Assessing Educational Needs of *FIRST* Robotics Competition Rookie Teams

An Interactive Qualifying Project Report

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Abstract

The rate at which students in the United States are pursuing and graduating with a degree in science, technology, engineering and mathematics (STEM) is declining steadily. Given the role of engineers in the world today; to meet the demand of society, there is a need to change this trend. *FIRST*, a not-for-profit organization is determined to fight this deviation by incorporating engineering through robotics competitions earlier in the lives of young students. The goal is to involve students in engineering, specifically the design and build of robots. This project is aimed at assessing the educational needs of students new to the *FIRST* Robotics Competition (FRC) and developing a set of requirements for an educational website. Using data collected by surveying students and mentors from the FRC community, this project provides recommendations for an online robotics learning resource designed to improve the retention rates of the competition through a support system for FRC Rookie teams.

Acknowledgements

In addition to our advisors, we would like to thank everyone who took the time to fill out our survey and give us personal feedback and recommendations. We would like to extend our thanks to Professor Skorinko, for aiding us in attaining IRB approval. We are especially grateful for the contributions of the *FIRST* Team 2191 for giving us the opportunity to discuss the proposed website with our target audience.

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Introduction

The report "Rising Above the Gathering Storm, Revisited" published in 2009, assesses the changes made in America, over the past 5 years, intended to improve the competitiveness of Americans fighting for jobs in the evolving world economy. The article states that while only 4% of America's work force is comprised of engineers and scientists, these individuals directly influence the jobs for the remaining 96% (Board, 2010, pp. 3-13). Figure 1 shows the average number of Americans employed in Science and technology from 1983 to 2007. Since 1983 there has been a gradual increase in the percentage of engineers in the workforce however, this number, only 4.5%, still remains very small.

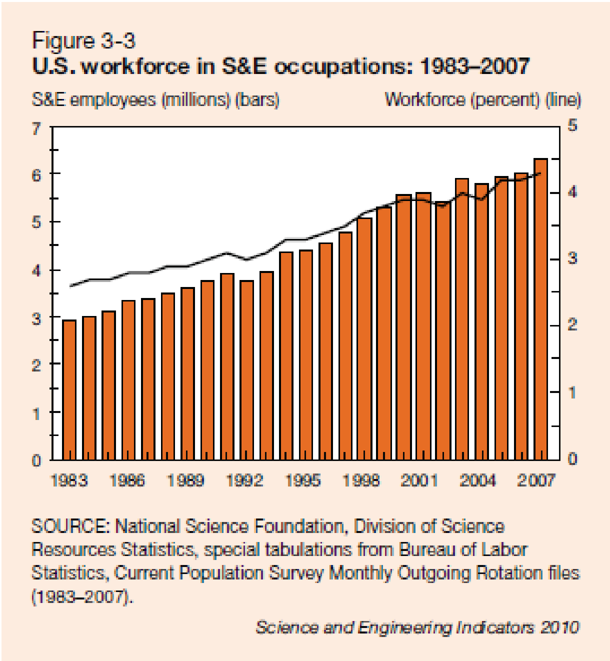


Figure 1: U.S. Workforce in Science and Education occupations: 1983-2007

The overall enrollment for students going into the engineering field has been stagnant from 1979 to 2007 (Figure 2); these numbers are discouraging because of the increase in the United States population; records show a population increase of 74.748 million from July 1979 to July 2007, an increase of 30%. For the past 2 decades according to data gathered from the annual Survey of the American Freshman, National Norms, administered by the Higher Education Research Institute at the University of California at Los Angeles, at least 1/3 of incoming University freshman intend on pursuing a degree in science and engineering.

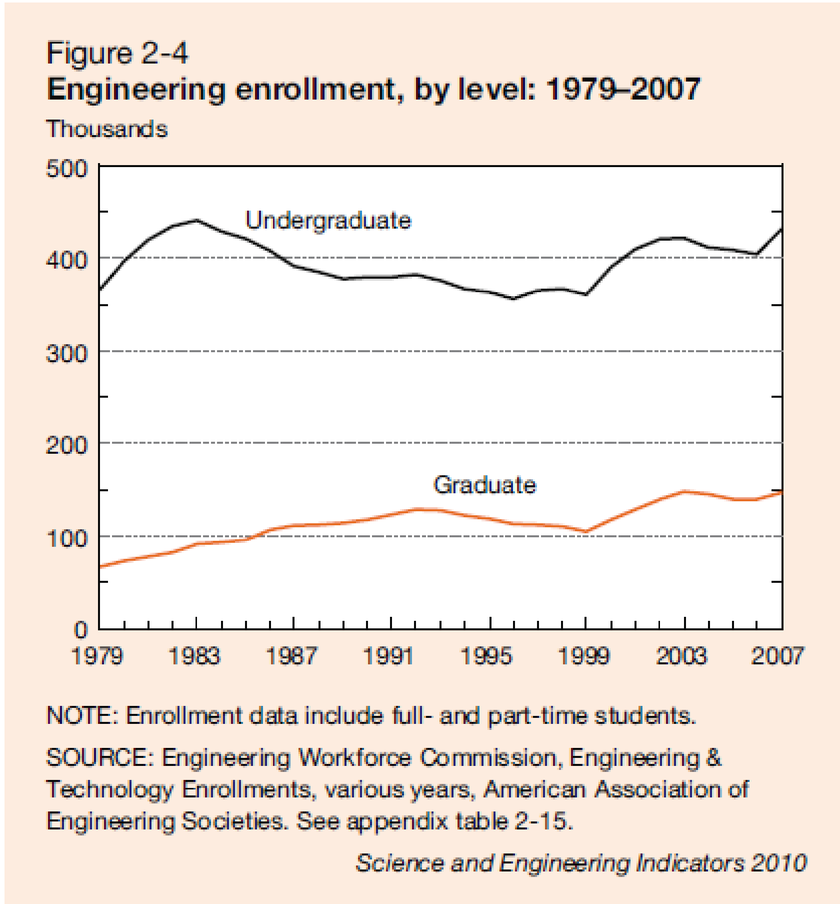


Figure 2: Engineering Enrollment, by Level: from 1979-2007

The number of students that graduate with an engineering degree however, is far fewer (Figure 3). The need therefore exists, to revisit techniques for teaching and motivating students towards pursuing STEM. In 2007 Science and Engineering associate's degrees, awarded in the United States, accounted for roughly 11% of all associate's degrees awarded. Though these numbers suggest a decline in the number of students pursuing and graduating with science and engineering degrees, the number of technical degrees awarded over the past 2 decades have been increasing and are expected to continue. These proposed early education changes will ensure that the United States remains competitive in the world, with regards to technological innovations (Board, 2010, pp. 2-13:2-15).

