FIRST Robotics in the University Environment

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***Abstract*—FIRST Robotics seeks to address the deficiency in science and engineering programs in grade school education by setting up a mentorship system in which high school students are challenged to design and build a robot in six weeks. The large-scale and cross-disciplinary project involves current and future engineering, computer science, business, graphics, and marketing majors. This paper discusses university participation in the competition as mentors.**

***Index Terms*—Creativity and design, electrical engineering, FIRST robotics, innovation technology, interactive education, interdisciplinary teams, K-12 education, mechanical engineering, mentorship, project-based learning, technical elective.**

I. Introduction

FOR Inspiration and Recognition of Science and Technology (FIRST) Robotics is an international competition created in 1989 to increase the level of student interest in science and technology. Through the competition, high school students are challenged to design and build a robot to accomplish a specific task in just under seven weeks. FIRST Robotics creates a multi-level collaborative environment by building a continuum of growth and interaction between different levels of technical expertise. During their education, students progress through increasingly more complex tasks of technical innovation and creativity and are eventually prepared for technical entrepreneurship.

In the competition, the high school students are guided and mentored either by corporate sponsors or by university student-peers. The intent of this paper is to underscore the benefits of university participation in the competition.

The University of Washington offers a two-course sequence focusing on FIRST. This approach, combined with the next-step mentorship, and a year-round structure, introduces the students to engineering in a stimulating and invigorating manner, and provides a realistic model of a corporate environment.

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II. Motivation

Technical leadership in the United States relies on a highly skilled high technology workforce [1,2]. Quality of life in developed countries increasingly depends on technological advances, as well as on societal changes that affect disadvantaged groups. American colleges and universities, however, are not graduating enough skilled individuals with expertise in technology and engineering to fill positions in government agencies, industry, or academia [1].

The existing appeal of science and engineering professions to youth is disproportionally low in comparison to the societal importance of these disciplines. Much of these problems are caused by weak K-12 education. In 1998, 28% of seventh and eighth grade math teachers in the United States were not certified to teach math, and 27% of science teachers at those grade levels were not certified to teach science [3].

Understanding of real career options comes to many students late or never, and their personal growth suffers from the lack of information and the lack chances to explore meaningful possibilities. The economically disadvantaged groups of our population are particularly vulnerable to this phenomenon, due to lack of counseling and absence of positive role models. Changes in the educational opportunities available to students, such as the Algebra Project, [4] can improve this situation. Unfortunately, most existing programs do not accurately reflect the key features of science and engineering fields, reducing studies to rote memorization of concepts and principles.

Even project-oriented classes fail to provide a sustained focus of individual interest and to promote excitement about science and engineering. School teachers have to follow the pragmatic path of assigning smaller, disjointed projects, because the logistical details of such projects are more manageable. Lack of resources and expertise reduce hands-on experiences to small group "design projects" in which students follow specific directions for assembly of a device or programming of a simple task. Without authentic context, glamour of a worthy endeavor, recognition by peers, and interaction with many partners in a complex project, some students perceive science and engineering projects to be formulaic exercises of interest to only a narrow range of enthusiasts. Without having a learning context that encourages technical creativity and provides a test bed for exploration and application of ideas, these efforts can fail to pull a diverse range of students into authentic inquiry that they find personally captivating. Project-based approaches need to connect to the disciplinary problems and practices of the fields in question in scaffolded ways that are appropriate for learners [5,6].

While many teachers recognize the need for more comprehensive and multi-faceted educational experiences, they lack the experience, resources, and clarity of goals that collaboration with a larger team, including university faculty and students, can provide. Large teams can give a project leverage from relevant distributed expertise amongst the team members [7,8].

The FIRST Robotics program is an experience designed to present science and technology to students in an interactive and exciting manner. The challenging, competitive environment, the professional facilities and materials, and the large scale of the project, culminated with the actual regional and international competitions, redirects the spotlight previously aimed at sports to the activities of engineers and scientists [1]. FIRST Robotics draws participation of over 30,000 high school students and a comparable number of their mentors.

The mentoring by corporate sponsors and government labs has been successful in generating interest and enthusiasm of all participants [1]. However, one of the most effective forms of mentoring, by the "next step" peers, such as undergraduate students, has been less successful. Most universities have not yet found an effective model for collaboration with high school students that goes beyond informal voluntary interaction. Interaction between university students and schoolteachers is even more scarce [9]. Partnership-based approaches [7,8] provide insights about how such efforts might be orchestrated, although they have not been applied to the coordination of large team efforts with heterogeneous expertise and authentically interdependent activities. The FIRST project incorporates such strategies and formalizes features absent in other models. Creation of a reproducible model that incorporates large projects into the university and K-12 curriculum in an integrative way would benefit similar projects nationwide.

