitions in the U.S. and won.⁸ The competitive nature of international schools to compete with the U.S. has made the capabilities of foreign students fairly well known in the Baja SAE community.

Universities that support Baja SAE have strengthened their international standing and have attracted new students that otherwise might have chosen another school.¹⁰ Companies now recognize the institutions that support Baja SAE and actively recruit new graduates from them. Alumni have been given a venue to maintain close ties to their alma mater and provide manpower to support current students Baja SAE participants.

Future Work

Future work in this area will include detailed participant, university and company surveys. In addition, focus groups will be held at future Baja SAE events and a comprehensive quantitative study will be undertaken measuring the international experience value of Baja SAE. Specific research will be conducted in the future on student opinions regarding diversity and the interaction of international students before and after participation in a Baja SAE international event.

Bibliography

1. Bhandari, Rajika and Patricia Chow. (2007) Open Doors 2007: Report on International Educational Exchange. New York: Institute of International Education, 2007.
2. V. Renganathan, L. Gerhardt and P. Blumenthal. (2008) Incorporating Global Perspectives in U.S. Engineering Education., Proceedings of the 2008 American Society of Engineering Education, Annual Conference & Exposition.
3. A. Casey, E. Bratschitsch and A. Millward-Sadler. (2008) Thinking Globally, Acting Locally: Strategies for Improving International Experience and Employability Skills of Undergraduate Students of Vehicle Engineering., Proceedings of the 2008 American Society of Engineering Education, Annual Conference & Exposition.
4. I. Esparragoza, M. Larrondo Petrie, D. Sathianathan. (2008) Global Engineering Education in the Americas: Challenges and Opportunities, Proceedings of the 2008 American Society of Engineering Education, Annual Conference & Exposition
5. K. Schwab and M. Porter. (2008) Global Competitiveness Report, 2008 World Economic Forum.
6. ABET, Inc. (2009) Criteria for Accrediting Engineering Programs. <http://abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2007-08%20EAC%20Criteria%2011-15-06.pdf> . Accessed January 23, 2009.
7. SAE International. (2007) 2007 SAE Collegiate Design Series Survey Results.
8. SAE International. (2008) Results for the Baja SAE Competitions 1996 – 2008. <http://students.sae.org/competitions/bajasae/results/>. Accessed March 3, 2009.
9. RIT Periodicals. (2007) Engineering Technology and Related Programs, publication 10M-P0344-06/07-MLI-PPB, 2007.
10. RIT Baja SAE Team Interviews. (2008) conducted by Dave Hallbeck and Chris England, October - December 2008.

11. Tomalin, Barry. (2007) *The World's Business Cultures and How to Unlock Them*, Thorogood. London. 2007.
12. Peterson, Brooks. (2004) *Cultural Intelligence: A Guide to Working with People from Other Cultures*, Intercultural Press. Yarmouth, ME. 2004.