FIRST - Engineering Partnerships Between University of Wisconsin-Platteville and Platteville High School

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Abstract

The University of Wisconsin-Platteville College of Engineering, Mathematics, and Science has partnered with Platteville High School and Wisconsin Power and Light to participate in the FIRST National Robotics Competition for the second year. FIRST, which is an acronym-- For Inspiration and Recognition of Science and Technology, is a program initiated by Dean Kamen of New Hampshire to provide a stimulating engineering exercise to high school students around the nation. High school students partner with universities and/or corporations to build a "robo-gladiator," from a kit of parts and limited other supplies, which competes against those from other teams with diverse backgrounds. The competition brings the spirit of professional sports to engineering, science and technology. Teams have a tight time frame in which to build the robot and prepare it for shipping; and much preparation goes into the planning, designing, and strategizing. The high school students enjoy working on the university campus with college students and get an opportunity to experience engineering design and construction first-hand. In addition, AutoDesk 3-D Studio Animation software has been granted to each the university and high school. Students use this high-tech application in designing and programming a 3-D animation video for a separate concurrent competition. Students involved in the project gain exposure to multi-disciplinary work teams, technical writing, public relations with the media, and coordinating the logistics of a moderate-scale project. UW-Platteville has enjoyed its successful partnership in promoting engineering to high school students.

Introduction

As stated in their promotional publications:

> *FIRST is a nonprofit organization whose mission is to create a demand for science and math learning. This effort is guided by a coalition of national leaders from business, government, education and the media. The FIRST Competition is the national creative engineering contest featuring school, business, and university partnerships. Played out in the spirit of sport, the Competition immerses high school students in the exciting world of engineering. Teaming up with engineers from businesses and universities, students get a hands-on, inside look at the engineer's profession. In seven action-packed weeks, students and engineers work together to brainstorm, design, construct and test their "robo-gladiator" which competes in national tournaments complete with referees, cheerleaders and time clocks. The result is a fun, exciting and stimulating environment in which students can discover the important connection between classroom lessons and real world application.*

The Annual FIRST Robotic Competition has been held since 1992. Each year the participation in this event has increased. The rules, the object of the game, and the playing field change each year and are announced at a Kick-Off Workshop held in January of the year. Some teams have been known to be so competitive as to fax 100 pages of rules back to their team at home so that no time would be lost to the competition. A kit of various parts to be used in the robot construction is also distributed at the Kick-Off workshop. The kit includes the remote control system and radio transmitters for each team; it is the only authorized control system as it limits the frequencies used at all Competition events and provides equal capabilities for all robots. Also included in the kit of parts are electrical components, such as wires, switches, servos, valves, and power connectors; motors and batteries; hardware, such as bearings, shafts, rods, springs, fasteners; and sample materials of wood, PVC, copper and conduit pipe, aluminum plate, fiberglass and polycarbonate sheet, which may be purchased in limited larger quantities. Following the Kick-Off Workshop, each team has about six weeks to prepare for the Competition.

Preparing for the Competition

UW-Platteville became involved in FIRST in January 1995 after receiving information on the Competition from Governor Tommy Thompson's office. After deciding to pursue involvement in the program, Wisconsin Power & Light was solicited as a corporate sponsor, and Platteville High School was invited to be our partnering school. Platteville High School is an ideal school for participation in this program, due to their strong Principles of Engineering course. The high school students had previously been shown ESPN footage of the Competition, and were excited to get an opportunity to participate as part of their class. With a couple of informational meetings and word of mouth, the college students also joined the effort enthusiastically. The team consisted of about 25 UW-Platteville engineering students, 5 college faculty and staff, 16 Platteville High School students, and 3 high school teachers.

We started the project with brainstorming sessions to develop ideas on team name, robot design, and competition strategies. In order to accomplish all of the tasks that are associated with an endeavor of this type in a six week time frame, the large team was divided into functional subgroups. The functional groups included robot design and construction, practice field construction, team logo and 3-D Studio animation, budget and fundraising, and public relations. Each group was assigned a faculty advisor and student leader, and was given a schedule of milestones needed to be achieved in order for our team to get to the competition with a robot. The choice to use functional groups permitted students to focus on a manageable task of the project in which they had a particular interest.

