The ASME Guide on FIRST and Universities

Imagine the following scene: thousands of cheering fans, competitors in the heat of battle, referees watching every move, a clock ticking down, a buzzer sounding and a winner declared. Does this sound familiar to sports fans? Of course. Does this sound familiar to engineering fans? For those familiar with FIRST Robotics Competitions, of course it does.

There has never been more of a demand for engineers. With such problems as a growing world population and limited resources as well as an increasing need for energy and the threats of pollution, there is no shortage of problems for engineers to solve.

But where will these engineers come from? As the number of challenges the world faces increases at a tremendous rate, the number of people educated to solve these problems must also increase at a tremendous rate. Unfortunately, we know that is not happening. Simply put, the engineering profession is not supplying the number of professionals that the world is calling for.

One reason the engineering profession is not attracting the needed cadre of problem solvers stems from the fact that our nation tends to glamorize and celebrate entertainers such as sports heroes, movie stars, and musical performers. Is it any wonder then that a young student would dream of being a professional athlete before considering a career as an engineer? As a nation, we are rewarded with what we celebrate. As a nation, perhaps we are celebrating the wrong things.

If we want to solve the looming problems facing us, our nation must shift its reward structure from its entertainment focus to a technology focus. Students, at the earliest age, must see engineering, science and technology as opportunities that are fun, rewarding and achievable. They must be inspired to learn.

FIRST: For Inspiration and Recognition of Science and Technology

FIRST is a national non-profit organization which inspires youth to pursue further study, experience and careers in engineering and technical fields. By doing so, FIRST helps ignite the curiosity and demand for learning, with the schools and universities then supplying that desired education. The premise of FIRST is to partner youth with practicing engineers so that the students can "play with the professionals" to solve challenging engineering problems. To achieve this goal, FIRST has established the FIRST Robotics Competition for high school youth and a Junior Robotics program for 9-14 year old students with a network of tournaments called the FIRST Lego League.

The FIRST Robotics Competition partners practicing engineers and university faculty and students with high school students to build sophisticated robotic devices to compete in mechanical sports. In the process, the students are exposed to some of today's true heroes: the engineers and technologists that continually improve society and raise the world's standard of living. Modeled after MIT Professor Woodie Flowers' introduction to design course, the FIRST Robotics Competition provides teams with a limited amount of materials and a challenging game to solve.

After only six weeks from the time the annual game is announced and teams receive their kit of parts to begin to design, test and build their robots, teams enter any number of regional events where between 40 and 100 teams compete. These competitions are wildly exciting, energetic and motivating. They have been described as part robot-festival, part rock-concert, part religious-revival, and all around fun. The culmination of the Competition is the National Championship which last year drew over 350 teams and more than 20,000 FIRST participants to Walt Disney World's Epcot Center for three days of celebrating technology. These events are regularly covered in the popular press and attract national leaders from government, education and industry.

The FIRST Lego League program has strong ties to the FIRST Robotics Competition and is tailored to engage 9-14 year old students in team-based problem solving of an engineering challenge. The program name is evidence of the strong partnership that exists between FIRST and the Lego Company, and the program itself is jointly developed and sponsored. Here too, students work with professionals to use a standard

This discussion of the opportunities for university involvement in FIRST was produced by the American Society of Mechanical Engineers.

kit of parts to accomplish a design goal, with groups of teams then assembling at local and state competitions. Though the FIRST Lego League students and robots are smaller in size compared to the FIRST Robotics Competition, the excitement and impact are equal.

FIRST Founder Dean Kamen

The true value of these competitions is not the outcome of the matches, but rather the purpose of the activity. What is celebrated at FIRST is not who can gather the most points during a competition, but rather which teams can best inspire and motivate youth to pursue studies and careers in technology. Throughout the Competition, FIRST teams demonstrate gracious professionalism through their respect for each other, courtesy, sportsmanship and best behavior at all times. By celebrating technology and providing a forum to promote engineers as role models, the culture of the participants is changed. And, who knows, the culture of our society may change as well.

FIRST and Universities: a Symbiotic Relationship

Since the mission of FIRST is to inspire students to learn, there exists a symbiotic relationship between FIRST and engineering colleges and universities. In short, FIRST excites students and universities educate students.

While there are many reasons why universities should be involved in FIRST, there is one primary reason: **university customers demand it**. This year approximately 5,000 FIRST participants graduated from high school and are en-route college. During their senior year, these students learned how to function as a team and solved demanding engineering problems. Much like other rewarding high school activities, these technically proficient and talented students desire to continue this experience in college. While FIRST graduates select universities that sponsor FIRST teams, others enter universities without FIRST teams and start teams at these universities. Such dedication and persistence of these freshmen students is commendable.