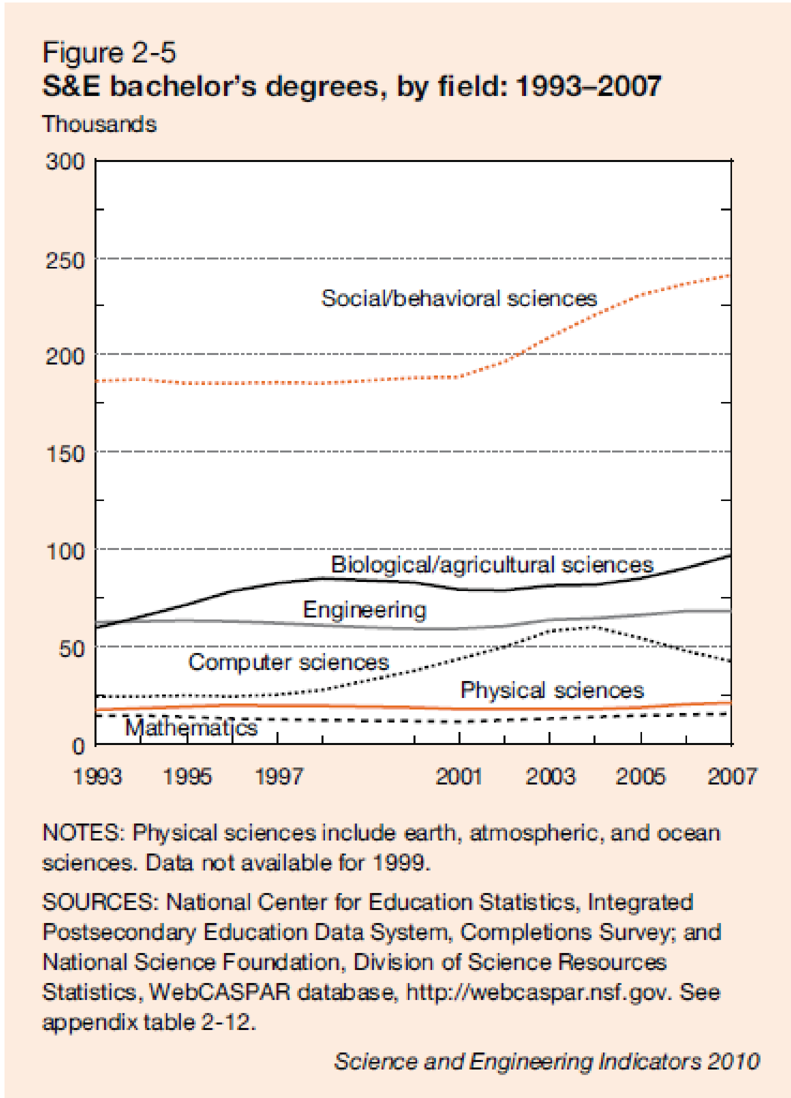


Figure 3: Science and Engineering Bachelor's Degrees, by Field: 1993-2007

Currently students in other countries are pushing to study engineering in the United States, recent census information notes an 11% increase in the number of foreign undergraduate enrollments from April 2008 to April 2009. These students are enrolling in undergraduate programs and furthering their education more aggressively than native students. These students make up an even larger majority of the individuals pursuing a graduate degree, increasing from 22% to 25% from 2000 to 2006. In 2008 alone only one third of white, black, Hispanic, and Indian American freshmen intended to study Science and engineering whereas almost 47% of Asian freshmen planned to major in S&E (Board, 2010, pp. 2-13).

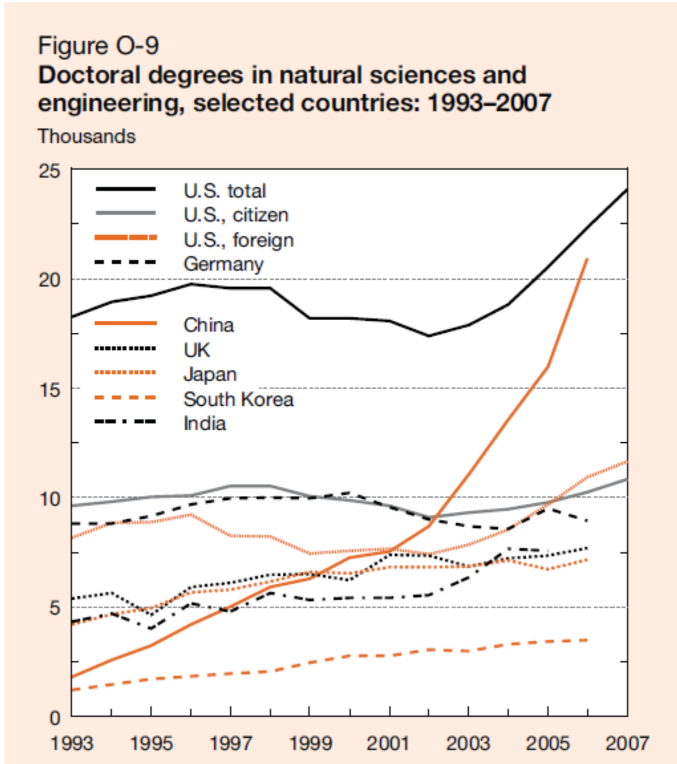


Figure 4: Doctoral Degrees in Natural Science in Engineering, Selected Countries: 1993-2007

One potential solution to the domestic technology gap is the *FIRST* Program. *FIRST* (For Inspiration and Recognition of Science and Technology) has been creating annual robotics competitions aimed at inspiring students to pursue careers in the fields of science, technology, and engineering. By exposing these young students to real world challenges, *FIRST* is introducing tomorrow's youth to fields of study often discussed much later in life and is building up these students' confidence and interest in those fields. This push for technology is furthered by the numerous scholarships that colleges around the nation are willing to provide to students eager to compete.

FIRST is a not-for-profit organization, founded in 1989. The *FIRST* competition differentiates itself from other robotics competitions, by utilizing team mentors to guide and aid students in the development of their robots. The nature of the competition also provides students with well-rounded life capabilities including but not limited to, self-confidence, communication and leadership (Vision).

The main challenge that *FIRST* faces is the inexperience that teams must overcome in their initial years of competing. Rookie teams, teams new to the competition, generally start with a very limited knowledge of robotic systems and minimal resources. These teams are posed with the same requirements as teams with far more experience; the design, build, and programing of a complex robot to complete a designated task of the competition, each part having a steep learning curve.

Despite many teams making it through their rookie year, they remain discouraged with the separation of competitive edge and fail to return to the competition the following year. Still many more high schools have yet to found a *FIRST* robotics team. These teams may never come to be, due to the lack of funding or the lack of confidence that the school could be successful if they were to compete. The need exists to lower these barriers to new teams competing in *FIRST*, to generate higher retention rates, as well as to entice more high schools to participate.

A potential way to increase the successfulness of rookie *FIRST* teams would be the creation of an easily accessible resource. This source of information would be available to anyone, anytime, and anywhere; an online curriculum designed to be self-navigated and self-taught.

The report is organized as follows: Chapter 1 provides an in depth background on the role of technology, and a review of recent STEM studies in the United States as well as the different competitions associated with *FIRST*. Chapter 0, Methodology, discusses the methods that were used to attain results to prove the need for a resource for *FIRST* participants. Chapter 4 displays the results attained from both the focus group as well as the multiple surveys administered. Chapter 0 examines and discusses the results of the research. Chapter 6 discusses some recommendations for the creation of an online resource for *FIRST* robotics competition participants. Chapter 7 concisely concludes the data collected and suggestions for an online medium.

1 Background

This section provides a more in-depth look at the problem America faces with the falling number of degrees awarded in the fields of science, technology, engineering and mathematics (STEM). Also provided in this section is a further look into *FIRST*, and all the robotics competitions they conduct. A special attention is given to the *FIRST* Robotics Competition (FRC), and rookie teams involved in FRC.

1.1 The Importance of Technology

Technological innovation is responsible for everything in today's modern world, this is evident through the means by which we travel, how we communicate, our education system, health care, military defense and many jobs countrywide. Every facet of modern life has technology woven into it. At the start of the 20th century it took over 38% of the labor force to produce the amount of food necessary to feed the population, this number has greatly declined, with less than 3% of the population needed to produce enough food to maintain it (Rising Above The Gathering Storm, 2007, p. 42). This reduction of human labor has been made possible through numerous inventions and scientific breakthroughs related to the production of food.

Great strides have and continue to be made in the medical field; science has been improving life span (Figure 1-1), faster medical recovery, shorter sickness times and overall quality of life. Through the creation of vaccines many once deadly diseases have been completely eradicated. People are now living longer and more prosperous lives due to the advances in modern medicine. None of these life enhancing benefits would be possible without technology and those individuals who pursue it.