The robot design and construction group discussed theories for offensive and defensive strategy. This group also designed and built the robot, its motion and control systems, and its ball handling and scoring elements. They determined pit crew membership and supplies required during competition. Small groups within this functional group's membership were responsible for specific parts of the design and construction: the chassis, the propulsion and drive mechanisms, the arm/gripper, controls strategy, and rule interpretation and compliance.

The practice field construction group constructed an easily transportable replica of the playing field for practice purposes. The field included a speed bump, ramp and goal. After the robot was built, high school students had an opportunity to test-pilot the robot to get accustomed to the radio control and how the robot handled the balls. There was also the potential of setting up of the field and inviting other area teams for a scrimmage before or after the actual competition, if time permitted.

The team logo and 3-D Studio animation group was responsible for designing the team logo for use on the robot, team t-shirts and hats. This group was also involved in producing a two-minute animated video of the logo and/or robot using AutoDesk 3-D Studio, a professional animation package. Two copies of the AutoDesk software, valued at $24,000, were received as a grant from AutoDesk. Students created a computer generated animation to enter in a separate, concurrent competition. Animation entries were displayed on a video screen during events at the Competition.

The budget and fundraising group wrote proposals to various campus and corporate offices to obtain funding beyond our corporate sponsorship. This group was also responsible for managing the budget including purchasing components for robot construction. The travel arrangements, such as arranging for a coach bus for the 24-hour ride to Disney World, disseminating information to the team, and taking reservation information and deposits, also became a responsibility of this group.

The public relations group coordinated media coverage including writing press releases, organizing television, radio, and print coverage, and helped coordinate the production of a promotional video of the team and robot, which was professionally prepared by the UW-Platteville TV/audiovisual broadcasting program. The FIRST team received much positive media attention, such as several front page articles with pictures in our local paper, as well as in nearby Dubuque, Iowa, articles in the university publications to campus and to alumni. The team also received television news coverage, and the competition itself was broadcast by the USA cable network.

With each of the functional groups working rigorously on their assigned duties, and putting in long hours over the six weeks of robot design and construction, the robot was ready to be shipped compliments of United Parcel Service, one of the many FIRST in-kind sponsors. The team was anxious to follow to sunny Florida to put their robot up against those from all over the country.

The Competition

The FIRST National Robotic Competition has been held at Walt Disney's EPCOT Center since 1995. This location makes the trip to the competition even more exciting. Some of the high school students had never been more than 100 miles from Platteville and so, for them, just seeing Disney World was an adventure. The competition was held on a large, outdoor stage. Many visitors to EPCOT saw at least a brief glimpse of the competition as they passed. Some stayed to watch and talked with various team members to find out what the competition was all about.

Disney and FIRST arranged accommodations and special transportation within Disney World. For a reasonable price, team members stayed at a hotel within Disney World, had access to all of the Disney parks, received coupons redeemable for two meals each day, and could take home a commemorative shirt. Each team was assigned a station in a pit area near the competition's playing field. This allowed teams space to work on their machine and make repairs as needed. Teams were also allowed access to Disney's extensive machine shop and technical staff. One year, our team spent a great deal of time in the machine shop trying to repair the robot arm. The students had many interesting stories about how various mechanical/electrical devices within the Disney attractions operated.

The competition was scheduled over a three day period. The first day was spent handling preliminary activities. After arriving at EPCOT, the team assembled the machine (which was shipped to EPCOT a few weeks earlier). FIRST officials then inspected the machine for compliance with the rules -- checking weight, height, materials used, and operation. The team was assigned times to practice operating the machine on the actual playing field. This provided valuable experience for the high school students operating the machine. It also allowed the team to meet a few other teams which were also practicing simultaneously.

On the second day, each team played in five seeding matches against randomly selected teams. The outcomes of the seeding matches were used to determine a team's starting position in the tournament. During times when our team was not scheduled to be in competition, many team members saw various attractions within Disney World. A small group of scouts watched each team compete. Those scouting notes provided valuable insight into how our opponents played the game.