Here, a large-team, large-project, high-stakes technology activity involves simultaneously a high school, a university, a company, and community on equal footing in pursuit of a common goal with many interdependent forms and phases of activity. The advantage of this model is that each participant feels he is a part of something great. The implementation difficulty is that the multitude of required activities precludes their incorporation into university and high school curriculum, limits development of instructional materials, and often creates conflicts of interest among the involved parties.

Another significant problem faced by the engineering community is the frequently encountered false assumption about the homogeneity of activities in the technical world. Dispelling the myth of solely technical and mechanical orientation of technology projects is one of the most significant aspects of this effort. For example, many people perceive the activity of a robot design team as a linear sequence of mechanical, electrical, and programming operations. The rich world of 3D animation, web design, aesthetics of implementation of solutions, media relations, human-computer interface, and many other aspects of information technology remain unknown to outsiders. The FIRST project involves collaborative problem solving, marshalling the distributed expertise of team members, systematic communication with the public, management of substantial budgets, sustained problem solving during design and development, fluency with technical standards and protocols, coordinated technical specification and documentation, as well as exploration of the legal aspects of the technical world. Consequently, all participants are able to deeply explore the possibilities of careers in high technology fields. Helping students overcome a fear of being an outsider is most critical, especially for traditionally underrepresented groups. A large project team is an excellent mechanism for addressing this issue.

The challenge of a large diverse project team is to keep participants with enormously diverse backgrounds productively involved and interested. The educational process should promote individually motivated learning and identity development, while maintaining the motivation of the overall success of the project. This project allows high school teachers and students, university staff and students, and practicing engineers to appreciate and learn from the same series of learning experiences and tools.

III. Philosophy of the Competition

The rules of the competition are designed to place teams on equal footing by limiting the types and costs of the materials used. These specifications promote teams with higher levels of competitiveness, dedication, and creativity, instead of those with larger budgets. The size and weight of the robot are also limited, to teach participants to optimize the desired parameters while maintaining quality.

Creativity of the participants is further stretched by the need for a unique concept and implementation for each competition. The tasks which the robots perform, as well as the field complexity and layout, change every year. Moreover, the competition is structured in such a way that other teams are randomly assigned partners for the seeding matches. This tests the teams' abilities to work in different alliances, in which they must adjust to ranging robot capabilities and produce a winning combination in a short span of time. Teams must make the decision whether to build a robot which would play to specific strengths and gamble that their partners would have complementary abilities, or to design a robot that is not particularly strong in any area, but without specific weaknesses.

The game is designed so that a sizeable team would have an increased ability to succeed. The multifaceted nature of the competition lends itself to a directed effort by multiple interconnected groups, comparable to the operations of a small entrepreneurial company. Subteams perform best when participants focus on one or two of the vast variety of areas available, which include mechanical engineering, electrical engineering, web design, marketing, finance, photography, video, animation, and graphics. This approach encourages intra-team interaction and communication, two highly valued skills in industry work.

IV. Pacific Northwest Regional

A. Introduction

The regional competitions place teams into a drastically different environment for testing their product. Teams are provided with tight, constrained workpit areas. The regional and subsequent international competitions represent the culmination of hours of dedication and labor. The flashy displays attract the public and inspire interest and excitement. Such events create a liaison between the university and the surrounding community and turn the university into a hub for technological ideas and innovation.

B. Organization

FIRST holds twenty-three regional competitions throughout North America, which attract teams from the United States, Canada, Brazil, Germany, and the United Kingdom (as of 2003). The competitions are organized by FIRST-recruited volunteer communities.

The regional competitions are three-day events. The first day is dedicated to unpacking, registration, inspection and practice rounds. Seeding matches and the elimination rounds happen during the second and third days. During the three days, the teams have access to their pit areas, on-site machine shops, and FIRST-supported spare-part vendors.

The FIRST competitions attract participants, sponsors and media from all over the world. The 2003 Championship competition in Houston, TX is anticipated to draw over 20,000 visitors and generate approximately 10 million in tourism revenues for Houston businesses [10].

C. Statistics

The following data compares teams with the university involvement to those without were obtained by surveying teams attending the 2003 Pacific Northwest Regional competition.