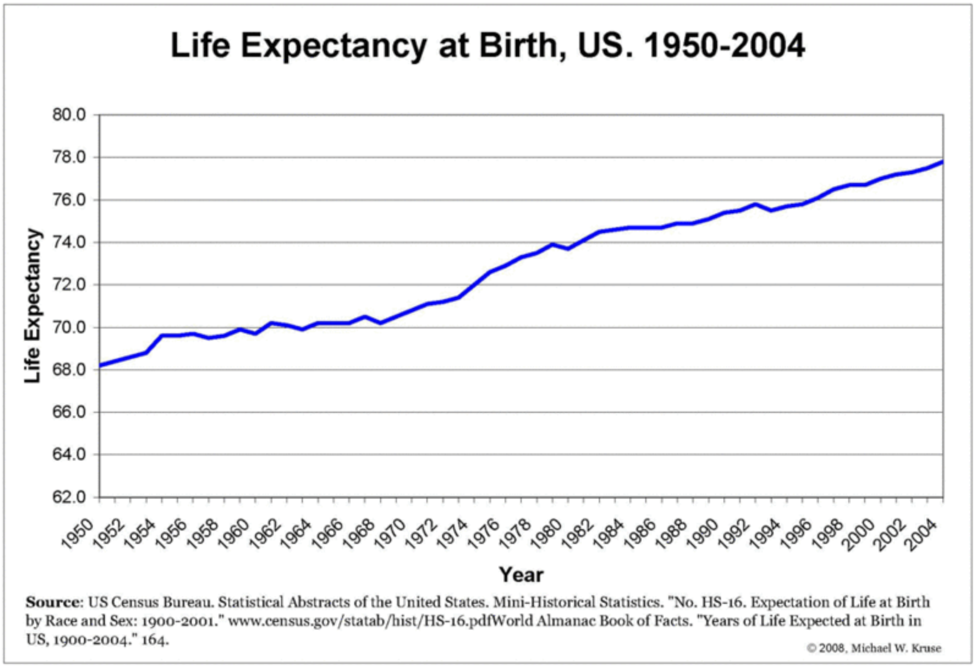


Figure 1-1: Life Expectancy at Birth, US 1950-2004

1.2 The Problem at Home

In today's ever evolving world and with the rapid advances in technology, the need for engineers and scientists to keep up with the flow of change is ever increasing. The United States is threatened with falling behind the times in the areas of science and technology. Companies in the United States are continuously increasing the amount of work outsourced to other countries, as well as more American investors are looking abroad for new business ventures. Alarmingly America is failing to keep up with foreign countries in the education of its citizens (Rising Above The Gathering Storm, 2007, p. 14).

As America continues to undermine their own technological future, other countries are filling that void. The United States used to be a net exporter of "high technology", exporting over 54 billion dollars in 1990, and now has fallen to net importing over 50 billion dollars in 2001 (Rising Above The Gathering Storm, 2007, pp. 76-77).

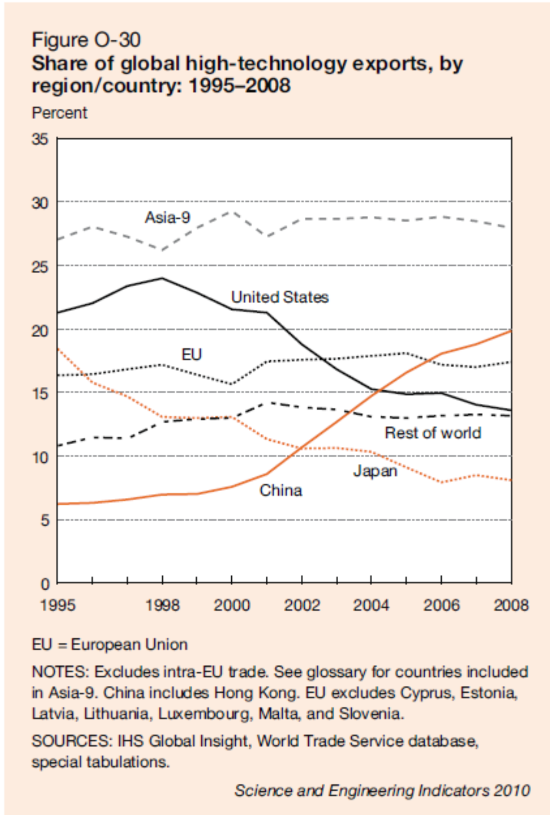


Figure 1-2: Share of global high-technology exports, by region/country 1995-2008

With American industry being outsourced and countries other than the United States becoming increasingly competitive, domestic companies find it financially beneficial to purchase many needed components abroad, and others that wish to begin producing components on American soil are confronted with the impossible task of being competitive with lower labor rates and overall business overhead. Countries determined to maintain their domestic entrepreneurship, impose steep taxes on imported goods to compete with the general low cost of outsourcing, this has an inverse effect on the price of the out-of-country goods and in some areas these taxes have made the domestic goods more desirable. As other countries continue to narrow the technology gap, they will be able to provide comparable complex technology, to that of United States, at a lower price than the American counterpart. In a recent period low wage employers such as Wal-Mart and McDonald's created 44% of new jobs, compared to high wage employers only creating 29% of new jobs during the same period (Rising Above The Gathering Storm, 2007, p. 14). As America focuses less on science, engineering, and technology; more jobs are going to the country's "low wage" sector.

IBM the creator of the first PC, back in 1981, sold its computer businesses to a Chinese assembler marking an enormous change for large American businesses; which have proceeded to reach overseas to reduce costs. This acquisition was one of the largest foreign acquisitions ever made by a Chinese company, on the same premise, American entrepreneurs seeing no promise in domestic business disperse their wealth overseas, “in 2005, American investors put more […] money into foreign stock funds than into domestic stock portfolios.” (Rising Above The Gathering Storm, 2007, p. 14) As individuals disperse their savings overseas, it displays an ever growing trend of discontent with American businesses. Technology will continue to retain a strong hold on the future, having a well educated population is a must for countries to stay competitive on a world stage.

America continues to fall behind in the number of degrees given to graduates for natural science and engineering; one out of every three students who goes into college intending to become an engineer switches into a different discipline before graduating (Rising Above The Gathering Storm, 2007, p. 16). This trend could be attributed to the lack of science and technology in earlier learning. Standardized testing has tracked student test scores in mathematics, and the results are troubling for future generations. In the 2003 administration of the Program of International Student Assessment (PISA) the United States ranked 24th out of 40 countries when it came to assessing 15 year olds ability to apply mathematics to real world problems (Rising Above The Gathering Storm, 2007, p. 15). Contributing to this staggering figure are the students’ themselves, American students lack the drive and desire, common to other eastern countries, to pursue math, science, engineering, and technology as a career choice.

When reviewing the amount of college graduates from the United States versus other countries, comparing how many American graduates move forward to pursue science and engineering is far fewer than other educated countries. Out of all the degrees awarded only 15% were awarded for natural science or engineering, compare this to South Korea which has 38%, France with 47%, China with 50% and Singapore with 67% (Rising Above The Gathering Storm, 2007, p. 16). These figures suggest that other countries will be able to match up to and surpass the United States in little to no time.

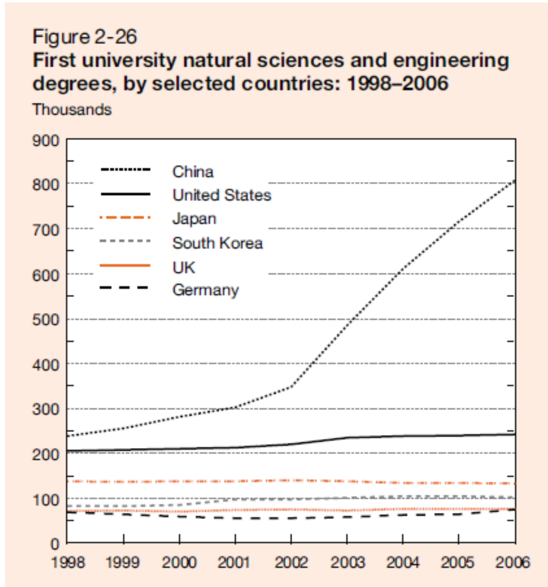


Figure 1-3: *FIRST* university natural sciences and engineering degrees, by selected countries: 1998-2006

As this technology gap increases many of the world's leading companies engage in a fierce competition fighting for talent. Students are finding as they graduate that skills and education afforded by an engineering degree are far more desirable now than ever before. Recently many engineering fields have been posting some of the highest starting salaries among all graduates due to a shortage of those with engineering degrees. Many companies fear that a certain "talent shortage" will plague them, as time progresses, a large portion of their talent will either move to another company or retire due to the number of experienced and aging workers in the current workforce. The need for new men and women to take up these jobs will steadily increase unless something is done to change the current trend.