The third and last day of the competition, a double elimination tournament was held and was followed by an awards ceremony and wrap party. With three teams competing in each match and two playing fields, the field of more than 60 machine was reduced to only eight in a few hours. Quarter-, semi-, and final matches were watched by all of the teams. An announcer talked to the crowd to get everyone excited and the speakers blared rock 'n roll music between matches. The atmosphere was very similar to a major sporting event. Team mascots lead cheers. The crowd danced in the aisles. The announcer directed the crowd in "the wave". To show their team spirit, a few members of one team shaved their heads and spelled "FIRST" on their heads! The awards ceremony was held near a main walkway in EPCOT and many people watched. The ceremony was exciting. Along with a few speeches and presentations for numerous awards, the ceremony had fireworks, dancers, and -- best of all -- video clips from the competition. The wrap party gave all the teams a chance to talk about the competition and what they were planning for next year.

During UW-Platteville=s two years of participation, some valuable lessons have been learned. Some of the most valuable lessons are listed in Table 1.

Table 1. Lessons Learned

1. Start as early as possible.
2. Let each student work on an area that interests him or her.
3. Get as many people involved as possible.
4. Hold meetings of the whole team to keep people informed of progress on all fronts.
5. Compromise, mutual respect and communication will make the team successful.
6. Let everyone contribute ideas for overall strategy, team logo, and animation story.
7. Take more spare parts to the competition than you think you will need.

1. Start as early as possible. It is difficult to convey the massive scope of this project. There are three distinct, but inter-related competitions: Robotics, Animation, and Chairman=s Award. Each competition has its own specifications, requirements, and rules. Each allows about 8 weeks between the announcement of the rules and the submission deadline. Each requires a different set of activities, resources, and talents. In addition, the team must complete support activities such as designing a team logo, team shirts, writing a team profile, and making travel arrangements to attend the competition. Starting early is definitely critical. Before the year=s rules are announced, it is important to begin what is not dependent on the rules - pick a team name, design a logo and shirt, begin writing a team profile, watch videos of past competitions to get ideas of different strategies, and begin making travel arrangements.

2. Let each student work within their interests. This project should be enjoyable while also providing a learning experience. Students should be free to choose to participate in as many different (or as few) activities as they wish. Many of the new students on the team are most comfortable in contributing to non-technical activities. These students can design team shirts and contact vendors, write letters to sponsors, and take photographs during meetings and work sessions. While not directly assisting with the design or construction, these students benefit from the exposure to the engineering process. Students interested in helping with the design and construction of the machine or in computer generated animation have been reluctant to assist in writing press releases, taking photographs, or doing other tasks that are not directly involved with the technical aspects of the competition; therefore, for our team, it has worked best to let students participate in the areas of their interest or talent.

3. Get as many people involved as possible. Since our team is comprised of students who have other course and extracurricular commitment, it is important for us to have a large number of people participating in the FIRST project. The team works to attract students with interests and talents in different areas. Along with this diversity comes the responsibility of the team leadership to ensure that each student feels that they are making a valuable contribution to the team=s success.

4. Hold meetings of the whole team to keep people informed of progress on all fronts. To ensure that everything gets accomplished on time, it is necessary that small groups of students take on the responsibility for specific tasks. For example, there have been about 8 students interested in the robot=s control system, between 6 to 10 students interested in computer animation, about 12 students willing to help build elements of the playing field, and a few students interested in designing a team shirt. Meetings of the full team are help to keep each small group informed of activities of other groups. By sharing each group=s successes (or obstacles), students gain a better understanding of the whole project and see the value of their personal contribution.

5. Compromise, mutual respect, and communication will make the team successful. In this project, ideas must be generated quickly and decisions must be made quickly. However, quick response is not the only key to being successful. Students learn the value of compromise and mutual respect as they share and discuss ideas. They discover that everyone=s input is valuable and needed. Many times ideas are combined or modified during discussion to generate a new and better idea. This occurs most often during discussions of strategy, machine design, animation story board, and logo design.