1) Size: Factors that positively affected team standing in the seeding matches were team size, experience, and structure. The average team size was 19 student members for teams without university participants, compared to the significantly more numerous 39 student members in teams with university participation. Fig. 1 shows a minor trend toward superior performance of teams with a larger number of members. Larger teams have more ideas, potential, peer encouragement, and manpower. A significant number of people allows for the subgroup-based hierarchical structure of professional organizations. The need for intra-team communication and conflict resolution is exacerbated, leading to greater level of involvement for successful team members.

2) Experience: Fig. 2 indicates a positive correlation between the experience in the competition and rank after seeding matches. It usually takes two to three years before the team is operating at its full potential.

3) Team Composition: Seven out of 37, or 19 percent, of the teams at the Pacific Northwest Competition were collaborating with a university. University mentors comprised an average of 22 percent of the team membership.

Three out of the seven university teams presented the FIRST competition through a formal class. Team 824 offered a course through the university, open to high school students for auditing. Two other teams (190 and 233) incorporated FIRST into the high school curriculum. Historically, these three teams performed better in the competition than the teams without a formal class structure: team 233 championed the Pacific Northwest Regional, team 190 placed third in the seeding matches and reached the elimination quarterfinals, and team 824 reached the divisional elimination quarterfinals in the 2002 international championship.

4) Female participation: The FIRST Robotics competition strives to be an outreach program toward females and minorities. In 2003, females comprised approximately 25% of the teams at the Pacific Northwest Regional. The average number of females in teams with university affiliation was much higher, at 10 per team, compared to four per team without university involvement, as shown in

Fig. 3. This increase may be related to the increased encouragement, role models and opportunities presented to females in post-grade school education. Camaraderie is formed between university and high school females as a result of the FIRST project, which allows them to support each other in a tough, male-dominated field.

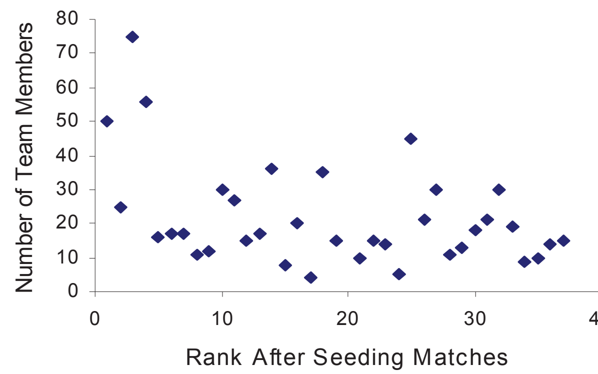
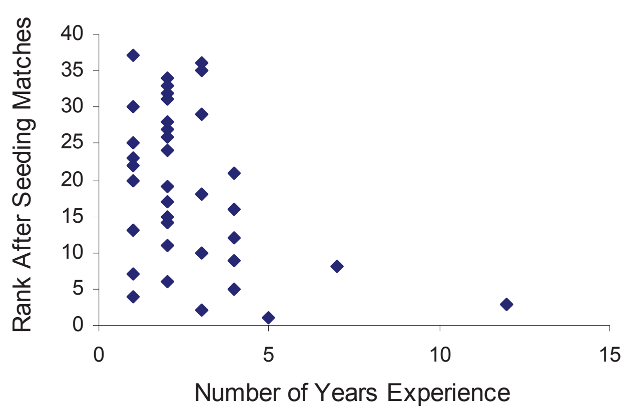


Fig. 1. Team size versus rank after seeding matches. Three out of the top four teams had the largest number of members at the 2003 Pacific Northwest Regional.



F ig. 2. Rank after seeding matches vs. team experience. The five most experienced teams at the Pacific Northwest Regional placed within the top nine after the seeding matches.

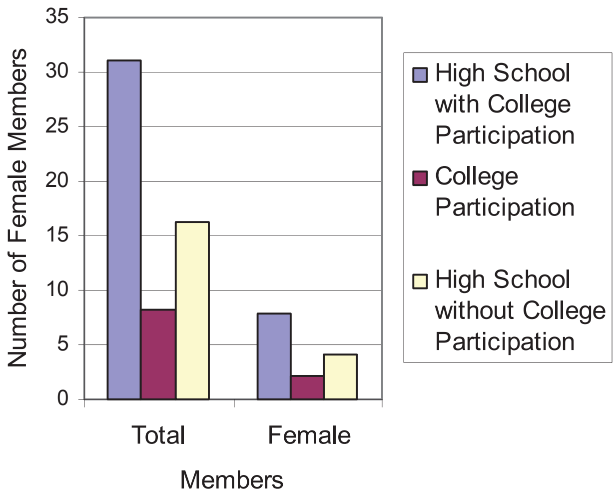


Fig. 3. Female participation at the 2003 FIRST Pacific Northwest Regional Competition. There was a significantly larger amount of female participation for the teams with university involvement. Female participants comprised an average of 25 percent of the teams in the three categories.