1.3 *FIRST*

What is *FIRST* (For Inspiration and Recognition of Science and Technology)? *FIRST* is a not-for-profit public charity, founded in 1989. By creating several innovative robotics challenges, for different age groups, *FIRST* motivates and encourages students to pursue education and career opportunities in the fields of science, math and engineering. One of the aspects of *FIRST* that sets it apart from other robotics competitions, is there use of mentors to guide and aid students in the development of their robots. The nature of the competition also provides students with well-rounded life capabilities. These capabilities consist of self-confidence, communication and leadership skill (Vision).

1.4 The Impact of *FIRST*

FIRST attracts many students, mentors, volunteers, corporations and institutes, and every year the competition continues to grow and evolve. As is described in their website, currently there are over 3800 *FIRST* teams, with growth rate of approximately 500 new teams a year. There are over 250,000 students from more than 50 countries who compete in *FIRST* events around the globe (Robotics Programs). *FIRST* has gained the support of over 100 colleges and universities, the government and numerous fortune 500 companies. *FIRST* receives sponsorship from many companies including Lego, General Motors, and Johnson and Johnson. There are over 925 individual scholarships being offered to *FIRST* participants from over 145 different schools, totaling to over 14.8 million dollars in college aid (Scholarships). The projected impact of *FIRST* for the 2011/2012 period, over 294,000 students, more than 26,900 teams, 24,300 plus robots, over 65,000 mentors and adult supporters, and more than 35,000 volunteers. In fact in the 2012 period there will be more than 2400 teams, with over 60,000 high school students competing at 100 plus qualifying and championship tournaments (FIRST At A Glance). *FIRST* has made its way into popular culture and has been featured in movies, television, and books. Celebrities such as Justin Timberlake, Steven Tyler, Jack Black, as well as many other important public figures have voiced their support for *FIRST*. This past competition season, celebrity Will.i.am from the Black Eyed Peas announced his endorsement of *FIRST*.

Student participation in the *FIRST* competition has been steadily growing since 2007 (Figure 1-4). Over the past 5 years there has been an increase in student involvement of 184% percent. New students are eager to engage in fun exciting robotics competitions. Although this suggests a greater number of students looking to enroll in STEM studies, if students who are engaged in the competition participate solely in high school and move away from science and engineering fields during their later education the overall technology gap remains. This study looks to help retain students interested in the field, give them access to the knowledge necessary to compete on an equal level and in turn continue to interest them later in life.

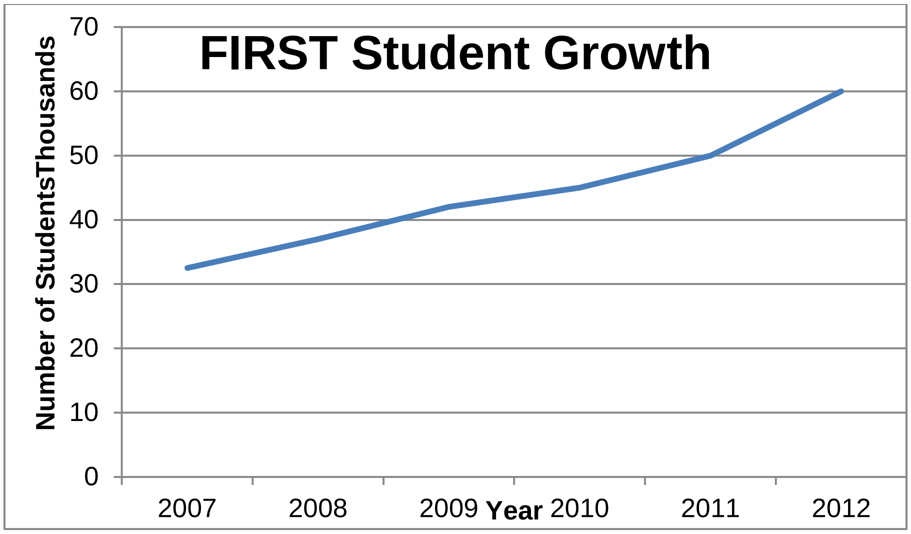


Figure 1-4: Student Growth in the *FIRST* Competition, from 2007 to Present

Not only has there been an influx of student participation over the past 5 years but teams, previously Rookie teams continue to compete, while fresh teams sign up annually (Figure 1-5). These retention rates give rise to the competition suggesting an overall participation of 60,000 in the year 2012 and a continued increase in years to come.

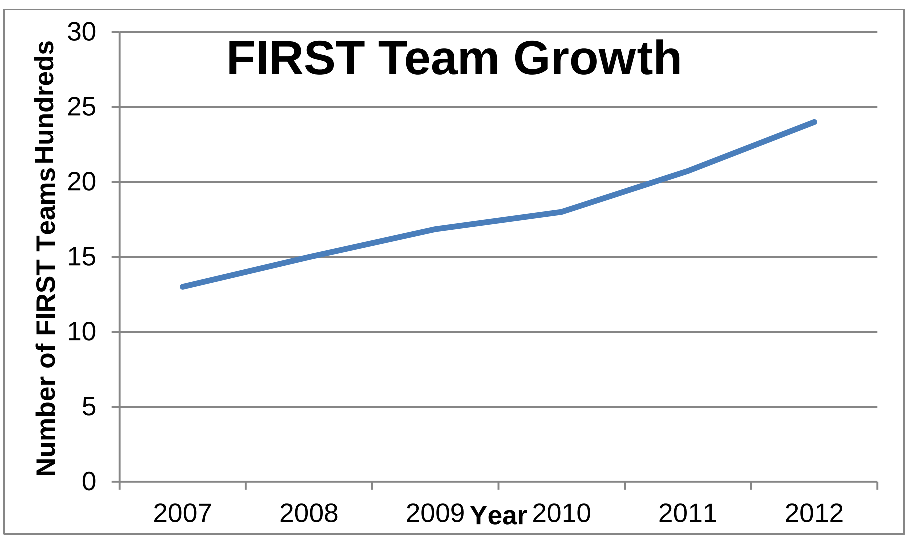


Figure 1-5: Team Growth in the *FIRST* Competition, from 2007 to Present

Rookie teams continue to participate in the competition despite the strong opposition from more experienced teams (Figure 1-6). In 2008 316 Rookie teams competed in the competition and that number continues to grow with this past year containing 414 new teams.