At the other end of the education pipeline, FIRST is supported by many of the country's leading technology companies that have a strong need for technically-educated graduates. As examples, Boston Scientific Corporation, Baxter International, DaimlerChrysler, Delphi Automotive Systems, General Motors Corporation, Johnson & Johnson, Kleiner Perkins Caufield & Byers, Motorola and the Xerox Corporation are all founding sponsors of FIRST. The leaders of these and other companies are committed to FIRST because the program works. In the words of the Chairman, CEO and President of Delphi Automotive Systems, J.T. Battenberg, "FIRST is a unique program that brings together five constituencies: the business community, professional engineers, high school administrators and teachers, universities, and the high school students. You've got all five constituencies, working together for the same common goal, and it's very special."

Similarly, NASA Administrator Dan Goldin views the value of FIRST as, "NASA needs the brightest minds in the nation. If our brilliant sons and daughters don't go into science and technology, we will limit America's ability to defend itself, create economic wealth and further open the universe. FIRST will provide them (corporations and NASA) with a workforce second to none in the world because these young men and women will already be tested, experienced, and motivated."

In answering this call for participation in FIRST, colleges and universities have been well served by their involvement in the program for it connects them with a large pool of talented high school youth. The scope of opportunities open to a university includes sponsoring teams, mentoring teams, hosting FIRST Regional Competitions, offering scholarships, and volunteering at FIRST events.

MIT Professor Woodie Flowers

Sponsoring a FIRST team allows universities the chance to partner with local high schools to develop technical literacy. By doing so, university students are put in leadership positions as they guide their high

school teammates through the many phases of the design process. Along the way, in addition to developing technical literacy skills, the high school students learn what it is like to study in college, and more specifically, what it is like to be a student at the university that is hosting their team. Developing these personal, long-term relationships between high school youth and university representatives has led to the enrollment of a number of FIRST team members in the college or university which sponsored their team. In the course of sponsoring FIRST teams, many universities have also developed stronger ties to the local business and engineering community by engaging professionals as sponsors and student mentors.

As more direct enticement to attend specific universities, some programs offer scholarships to FIRST participants. Colleges and universities value FIRST students since they have demonstrated teamwork, creativity, and the ability to complete a given task. FIRST scholarships range from single year scholarships to full-tuition, fully renewable scholarships. In 2001, over a million dollars in scholarships were awarded to FIRST participants by Clarkson University, Daniel Webster College, Drexel University, Georgia Institute of Technology, Kettering University, Northeastern University, Olin College of Engineering, Polytechnic University, Purdue University, San Jose State University, University of Detroit Mercy, and Worcester Polytechnic Institute. These colleges and universities recognized the value of making their program highly visible to the students involved in FIRST.

Having up to 4,000 high school students on a college campus for three days is a tremendous marketing opportunity for programs that host Regional FIRST Competitions. In 2001, FIRST Regional Competitions were held at Columbia University, Drexel University, Eastern Michigan University, San Jose State University, Northwestern University, and Virginia Commonwealth University. In addition to the FIRST team participants, each of these venues hosted corporate sponsors of the competition, news media, and members of the public. Some universities have capitalized on the chance to connect with so many youth at one time and have sponsored campus tours, parties, and raffles, all coordinated by their admissions departments as methods to establish an even stronger connection with these students. In addition to hosting Regional FIRST Competitions, some universities sponsor summer season FIRST Competitions both to further excite youth about technology and to showcase their campuses and programs.

To reach younger students, universities have also hosted FIRST Lego League tournaments which bring as many as 2,000 9-14 year old students and their parents to the college campus for one day. As an example, Virginia Polytechnic has found this Junior Robotics program to be a very effective tool to reach younger students, and the university is working to broaden the program's impact throughout the state. Virginia Polytechnic and others view the Junior Robotics program as a valuable method to motivate these young students about the many educational and career opportunities that await them.

Beyond these very public means of involvement, university faculty, staff and students have been important volunteers for FIRST. As one example, the ASME student section from Rowan University organized and sponsored a series of "Introduction to Design" workshops for FIRST teams located in their area. In these workshops, the university students led FIRST teams through the steps of the design process and demonstrated how the motors and actuators in the FIRST kit of parts could be used to build mechanical systems. As other examples, university faculty serve as Judges for FIRST Competitions and students are valued volunteers at FIRST Regional Competitions.