V. FIRST IN THE UNIVERSITY ENVIRONMENT

A. Mentorship

Mentorship is an essential aspect of FIRST. FIRST provides mentorship by other schools, by corporations, and/or by universities. The last possibility is frequently the most natural and the most effective. University students form the natural "next step bond" between high school and the professional world. Next step mentors are advantageous because of their similar mentality and positive peer influence. The university students may share their experience and offer advice to the high school students, who often value the opinions of the "next step" peers more than those of adults. Reciprocally, university students reinforce their own knowledge through instructing the high school students. University involvement also magnifies the scale of the project, altering and increasing the importance of the organization and structure.

B. Benefits of University Participation

University involvement in the FIRST Robotics competition proffers benefits to all parties involved. FIRST presents a real engineering problem in the form of robot design and fabrication and provides a practical design project basis. Participation in FIRST gives students an excellent opportunity to experience the design process first-hand, instead of vicariously, through books and lectures. Students are exposed to the technical, social, and logistical aspects of a large-scale engineering project.

In addition, participation in the competition provides opportunities for community involvement, corporate support, faculty development, and student recruitment. The university gains visibility, develops high school and cross-departmental connections, and builds a sense of community. As different schools within a university frequently have minimal interaction, a common problem also faced by corporations, is the inability of individuals from different departments to communicate ideas efficiently [1]. FIRST fosters interaction between university students and high school students, cross-departmental university students, students and faculty, and other uncommon intra-university collaborators.

C. Obstacles

There are many challenges inherent in the implementation of a large-scale project such as this. FIRST is an expensive endeavor, costing teams from 9,000 to 60,000 dollars per season for materials, registration, and travel. Faculty members and students may be uninterested in becoming involved in such a time- and resource-consuming project. Another drawback is a timing and duration mismatch with the academic calendar: the six intense weeks occur in the beginning of the winter quarter or second semester, but last only until the middle of February. It is difficult to structure student efforts for academic credit, both due to the multi-departmental aspect and the inconvenient scheduling [11]: because the project takes place early in the second half of the school year, the shop and lab access needed for the robot construction are also in high demand by other projects [11].

D. Implementation

The Worcester Polytechnic Institute (WPI), Ohio State University (OSU), and the University of Washington (UW) are three universities that participate in the FIRST robotics program. In order to resolve the issue of academic credit and the burst of activity in the middle of the academic year, the UW presents FIRST as a two-quarter course sequence. The class is offered during the autumn and winter quarters. UW is unique in its method of resolution for this particular issue. OSU [12] and WPI [11] have offered FIRST as a class for departmental credit, but instead structured the classes to be offered during the winter and spring quarters. The advantages of an autumn and winter quarter sequence are that students have the opportunity to become acquainted with each other before the six week burst, go through organized training, and have a more fluid cycle of activities. The training period gives students a higher chance to use calculated planning in their robot building, based on science and mathematics instead of haphazard construction. The disadvantage of using autumn and winter quarters instead of winter and spring is that there is no structured opportunity for in-depth analysis of the flaws and advantages in the robot design after the competition. Even though several weeks remain in the quarter after the completion of the building season, the students are frequently burnt out by the project. An additional quarter would allow a detailed and applied breakdown of the season's work and a structured strategic preparation for competition.

E. Course Structure

The two-quarter sequence is offered to the university students, but encourages high school participants to attend. The autumn quarter covers engineering creativity techniques (such as the Theory of Innovative Problem Solving), project management and team building, concept selection and project planning, reverse engineering, research methods for technical literature, hi-tech startup structure, machine shop training and certification, and review of previous FIRST events. Winter quarter includes the six intense weeks where the participants apply what they learned into a practical application and the reflection and analysis of the six weeks. University of Washington students are given independent study credits towards their major for participation in the project. The course sequence also satisfies the senior capstone requirement for engineering majors.

Other universities also incorporate FIRST into their curriculum. WPI, for example, has a degree requirement called the Major Qualification Project (MQP) that requires students to demonstrate their ability to integrate the fundamental engineering, mathematics, and sciences into the solution of a "real-world" design activity. The concern of WPI is that the duration of the building period of the project is brief, causing the science and math of the project to be analyzed more thoroughly after, and not during, the project [11]. The duration of most MQPs lasts three quarters.