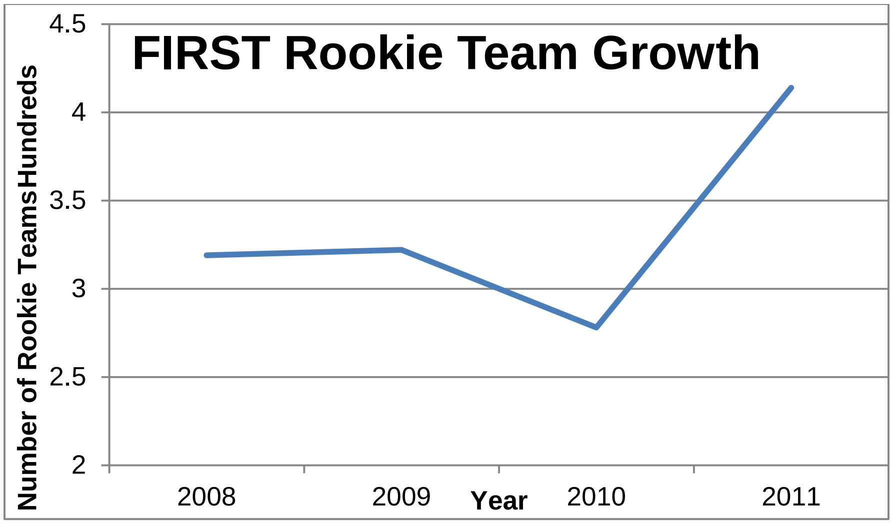


Figure 1-6: Rookie Team Growth in the *FIRST* Competition, from 2008 to 2011

1.5 *FIRST* in Education

FIRST participants feel that the opportunity to participate and compete in this widespread event has provided them with challenging experiences, a positive introduction to working as a team, and engineering as a possible career. Students involved exhibit a better understand of the role of science and technology in everyday life. *FIRST* increases the interest of both young and old participants in contributing their time to community service; students reported that as a result of *FIRST* they were more willing to help younger students learn and understand math and science.

Participants find that *FIRST* helps them gain crucial communication skills, such as how to listen and cooperate with other students and mentors, problem–solving skills and how to apply these skills elsewhere. Students that develop an early appreciation for communication and cooperation perform better in academic environments because of their ability to listen and learn from others. The *FIRST* competition requires students to operate under strict deadlines, to submit and document their build and design phase.

Many graduates find that their *FIRST* activities were an “excellent” use of time and that the program had been more influential than their other extracurricular high school activities. Students reported after competing, that their desire and drive to graduate high school was far greater. This is evident by the fact that *FIRST* students represent a much greater percentage of all high school graduates than the national average. Once enrolled in college, students involved in *FIRST*, were seven times more likely to major in engineering fields. *FIRST* alumni are substantially more likely to attend college on a full time basis than comparable students (Impact).

1.5.1 Other *FIRST* Competitions

In addition to the *FIRST* Robotics Competition, *FIRST* also sponsors three other similar challenges aimed at various age groups. Each of these challenges Jr. *FIRST* Lego League, *FIRST* Lego League and *FIRST* Tech Challenge share the *FIRST* Robotics Competition's core values and similar real world approach to science, math, and engineering.

1.5.2 Jr. *FIRST* Lego League

The Jr. *FIRST* Lego League is designed around introducing younger children to the world of math, science, and engineering. The target age group for this challenge is from grades K through 3 or ages 6 to 9. The competition features real-world challenges to be solved using critical thinking, research, construction, teamwork, and most importantly imagination. Teams are aided by a coach and work together to develop a solution to a unique challenge using Lego components and motorized parts. Participants then present their solution for review. Amongst the many benefits of the Jr. Lego league is the development of employment and life skills along with a lifelong love of learning.

Figure 1-7: *FIRST* Jr. Lego League

1.5.3 *FIRST* Lego League

The *FIRST* Lego League takes up where Jr. Lego League leaves off. Targeting participants from grades 4 through 8 or ages 9 through 14, *FIRST* Lego league strives to provide children with real world science and technology challenges. By using Lego Mindstorm technology participants are given more challenging builds and are immersed with more complex build components in order to develop their projects. Common to all the *FIRST* programs this competition also strives to reiterate and stress the importance of specific life skills; participants learn about future engineering career possibilities, as well as how they can make a positive contribution to society, while boosting self-confidence, and experiencing time management, collaboration, communication and critical thinking. Lego league promotes participants within the competition to strategize, design, build, program, and test robots in a more competitive setting than the junior league.

Figure 1-8: *FIRST* Lego League

1.5.4 *FIRST* Tech Challenge

The *FIRST* Tech Challenge is more widely available than either the Jr. *FIRST* Lego league or the *FIRST* Lego League. In the *FIRST* Tech Challenge, teams of up to 10 students compete in head to head competition; two teams form an "alliance" and are pitted against another "alliance". Teams receive a kit to be used in the construction of their robot; this kit is reusable from year to year. Alongside with coaches, mentors, and volunteers, students design, build, and program robots with sound engineering principles. Awards are given to teams not only for their success in the competition, but also for community outreach, along with other real world impact. Teams get a chance to compete in regional area competitions as well as a world championship. Currently available to the *FIRST* Tech Challenge participants, are over 7 million dollars in college scholarships. Members of this competition develop skills, and traits that colleges are looking for in their applicants.

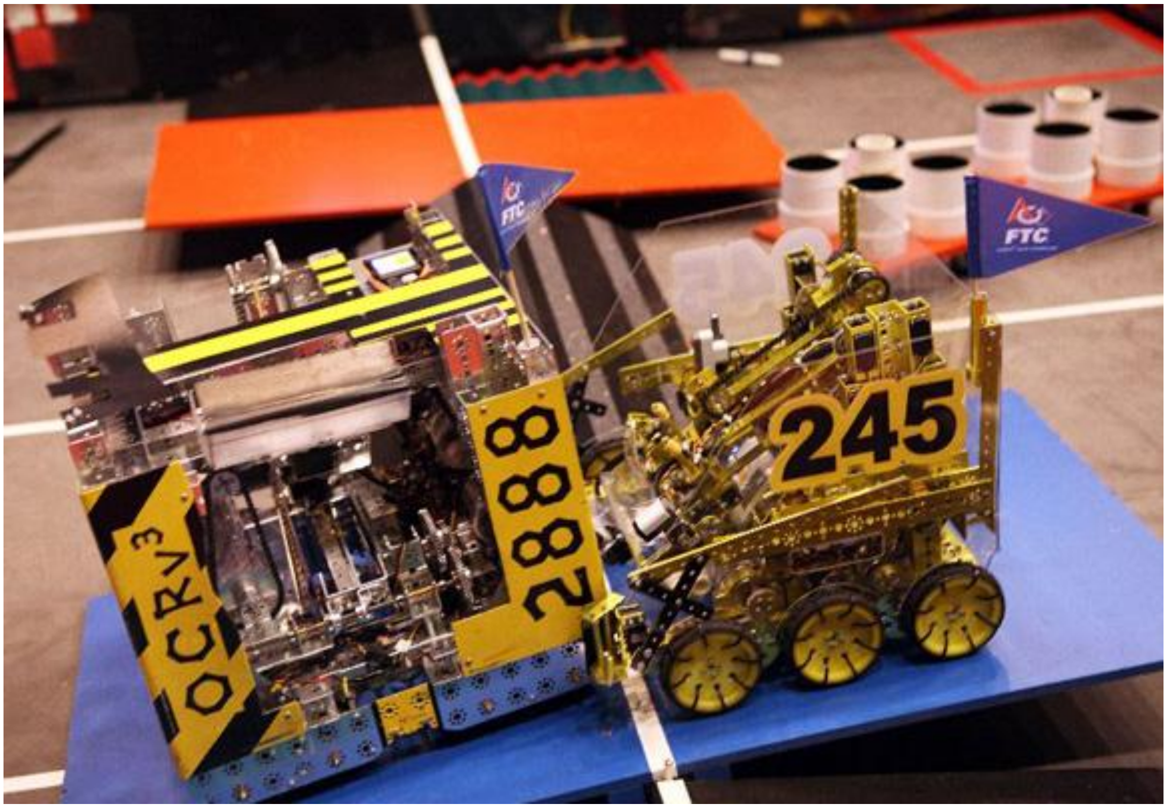


Figure 1-9: *FIRST* Tech Challenge

1.5.5 *FIRST* Robotic Competition (FRC)

The most well know competition affiliated with *FIRST* is the *FIRST* Robotics Competition, "dubbed the "varsity sport for the mind" (Robotics Programs). Competitors range from grades 9 through 12 or ages 14 to 18. This competition provides a sport like atmosphere for students to compete in regional competitions as well as a world championship event. Teams of students alongside with professionals and mentors design, build, and program robots to compete in an annual challenge. Although the game may change from year to year many of the aspects related to a team's physical robot and the competition's field of play remain consistent. In addition to the design and construction of robots, teams must work together to raise funds, and design a team "brand" that sets them apart from other teams. Teams are also encouraged to raise public awareness about *FIRST* and help their local communities and fellow *FIRST* teams. The competition provides participants with real world engineering experience, including the use of sophisticated hardware and software.