Through these partnerships, universities are inspiring FIRST participants to pursue a technical education and, in the course

of doing so, are showing these potential college students why they should choose their university as the place to receive that education. All benefit by such strong partnerships.

Case Studies of University Involvement with FIRST

In 2001, 57 different colleges and universities partnered with local engineering companies and high schools to sponsor FIRST teams in their community. While that number can be viewed as impressive, there were 515 FIRST teams in 2001 that had no university involvement.

There are a number of formats that have been used by universities to sponsor FIRST teams. For example, some university students are involved on FIRST teams as part of their engineering professional society student sections. In such a scenario, students do not receive academic credit for their work and the participation could be classified as a volunteer contribution to the local community. In other programs, participation in FIRST is part of the engineering curriculum and the university students receive college credit for their involvement. In this scenario, students have participated in FIRST as part of an freshman introduction to engineering course, as part of a directed studies in engineering, and as a capstone design course. In each of these instances, the faculty lead for the project is usually as engaged as the students in ensuring the success of the project. A few case studies are used to illustrate the range of possibilities for university involvement in FIRST.

Full Range of Involvement at WPI: WPI is one of ten teams that participated in the inaugural FIRST Robotics Competition in 1992 and have remained involved ever since. Since sponsoring that initial team, WPI has continued to serve as a model program for university involvement in FIRST. With the commitment and support of WPI President Dr. Edward A. Parrish, who serves on the FIRST Executive Advisory Board, WPI has continually expanded its involvement with FIRST each year. WPI has maximized community involvement in the program, provided a means for every interested student to participate on its local team, and has provided incentives for faculty and graduate student participation in the program.

WPI partners with a math and science high school that is located on the WPI campus to participate in FIRST. Under the guidance of a faculty member, the WPI team consistently produces a competitive device for each year's competition. To reward the enthusiasm of the thousands of high school students involved in FIRST and to further pique their interest, WPI offers a full-tuition, four year scholarship to one FIRST student each year. FIRST teams nominate other teams to receive this scholarship and as such each team participates in WPI's efforts to reward success.

Beyond these activities, WPI hosts a summer tournament for FIRST teams. During this two day tournament, WPI hosts 30 teams that compete against one another and celebrate the FIRST values of gracious professionalism, inspiration, teamwork, and creativity. Over the course of the weekend, WPI's visibility is raised to a new level as the high school participants and the broader community witness WPI's commitment to learning and student development.

Benefits of Hosting FIRST Regional Competitions at San Jose State University: The 2001 FIRST Competition season marked the second year that the San Jose State University has hosted the Silicon Valley Regional. The venture capital firm Kleiner Perkins Caufield & Byers, along with NASA Ames Research Center, Barclays Global Investors and a number of other contributors joined SJSU to host nearly 50 teams at this Regional Competition. In addition to the teams, the event drew a large number of the sponsoring organizations' partners who viewed the competition at the University. Having venture capitalists on board a university is always a welcomed occasion. As an additional level of support, the SJSU

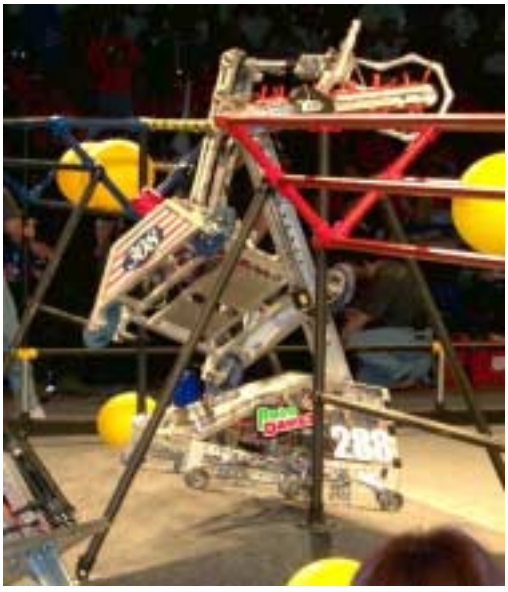
Department of Technology awards two, one-year, merit-based full tuition scholarships to FIRST participants.

SJSU's involvement highlights the wealth of opportunities that are possible for universities hosting FIRST Competitions. In addition to having thousands of motivated high school students on campus for three days, hosting a FIRST Regional Competition affords an opportunity for the university to partner with local businesses to promote a rewarding activity that benefits all. The SJSU involvement received substantial coverage in the print and television media, thereby providing a exceptional marketing opportunity to reach an even wider audience. As an example of the immediate returns for the university, the SJSU Engineering program has had several FIRST participants applying to the university: students who normally would not have considered SJSU as their first choice.