OSU also offers a course based on the project. The course, titled Introduction to Engineering Design, focus on students' exploration and analyses of the robot they constructed for strengths and weaknesses on the basis of physics theory [12]. The course also teaches the economic theory involved in the project, as well as creativity, critical thinking, teamwork, and leadership.

The United States Coast Guard Academy teaches an Introduction to Mechanical Engineering design course based around the FIRST EduRobotics Rapid Prototyping Kit. The teams of students use the kit materials to construct robots to simulate a maritime mission [13].

F. Facilities

The University of Washington /Roosevelt High School FIRST robotics team (henceforth referred to as team 824) concentrates its facilities at the university. The variety of technically advanced facilities needed for a FIRST team is often easier to attain at a university than high school. At the same time, there are many examples of successful space arrangements in high schools nationwide.

Modularity is important for accommodating the different purposes needed throughout the project. Modular spaces provided by the University of Washington include meeting areas, a computer room, a large open-spaced room, a machine shop, and an area to set up a mock-playing field.

The team members need access to classrooms and conference rooms for team and group meetings. Most meetings occur in rooms with a large whiteboard. In the development of ideas, the whiteboard is used for drawings, charts, and idea maps, which are captured with a digital camera and posted on the team website for reference.

The computer room is an area prioritized for graphics and animation groups. The university provides some computers, while others are brought in by team members. The additional computers are used to improve the efficiency of the "render farm" and overall productivity. All parts for the robot are modeled in a computer-assisted design program, SolidWorks. This tool is used to determine the realistic value of constructing each design, and the robot's conformance to the maximum dimensions and weight.

For the construction of the robot, there is a need for a large open-spaced room with workbenches to lay out and assemble the robot parts. Access to a machine shop is also important for the team members to manufacture the parts needed. At the University of Washington, the team is given access to the university machine shop, with special arrangements to allow high school students to assist in the shop under supervision. The team works on an evening schedule which avoids interference with scheduled machine shop classes.

A large open area is also needed for a mock setup of the competition field to test the robot. Testing with the actual surfaces and field size gives the drivers a realistic sense of traction, maneuverability, and amount of space to play with, preparing them for the actual matches.

G. Team Organization and Structure

Team 824 is led by an Electrical Engineering faculty member and a group of undergraduate students from different departments, including Pre-Engineering, Electrical Engineering, Computer Science and Engineering, Mechanical Engineering, Business, Biology, and Communications. The undergraduates and high school students hold the majority of responsibility for organizing and running the project.

Since the project is cross-departmental, team activities are interrelated. Fig. 4 shows the relationships and types of team activities: Technical, Humanities, Organizational, and Business/Marketing. Fig. 5 shows a simplified timeline of the team's yearly activities.

Team 824 is structured in a hierachical fashion, resembling a startup company. Fig. 6 shows a simplified structure. University students carry out the primary hierarchy, while the high school students mirror a similar structure. University and high school executives collaborate in decisions.

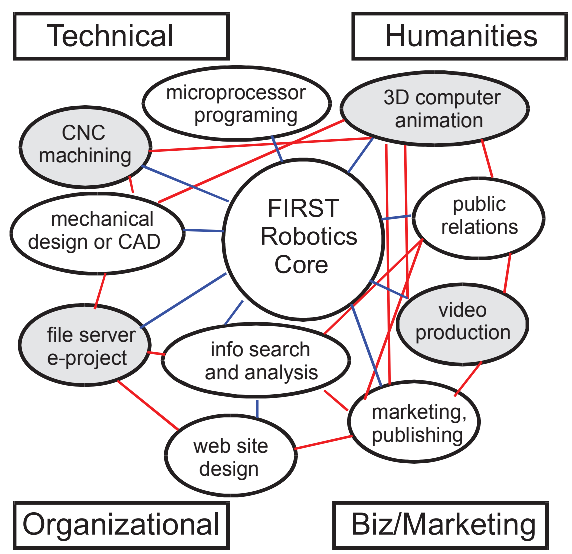


Fig. 4. Possible web-like structure relationship between individual elements of the team project. Non-shaded areas apply to the high-school level expertise.

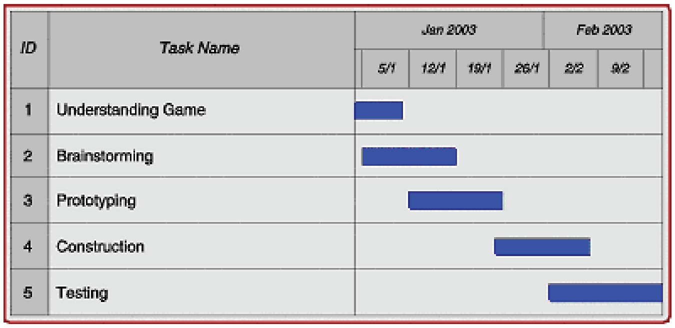


Fig. 5. Yearly cycle Gantt chart for 824's FIRST activities.