Figure 1-10: *FIRST* Robotics Competition Logo-motion 2011

1.5.5.1 The Challenge

Generally competitions require robots to pick up and manipulate either a ball of varying size, inflatable tubes of some shape, boxes, or triangular objects. Robots then take one or more of these objects and have to place, hang, deposit, or in some other way position them into or onto a goal of some kind. Goals in the past have been located in the air, on the ground, on the back of an opposing team's robot or anywhere in-between.

The robots themselves have to meet strict weight, size, and safety regulations. In addition to building a reliable robot that can complete the designated challenge, the robot must be robust; being able to withstand the physical contact of other robots during play. In more recent competitions, two teams of three robots each, go head to head simultaneously competing to manipulate objects around the field to gain points. Multiple *FIRST* teams must work together and strategize to complete the challenge. This creates greater team building skills among participants, as well as leadership traits.

1.5.5.2 Kickoff and Build

Each year the *FIRST* robotics season starts with the “kick off”. The kick off, is the release of the competition rules and regulations for the year. From that point on, teams have 6 weeks to build their robots before competing with them in the challenge. At kick off events, teams are given their “kit of parts”, a kit common to all teams comprised of an assortment of hardware, software, and electrical components.

The contents of the kit changes each year, some items that can be found in the kit with consistent regularity are motors, controllers, and pneumatics. The kit of parts is designed so every team possesses base components commonly used to build a simplistic robotic platform. All parts outside of the kit are purchased by the teams themselves; requiring teams to schedule and run fundraising events to afford the extra parts.

Throughout the 6 week build season, teams must design, prototype, troubleshoot and repeat this process until their robot is ready to compete. Experienced teams, teams that have participated in many different competitions, have an advantage; namely knowing how to build the basics. This allows the more experienced teams to move on to the more difficult and challenging aspects of their design. Building a robot to maneuver around may be easy for experienced teams, but for rookies this is an entirely new concept. Building a robot drivetrain is an essential part of the robot that is needed every year; regardless of what rules pertain specifically to that year’s competition.

The start of every match in recent years has been preceded by a short autonomous period, during this autonomous period, the robot proceeds to attempt as many or as few goals as possible. Teams are instructed to program their robot to locate the game piece, move towards and acquire the game piece, manipulate it and in the best case scenario place it in the goal. The robots must use sensors to determine their location, orientation, whether or not they have obtained a game piece, and where the goal is located. This requires teams to not only understand when and where to use what type of sensor but also how to mount and program them properly. Rookie teams do not have the prior knowledge to guide them in the right direction, during this selection, mounting, and programing process.

1.5.5.3 Rookies in Need

Rookie teams are also at a disadvantage when it comes to knowing what resources are available to help guide them through this process. There are many internet resources available for anyone, however many of these resources are either inaccurate or incomplete. These websites can lead teams astray as well as burdening them with sorting through what information is accurate and useful and what is misleading or incomplete.

Teams that are not successful in competition are less likely to return to compete the following year; likewise sponsors are less likely to pledge money for a team who does not make it to the competition. For teams who do wish to continue for a second year lack of funding may make this impossible, and further discourage teams. This may further discourage the students themselves from pursuing careers in engineering fields.

1.6 *FIRST* Robotics Competition Games

In order to be able to provide the most useful website for *FIRST* robotics competitors, all competitions were analyzed. The critique process focused on three main areas involving each year's competition. The game pieces, the finale and the field terrain. By focusing the proposed website on areas directly related to game challenges, *FIRST* participants will be more enticed to use the proposed website. For a more detailed description of each year's game see appendix *FIRST* Robotics Competition Games (FRC 20th Season).

1.6.1 Game Pieces

Every year the *FIRST* competition has rewarded competitors with points for picking up, manipulating, or depositing various objects. The *FIRST* competition has been around for the past 20 years and of those years; fourteen competitions have required teams to manipulate a ball. This ball ranged in size from a tennis ball up to a 40in diameter ball. The composition of these balls has also varied over the years; some balls were filled with water, others were hollow (comprised of soft collapsible rings) and others solid rubber. The most common size ball being utilized by these competitions was a soccer ball. In addition to sports balls being the center piece of the game, recent competitions have begun to utilize other objects. In 1997 the central game piece shifted from the traditional ball to a circular inner tube, this was again the case in 2007. In 1999 the central game pieces were "Floppies" (light-weight pillow like objects that had Velcro wound around the center) and "Pucks" (octagonal platforms that rolled freely on castor wheels). In 2003 the competition used plastic containers approximately 24-1/4" long x 17-1/4" wide x 15-3/4" high (similar to those used for household storage or city recycling). In 2005, teams competed using "Tetras", a tetrahedral made from 1.25 in (31.8 mm) PVC pipe, with a side length of 30 in (762 mm). In 2011, the game pieces were again inner tubes however, three different shaped inner tubes (circular, triangular, and square inner tubes); the competition required teams to arrange the tubes to mimic the *FIRST* logo.