6. Let everyone contribute ideas to overall strategy, team logo, and animation story. By discussing strategy, logo, and animation story with the whole team, students feel some ownership - even in areas on which they did not directly work. This takes advantage of the creativity of the whole team and ties into items 2, 3, 4, and 5.

7. Take more spare parts to the competition than you think you will need. During the actual competition, machines get jostled, bumped, pushed, and possibly over-turned. The machines weigh about 120 pounds and can travel at surprisingly rapid rates. While opponents can not maliciously attempt to harm another team=s machine, a team can pretty much count on the equivalent of body-checking in every round. Having a generous supply of spare parts can make repairs on the fly possible.

Feedback from students

One of the unique aspects of our team was that students designed the machine and assisted in the construction. Most teams have practicing engineers do most of the machine design. Our team consists of only university and high school students with a few faculty and support people. The university and high school students design the entire machine themselves. Upper level university students assist during the construction and many other students watch and pray during the construction. The animation is similarly done exclusively by students.

Both high school and university students enjoy the challenge of starting with the rule book and taking the project through all of the necessary design phases to have an operational machine which successfully competes against machines built by other teams. Students are inspired and impressed that their machine can hold its own against machines built by teams with corporate partners like Texas Instruments and NASA, and universities like Rensellear.

Students learned to work within a group. Especially when selecting a strategy, the team members learned to discuss and compromise. Time management skills were also improved as students tried to schedule work sessions while maintaining their normal load of studying, work, and assignments. Communication was a vital element. Without clear communication between groups working on various aspects of the machine, construction would be nearly impossible. The animation group also needed to be kept up to date on the overall strategy and machine appearance. The e-mail distribution lists and central bulletin board for updates were key in facilitating the communication among team members.

One of the things students mentioned as having enjoyed at the competition was just seeing the huge variety of designs. Almost every design or strategy our team discussed was incorporated into someone's machine. No two machines were identical. The diversity of the designs was amazing and wonderful to see. It made the competition much more interesting because each team was unique -- with its own machine and a strategy built around the capabilities of the machine.

For UW-Platteville students, several mentioned that participating on the FIRST team had reinforced their career choice (particularly of EE for some reason -- several mentioned being unsure, but seeing the seniors having such fun with the control systems inspired the younger students to stick with it).

Future plans

Happily, after last year's competition the students have taken the initiative to organize themselves into a continuing group. In May, officers were elected to the posts of design leader, treasurer, public relations director, and animation leader. Each post represents two positions -- one filled by a high school student and one by a college student. The officers are planning to hold meetings twice per month September through December and at least weekly January through March. Each meeting will have a technical session such as AutoCAD instruction and an activity session such as creating a team name. As students take over these responsibilities, faculty can focus on another major obstacle -- finding a source of funding.

We are beginning to draw students from non-engineering areas to help with the non-engineering facets of the team and the competition. Public relations and communications majors are being actively recruited. The photographer/reporter, who attended one meeting as a student working part time for a newspaper, is now a member of the team, and is being asked to take a leading role in getting the team's media coverage.

Conclusions

FIRST has been an excellent program in which to provide high school students with an exciting first-hand experience of multi-disciplinary engineering design and construction in action. This program has provided high school and college students with opportunities to develop time management, interpersonal, and communication skills. FIRST also serves to promote engineering and technology as a rewarding career choice to students who might not have otherwise considered it. Through UW-Platteville=s involvement in FIRST, we have developed a strong link with our community, and have received recognition in doing so. Furthermore, this program has served as a recruitment activity for our college and university admissions. Since our involvement in the competition, each fall some of the students who participated as high school students have joined the student body at UW-Platteville, with 2 or 3 each year registering as engineering students. Several of these students have continued to participate in the FIRST team as college students. One student, who participated on a different FIRST team in high school, has participated on our team as a college student. UW-Platteville looks forward to continuing its partnership with Platteville High School in competing at the FIRST National Robotic

Competition -- a program that provides our students with the popularity of an athlete and the respect of an engineer.

Biographies

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