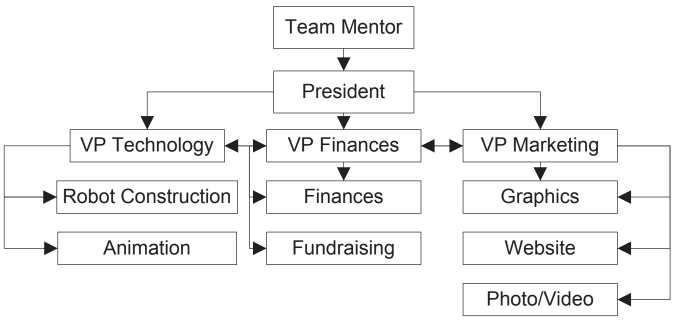


Fig. 6. Organizational chart of team 824.

VI. The Competition

A. The Game

The 2003 competition was played on a 54-foot long by 24-foot wide arena, as shown in Fig. 7. The playing field was enhanced by a platform accessed from each of its long sides by 8 foot ramps. Two randomly-assigned alliances of two teams each competed in every match. A match consisted of a 10-second Human Player Period, a 15-second Autonomous Control Period, and a 1 minute and 45 second Remote Control Period. The objective of each alliance was to move and stack plastic storage containers on its side of the arena. A detailed description of the rules of the 2003 competition may be found on the FIRST Robotics website [14].

Fig. 7. Arena setup used in the 2003 Competition.

B. The Robot

Building a robot for the FIRST robotics competition is an intricate process. The rules are complex, detailing the task description, financial and material limitations, the control system and power distribution, the supplier contact, and the safety procedures. Teams are provided with a kit of standard mechanical and electrical parts, including motors, sensors, and a radio control system, which allow for the immediate construction of a primitive robot. Each robot has a maximum weight of 130 lb, and must be able to fit unconstrained into a 30 in x 36 in x 60 in box.

Defensive capabilities are just as important as offensive capabilities, therefore, robots must be able to withstand substantial amounts of vigorous interaction with other robots or be extremely quick and maneuverable to avoid it.

Rules and restrictions are detailed for the software and hardware of the robot. The software must be written in PBASIC. The controllers to be used are provided in the kit, and other components such as motors must be either from the kit or on the restricted parts list. Following is information about subsystems built for team 824's 2003 robot.

1) Electrical: The electronics and control system was a complex, multi-faceted aspect of the project. This aspect can further be divided into three subsystems: electrical power distribution, on-board control system, and remote operator interface.

Power distribution was conceptually the simplest of the three, consisting primarily of integration of stock kit components, such as circuit breakers, pulse-width modulation drivers, relays, and motors.

The industrial design components offered the greatest latitude for creativity, innovation, and hands-on learning; students needed to devise the "best practices" and engineering standards for which to design a modular, maintainable, infallible system that was extremely space-efficient yet ensured effective heat removal and easy maintenance access.

An optional "Dashboard Port Interface" was also implemented. This combined a graphical display and a data logger for remote navigation sensing and robot system monitoring, designed to assist in troubleshooting and in competition driving. Implementation involved back-end protocol design and team development of a Java client application.

The on-board control system was the most complicated, involved, and innovative subsystem of the aspects within the electronics and controls. FIRST supplies each team with a complete control system kit, custom manufactured for the competition by Innovation First, Inc. The provided control system was the 8 MHz ATMega163 AVR RISC microcontroller running custom software, about 3500 lines of C code compiled with AVR-GCC. It is not essential to go beyond the basic functionality offered by the kit. Some teams, particularly the new teams, choose to use the provided parts with minimal modifications. The control system can simply be wired and used. However, most teams develop a custom control program written in PBASIC, a simplified embedded programming language, giving the team complete control over the robot via a more thorough engineering project.

Reflecting upon the team's past experiences and future ambitions, it was decided to follow the more challenging path and abandon the FIRST-supplied control system to the greatest extent permissible under competition rules, instead designing a custom circuitry and embedded system. The circuitry of the electrical system was designed in CircuitMaker, which was sent to Advanced Circuits, Inc. for printing. Fig. 8 shows the blueprint of team 824's electrical system.