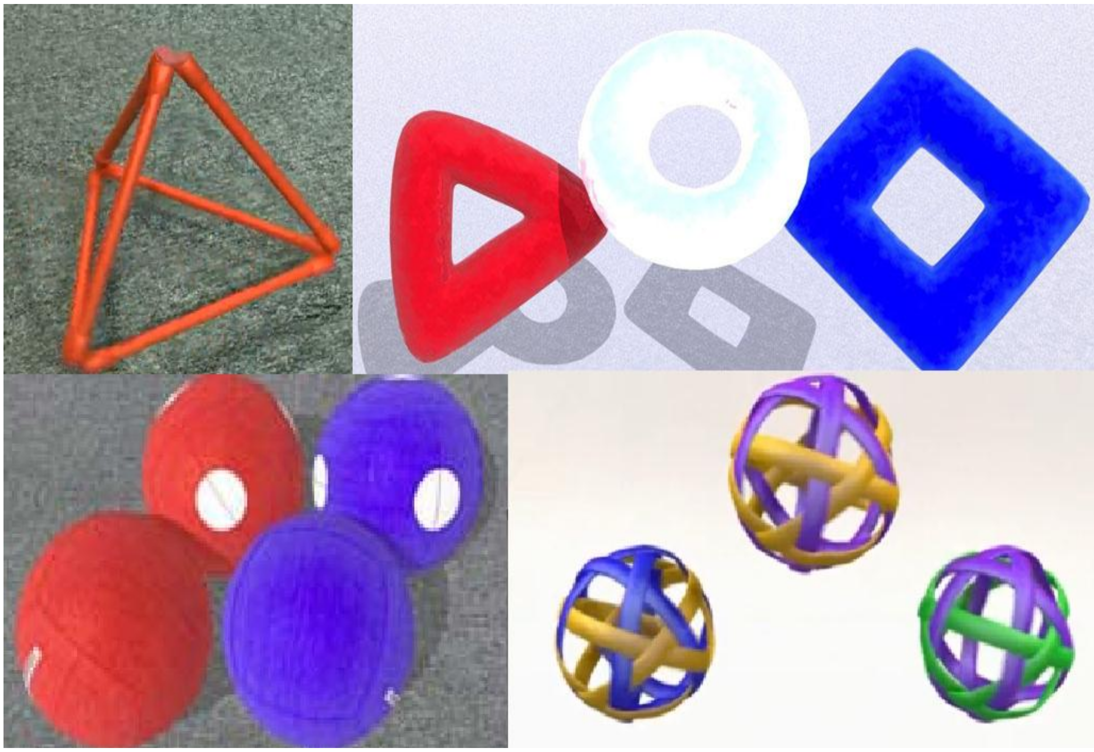


Figure 1-11: Game Pieces From Various *FIRST* Robotics Competitions

1.6.2 Finale

When the competition was initially conceived the rules did not include a "finale" (a specific event at the end of the match for teams to earn extra points). The *FIRST* year that the competition did include a finale was in 1999. This initial finale awarded points to a team based on the final location of the "puck" (a game piece comprised of a flat board with caster wheels on the bottom) and if the team was able to place one of their robots on top of the puck before the match ended. This new rule provided teams with point multipliers and/or additional points for their final score. Throughout the lifetime of the competition there have been multiple years where robots were required to push an object into various predetermined locations to score points. Only three times in the history of the competition have the judges awarded extra points based on the final location of a game piece or pieces. In three of the past competitions, teams have acquired additional points at the end of the match by parking in designated areas outlined in the rules. Teams have been awarded points for hanging from or climbing onto various in game structures. In 2007 the bonus objective was to elevate your teammate's robot off of the playing field, additional points were awarded based on the distance the robots were elevated and the number of robots lifted. In 2011 mini bots (deployable self-contained robots designed to scale a tall metal pole) were launched from the main robot in the remaining 30 seconds of the match awarding additional points to the team with the *FIRST* mini bot to reach the top of the pole.

Figure 1-12: ***FIRST*** **Robotics Logo-Motion Finale**

1.6.3 Field Terrain

Every competition, with the exception of two, has had the playing field covered in carpet. Contained within this field have been various obstacles, fake rocks, speed bumps and immovable objects designed to force robots to move around over and through them as well as designated goals for robots to score points. The competition has deviated from the carpet flooring twice in its history, covering the floor in more difficult terrain; in 1992 the floor was covered in 1 to 2 inches of corn and in 2009 the floor was covered in Glasliner FRP, commonly known as “Regolith”. These changes were designed to force competitors to design new and innovative modes of locomotion to combat the decrease in traction and to simulate a foreign “outside Earth” environment.

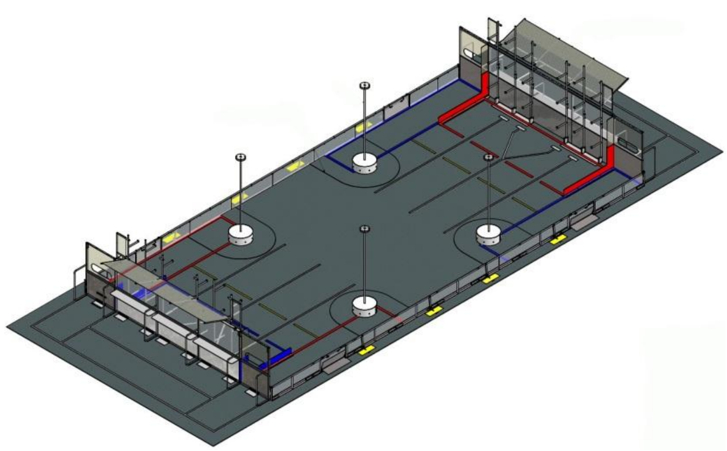


Figure 1-13: ***FIRST*** **Robotics Logo-Motion Field**

1.7 Problem and Objectives

The problem that this project addresses is to determine the educational needs of *FIRST* Robotics Competition rookie teams. The specific objectives are;

- To identify if there is a need in the *FIRST* Robotics community for a consolidated, accurate source of information via an online medium.
- To determine the content of this source of information
- To establish recommendations on how to present the information based on potential user input and an online format.

In view of these objectives, the following Chapter outlines the methodology used in this project.

3 Methodology

The team explored different methodologies to achieve the three project objectives.

1. To identify if there is a need in the *FIRST* Robotics community for a consolidated, accurate source of information via an online medium.
2. To determine the content of this source of information.
3. To establish recommendations on how to present the information based on potential user input and an online format.

Among the methods considered were; surveying students and mentors participating in FRC, personal interviews with students and mentors participating in FRC, and focus groups with entire teams participating in FRC. The following methods have been employed to achieve the project objectives

1. The team performed background research to:
    a. Evaluate websites frequently visited by FRC participants
    b. Analyze past FRC challenges
    c. Monitor the growth of FRC over the past 5 years
2. The project team designed and administered a survey to specifically address objectives 1 and 2.
3. The project team managed a focus group discussion to further address objectives 1 and 2.
4. The project team designed and administered a supplementary survey to collect additional data in order to clarify findings as a result of the earlier survey.

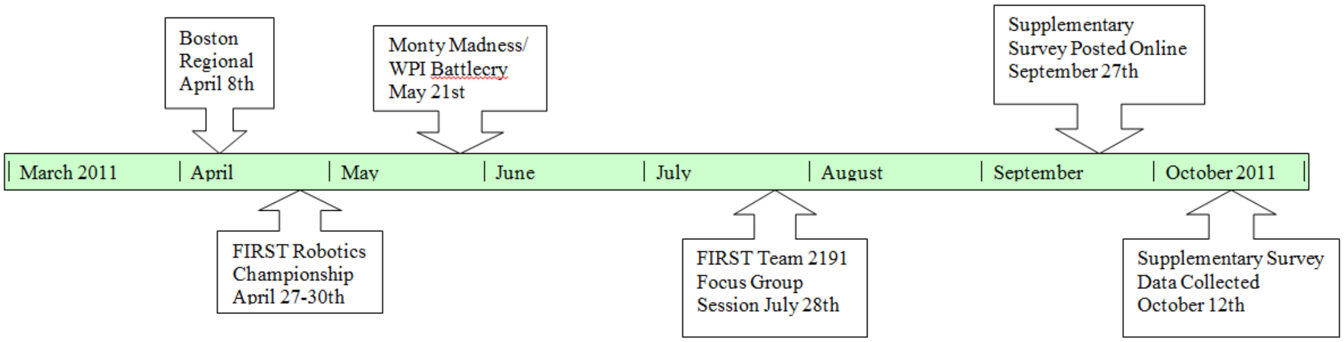


Figure 3-1: Project Timeline, Completed Over 8 Months

The project has been completed over the course of 8 months (March-October 2011). The first 3 months of the project coincided with the FRC regionals and championship, as well as post season events. This allowed for the team to attend these events and perform research for the project.

3.1 Background Research

To better determine the content of material intended for the survey as well as the topics to be discussed with the focus group, background research was conducted. This research was divided up into 3 main categories;

- Evaluate websites frequently visited by FRC participants
- Analyze past FRC challenges
- Monitor the growth of FRC over the past 5 years

From prior involvement with FRC the team was able to identify websites that are frequently visited by FRC participants. After evaluating these websites the team then selected them for use in the survey. The websites used were;

1. Chief Delphi
2. WPI *FIRST* Resource Center
3. WPI Think Tank
4. Official *FIRST* Website
5. Team In A Box (Team 341)
6. RINOS Rookies In Need of Support (Team 25)

The next area that the team looked into was past FRC challenges. Some common themes over the years have been the use of balls, and inner tubes of varying size and shape. The field has stayed consistent with each passing year, aside from two deviations, while the finale has seen the most variation. With the finale teams have been challenged to lift other robots, lift their own robot, drive up or over inclines, and most recently deploy smaller robots to climb up a pole. For a more in depth analyses of past games see *FIRST* Robotics Competition Games in Chapter 1 Background or for a look at each year's challenge look at 9.3 *FIRST* Robotics Competition Games.

Further research into the growth of FRC over the past 5 years was conducted by the team. These findings have seen the number of participants increase from 32,500 students and 1,300 teams in 2007 to over 50,000 students with 2,073 teams in 2011. For a further look at these finding, they can be found in section 1.4 The Impact of *FIRST* in Chapter 1 Background, and also section 9.4 *Participation to FIRST* in the Chapter 9 the Appendix.