On a local level, the FIRST Robotics Competition focused SJSU faculty and administrators, including Deans, Vice Presidents, and the President, on a single mission. These leaders recognized and valued the excitement and interest the event created. SJSU's relationships with local high schools was strengthened by their involvement in the program, and the university expects to see many more local students participating in the San Jose State University robotics programs in the future. In the highly competitive university market, hosting a FIRST Robotics Competition clearly distinguishes one program above another.

Teams and Scholarships at Northeastern University: As the national champions of the 2001 FIRST Robotics Competition, the Northeastern University sponsored team was placed in the limelight before the tens of thousands of high school FIRST participants. Even more enticing to the students is the Northeastern University College of Engineering full-tuition, fully renewable scholarship awarded to a high school junior who has participated on a FIRST team. NU's College of Engineering offers this merit-based scholarship for an undergraduate degree in any engineering discipline.

The Northeastern University team includes participants from four Boston high schools and is supported by Textron Systems. The origins of the NU team speak to the capabilities of the participants in FIRST. A mechanical engineering freshman that participated in FIRST in high school approached the Dean of the College of Engineering to start a team. Simultaneously, the chair of the Mechanical, Industrial, and Manufacturing Engineering Department had heard about FIRST through ASME and was exploring starting a team with the help of a colleague at Textron who previously participated on another FIRST team. From this combination of student interest, university sponsorship, and corporate experience, the Northeastern University FIRST team was formed.



The Northeastern University team has grown to include over a hundred members, thanks in part to the enrollment of several high school team members at the university. In 2001, 14 members of the NU FIRST team were students who matriculated to Northeastern University from their respective high school FIRST teams. NU students participate in the program as an extra-curricular activity. In addition to the rewards associated with leading high school youth, the college students develop their technical skills and project management abilities. The community outreach of the NU team is significant since the FIRST Robotics Competition allows the university to simultaneously work with a large number of high schools and students. The accomplishments of the Northeastern University team are a model for all university sponsored FIRST teams.

An Internet FIRST Team at the U.S. Coast Guard Academy: A unique FIRST team, called CGA Team USA, was created by the U.S. Coast Guard Academy to participate in the 2001 FIRST Competition. The internet was used to link high school youth from across the U.S. with Coast Guard Academy cadets

to form a distributed team made up of members located in different geographic locations. This year long project was first led by management students who built the web communication portals and developed the protocols for team interaction. In the spring, seniors in Mechanical Engineering led the project as part of a capstone design course. The team used off-the-shelf technology to generate ideas, design components and remotely manufacture a series of three robotic devices, the last being a robot for the FIRST Robotics Competition.

High school members of the team first participated in a week-long introduction to engineering program at the U.S. Coast Guard Academy in New London, CT. Following this introduction, the team was instructed, remotely, on how to use the internet discussion forums, file servers, and communication tools developed for the project. After an initial round of internet based team development activities, the team completed a series of three robotic projects, each increasing in its level of sophistication. The remote team developed procedures for sharing design ideas, including software, applied decision matrices to make design decisions, and established methods to work in small groups on specific components of the design. The uniqueness of the team's organization was noticed at the FIRST Regional Robotics Competitions where the team received awards for creativity and innovation from the FIRST Judge panels.

This project was initiated for two reasons. It is highly probable that today's students will be conducting a significant amount of their professional work via the web, and educators need to prepare students for a distributed work environment. As a corollary reason, the members of this team, talented high school students from across the U.S., are the population the Coast Guard Academy draws on for applicants. The project created a venue to develop long-term personal relationships between college mentors and high school students during their senior year. It is no surprise that a majority of the high school members of CGA Team USA applied to the Academy, thereby validating the rewards to the institution for sponsoring the program.

Reaching Out to a Younger Audience at Virginia Tech (Virginia Polytechnic Institute and State University): The composition of the Virginia Tech FIRST Robotics Competition team is unique in that it is run by university students enrolled in a year long, for-credit, engineering mentor program. These students work with high school students from the four county high schools enrolled in a FIRST Robotics Competition class. With each team member receiving academic credit for their contributions, whether in high school or college, the Competition has developed as part of the curriculum. The engineering and manufacturing of the Virginia Tech team is accomplished primarily by the students themselves. FIRST Robotics Competition trained students complete the majority of the engineering applied to the project. As stated by Bill Duggins, an advisor to VT team, "The FIRST Robotics Competition is so good, so strong that its graduates can not only build and design a good robot, but more importantly, they can lead a technical team."