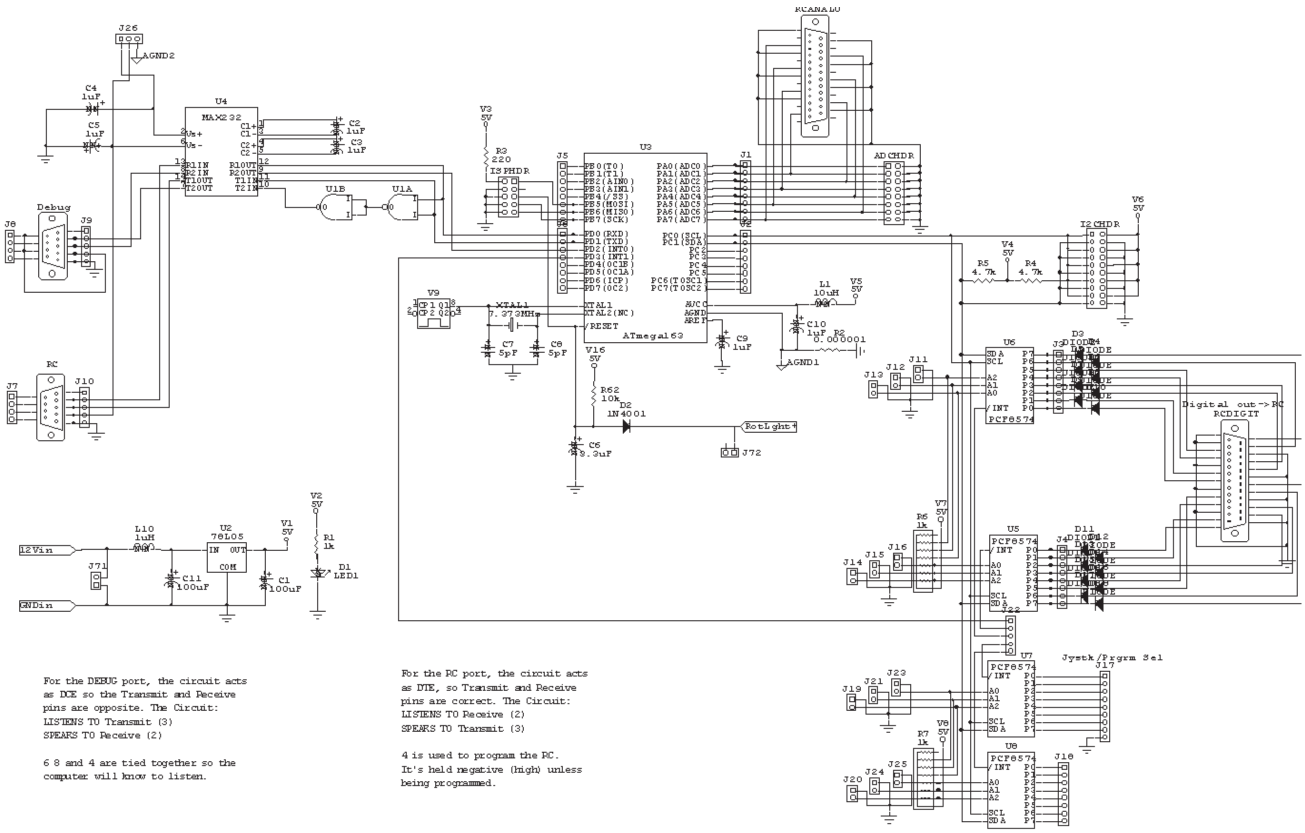


Fig. 8. Blueprint for UW/RHS robot's electrical system. Team members designed their own electrical system using CircuitMaker for greater efficiency and reliability in comparison to what was received in the kit of parts.

This approach offered a great deal of opportunity for incorporating sensors. Some were trivial to operate and integrate, such as the FIRST-supplied optical and pneumatic switches. Others were much more challenging, such as motor current monitoring, which required inexperienced students to design and build custom series resistance amplifiers. The most challenging task was the drive train shaft encoders, which monitored speed and distance. All sensors sent data directly to the microcontroller, and through the custom interfaces to the FIRST-provided black box, which read in packets updating all the remote control parameters, and in return, provided packets filled with relay settings, PWM duty cycles, and operator feedback data. Obstacles included appropriate sensor selection, system integration with the drive train, interface circuit design, real-time software drivers, fixed-point numerical analysis of results, PID feedback loop implementation, and debugging.

2) Mechanical: The drive train was another essential system of the robot. The robot had to be able to move in order to compete effectively. Below is a drawing of the drive train used in the 2003 competition by team 824. Implementation of this design presented many obstacles. Initially, the drive train was designed to have multiple speeds so as to quickly traverse the arena, win pushing matches, and plow through boxes. To achieve this, two of the kit motors were combined for each side of the robot, and custom gear set was fabricated to match their speeds. The two motors used on each side were the CIM model FR801-001 and Bosch 1/2" 12V drill motor. Each motor was capable of a maximum of approximately 1/2 hp, which produced a total of approximately 2 hp to drive the robot. With this setup, 260 lbs of forward force or a top speed of about 8 feet per second could be achieved. Time constraints forced the team to simplify the design, and remove the option for multiple speeds.

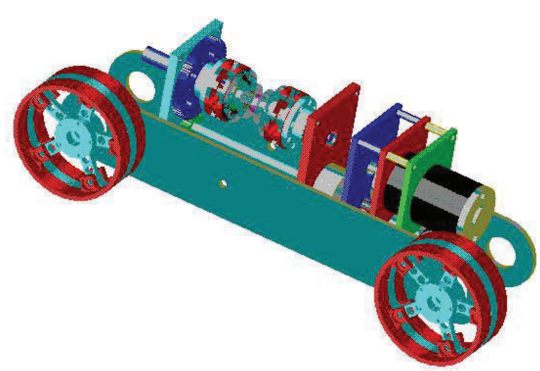


Fig. 9. One of the two drive pods for the drive train of team 824's 2003 robot.

Naturally, in the design process of the robot, some designs were used, while others were discarded. An example of an idea that functioned, but did not make weight restriction was the ratcheting system, as shown in Fig. 11. This system would allow the robot to travel under a horizontal bar on the side of the field, while passing its top over the bar.

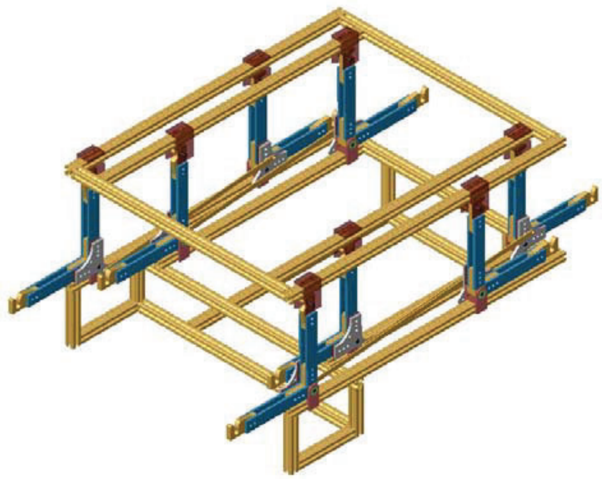


Fig. 10. The ratchet system was implemented to allow the robot to pass through the bar on the side of the arena.

Another system that was designed and built but not tested to reliability was the box manipulation system shown in Fig. 11.

Fig. 11. The robot with the box manipulation system extended during testing. Pneumatic pistons were used to extend the rails of the box manipulation system.

Additional experience was gained by students when components failed to work as intended. Further along the design process, the common practice of building a prototype was overridden by the need for engineering a solution to specific problems that required an immediate solution. Both the university and high school students were able to experience an actual engineering situation in which common sense, intuitive design, and practical concepts had to be supplemented by higher level engineering approaches [12].

C. Sub-Competitions

FIRST sub-competitions are an integral part of the project. The sub-competitions demonstrate the larger vision of FIRST: a project that is more than mere engineering exercises, turning the participants into well-rounded individuals.

1) *Chairman's Award:* The Chairman's Award was created to encourage FIRST Robotics participants to give back the knowledge that they received to the community. This award is given to the team with the greatest involvement in community education. The Chairman's Award is considered to be FIRST's most prestigious award.

2) *Autodesk Visualization Award:* Another notable award is the Autodesk Visualization Award. This award is given to the team with the best animation which creatively and clearly expresses the goals of FIRST.

3) *Other Awards:* Aside from the aforementioned awards, there are many other awards that recognize other forms of creativity, innovation, team spirit, sportsmanship.

VII. Conclusion

Students involved in this project gain exposure to multi-disciplinary work teams, technical writing, public relations with the media, and coordinating the logistics of a moderate-scale project. The program serves as an educational outreach tool, as well as a strong link between the high school, university, and surrounding community. The exploration of the next step mentoring of high school students by university undergraduate students is presented. The results of this project are encouraging and form the basis for continuing improvement of university and K-12 education.

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