In addition to sponsoring a team for the FIRST Robotics Competition, Virginia Tech is a strong supporter of the FIRST Junior Robotics program in the state of Virginia. The university promotes the FIRST Lego League throughout Virginia because of the program's ability to reach a large number of students at a young age. In 2000, Virginia Tech hosted the state's FIRST Lego League tournament and even provided college student mentors to guide the local middle and elementary school teams that participated in the competition. During the state FIRST Lego League tournament, the college partnered undergraduate volunteers with each participating team as a "team guide". In this role, the college students assisted the teams in the competition process, and most significantly, served as role models to the young students. The university offered tours of the college's robotics labs and science exhibits on volcanoes that correlated with the Junior Robotics game challenge, and exposed these young students to the university environment. For some of the participants, this competition was their first visit to a traditional college campus.

Virginia Tech is now building on the success of their experience with FIRST and is developing a collaborative effort with the Cooperative Extension Service's 4-H program and with other universities and colleges in Virginia to introduce students and schools to the FIRST Lego League. The effort will mirror the successful program used at Virginia Tech, including assigning college students as mentors to teams

and hosting regional and state competitions in higher education environments. Virginia Tech recognizes that a strength of the FIRST Junior Robotics program is that teams can be successful everywhere, even in areas that do not have the economic or technical resources to effectively participate in many programs. As such, Virginia Tech is committed to seeing the FIRST Junior Robotics program grow throughout the state because the program has proven to be effective and affordable.

FIRST and Universities: A Valued Partnership

The returning participants of FIRST - the college students that start a team at their new university, the FIRST participant that graduates from college and starts a FIRST team with their initial employer, and the college alumni that partners their college with a local high school to start a FIRST team - are testimony to the impact and efficacy of FIRST. As proven by their commitment and success, and echoed by FIRST's corporate sponsors, FIRST works. It is an engaging and effective program that has long term impact on its participants.

As a nation, we need to showcase the very best of this nation and present youth with real heroes – educators, business and government leaders, engineers, scientists, and technologists – heroes that these students can in turn become. We all understand the value of technology, and it is our collective responsibility to ensure the resources are in place to help others both see that value and play a part in discovering and implementing future technologies. FIRST inspires, motivates, and prepares students to become the next generation of technology heroes.

Contact Information

For information on how your university can be involved in FIRST, or to contact a university faculty member that participates in FIRST, please call the Director of the FIRST Robotics Program, Bob Hammond at 800-871-8326, ext. 404 (rah@usfirst.org) or the Director of the FIRST Lego League, Anna Maenhout at 800-871-8326, ext. 405 (maenhout@usfirst.org).

Information on FIRST can be found on the FIRST web site at www.usfirst.org or by calling 800-871-8326.

Contact information is provided for representatives from those programs highlighted in the case studies:

- **Worcester Polytechnic Institute**: Ken Stafford, Manager of Academic Initiatives, 508-831-6122, stafford@wpi.edu
- **San Jose State University**: Jim Beck, Director of Lifelong Learning, College of Engineering , 408-924-3598, jbeck@sjsu.edu
- **Northeastern University**: John W. Cipolla, Chair, Mechanical, Industrial & Manufacturing Engineering, 617-373-3805, jwc@neu.edu
- **U.S. Coast Guard Academy**: Vince Wilczynski, Associate Professor, Mechanical Engineering, 860-444-8678, vw@alum.mit.edu
- **Virginia Polytechnic Institute**: FIRST Robotics: Dr. Leslie Graham, Electrical and Computer Engineering; FIRST Lego League: Bill Duggins, Computing Center, 540-231-8124, duggins@vt.edu

ASME & FIRST

ASME International (The American Society of Mechanical Engineers) is a 125,000 member professional association committed to technological literacy by supporting improvements in the quality of math/science education for grades K-12. ASME and FIRST joined forces through an agreement of affiliation whereby both agree to work together to foster technological literacy. Central to the partnership is ASME's commitment to extending the reach of FIRST.

ASME encourages its members to get involved at every level of the competition including sponsoring teams, joining teams, hosting FIRST workshops, and volunteering at FIRST events. ASME sponsors a college scholarship for FIRST participants who are nominated by ASME members from their team.

Another perspective on the role of FIRST for universities was reported by ASME in a series of articles entitled "Wrangling Robots Inspire Engineers of All Ages" in ASME's *Mechanical Advantage* newspaper (September 2000, Volume 9, Number 5). That article is available at www.asme.org/mechanicaladvantage/September2000/robotics.html.