3.2 The Survey Design

The project team chose to administer a survey because a survey could be targeted quickly and easily to a group of participants especially at an event run by *FIRST*. Surveys were distributed to individual participants, mentors, students and especially teams new to the competition, in order to best accomplish the objectives outlined.

The survey was broken down into 5 main parts; personal involvement in FRC, prior knowledge in robotics, individual research, desired knowledge, and generic age, gender, and student/mentor demographic.

The first section of the survey (Figure 3-2); personal involvement asked participants how many years they themselves had been a member of the FRC community, and what their primary role on their team is. This was done in order to better analyze the following questions in regards to self-assessed knowledge in various robotics categories.

- Please circle the number of years that **you** have been involved with F.I.R.S.T. Robotics
  1 2 3 4 5+

- Please indicate **your position** on your FIRST team: If mentor please indicate what areas you helped students in: (circle all that apply):
  Mechanical-Design Robot-Programming Electrical/Wiring Mechanical-Build
  Other:______________________________

Figure 3-2: Personal Involvement in FRC

The second section of the survey (Figure 3-3), prior knowledge in robotics, was a series of questions directed towards the self-assessment of individual's own knowledge in given robotics related topics, and more specifically where they had acquired this knowledge. These topics included Mechanical Design, Robot Programming, Electrical/Wiring, and Mechanical Build. These questions were designed to assess how much participants felt they knew about a given topic related to robotics. This information would then be used to determine if participants had a need for improved information in the given topic. Asking where a participant learned about this knowledge was included to determine where participants are already looking for information in a given area.

- For the following questions, we would like you to think about a topic and then indicate the amount of knowledge you feel you have in that topic:

1. Mechanical Design
   (Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)
   1b) How have you been learning about Mechanical Design? Circle all that apply:
   Mentors Internet Other Teams Other Team Members School
   (Have Not Learned About Topic Yet) Other:_______________
2. Robot Programming
   (Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)
   2b) How have you been learning about Robot Programming? Circle all that apply:
   Mentors Internet Other Teams Other Team Members School
   (Have Not Learned About Topic Yet) Other:_______________
3. Electrical/Wiring
   (Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)
   3b) How have you been learning about Electrical/Wiring? Circle all that apply:
   Mentors Internet Other Teams Other Team Members School
   (Have Not Learned About Topic Yet) Other:_______________
4. Mechanical Build
   (Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)
   4b) How have you been learning about Mechanical Build? Circle all that apply:
   Mentors Internet Other Teams Other Team Members School
   (Have Not Learned About Topic Yet) Other:_______________

Figure 3-3: Prior Knowledge in Robotics

The third section of the survey (Figure 3-4); individual research was a series of questions asking about websites frequently used by FRC participants. Participants were asked to rate the usefulness and accuracy of 6 specific websites; Chief Delphi, WPI *FIRST* Resource Center, WPI Think Tank, The Official *FIRST* Website, Team In A Box (Team 341), and RINOS-Rookies In Need Of Support (Team 25); as well as any other FRC team website they may have used.

- For the following questions please rate the **usefulness** of the each website:
  1. Chief Delphi
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  2. WPI FIRST Resource Center
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  3. WPI Think Tank
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  4. Official FIRST Website
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  5. Team In a Box (Team 341)
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use

Continue on other side

- For the following questions please rate the **usefulness** of the each website:
  6. RINOS - Rookies In Need Of Support(Team 25)
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  7. Individual Team Websites
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
- For the following questions please rate the **accuracy** of the information found on the following website:
  1. Chief Delphi
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  2. WPI FIRST Resource Center
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  3. WPI Think Tank
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  4. Official FIRST Website
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  5. Team In a Box (Team 341)
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  6. RINOS - Rookies In Need Of Support(Team 25)
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
  7. Individual Team Websites
     (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use

- Please list any other websites that you found helpful, that were not listed above:
  ____
  ____
  ____
  ____

- Please list anything you liked in particular about any of the websites you used during the robotics season:
  ____
  ____
  ____
  ____

Figure 3-4: Individual Research

The fourth section of the survey (Figure 3-5) ; desired knowledge was a multiple choice question where participants were asked to circle any and all topics related to robotics that were listed that they would like to know more about. This allowed the team to analyze where FRC participants were not finding the information they needed in areas they felt necessary to be competitive.

- Please indicate areas of robotics that you feel would have made your team more successful this past robotics season: circle all that apply:

Power System	Sensors	Chassis	Programming
Batteries	Sensor Type	Wheel Types	Controller Basics
Power Distribution	Contact Sensor	2 Wheel Drive	Operator Control
Protection (relays/fuses)	Ranging Sensor	4 Wheel Drive	Driving Straight
Custom Electronics	Non-ranging Sensor	Steering	Turning
Add On	Vision Sensor	Non-traditional-	Following Lines
Manipulators (Arms/Claw)	Actuators	-Drive Systems	Color Detection
Lifting Devices	DC Motors		Programming-Sensors
Shooters	Pneumatic Actuators		

- Outside of the classroom what would be the best way for you to learn about robotics: circle all that apply:

Instructional Videos   Informative articles   Power Point Presentations   Podcasts

Interactive Multimedia (Question and Answer)   Other: ______________________

Figure 3-5: Desired Knowledge

The fifth and final section of the survey (Figure 3-6); generic age, gender, and student/mentor demographic, asked participants whether or not they were male or female, a student or mentor, their age (in years) and their team number. This allowed for the project team to keep track of participants' answers and divide them up between; newer and older teams, as well as between student and mentor.

Gender (please circle):		Are you a (please circle):		Ages (in years)	FIRST Team Number
Male	Female	Student	Mentor	________	__________

Figure 3-6: Generic Age, Gender, and Student/Mentor demographic

3.3 Administering The Survey

The survey was administered during FRC regionals, championship, and offseason events. The first of these events was the Boston Regional, on April 8th. The second event was the *FIRST* Championship held in St. Louis on April 27-30, 2011. The last two events where the survey was administered, was Monty Madness at Montgomery High School, Skillman, New Jersey, and WPI BattleCry at Worcester Polytechnic Institute, Worcester Massachusetts, both taking place on May 21st.

The goal of this survey was to evaluate the knowledge of rookie teams in the *FIRST* Robotics Competition. Using this information, the project put forth suggestions for a clear culmination of useful knowledge, directed towards anyone interested in *FIRST*. The key focus of this survey is to evaluate the prior knowledge that rookie participants have, to understand how they have obtained this information, and to provide a useful new resource to them based on what information is determined to be necessary for building robots. Since the information gathered is to be used in making suggestions for a website, and to avoid suggesting solutions that are both currently available and easily accessible, while still presenting the information in a digestible manner, participants were asked to rank the usefulness and perceived accuracy of popular informational robotics websites. This was also done in order for the team to find a correlation between both the perceived accuracy of high traffic robotics websites, the amount of use they garnered, the methods in which they distribute their information, as well as the information posted on the websites.

Figure 3-7: *FIRST* Boston Regional

3.4 Focus Group

Thanks to *FIRST* Team 2191, the project team was able to collaborate with the target audience. An assorted group of team members were asked to attend a focus group; in order to investigate what students involved with *FIRST* Robotics deem most important for building robots. Each topic on the survey was discussed in detail, dealing with what students and mentors wanted to know more about;

- power systems
    - batteries
    - power distribution
    - protection (relays/fuses)
    - custom electrons
- add-ons
    - manipulators (arms/claws)
    - lifting devices
    - shooters, sensors
- sensor types
    - contact sensors
    - ranging sensors
    - non-ranging sensors
    - vision sensors
- actuators,
    - DC motors
    - pneumatic actuators
- chassis,
    - wheel types
    - two wheel drive
    - 4 wheel drive
    - steering
    - non-tradition drive systems
- programming,
    - controller basics
    - operator control
    - driving straight
    - turning
    - following lines
    - color detection
    - programming sensors

After each of these topic areas were covered the team was given the chance to discuss and any all other problems they have had over the years, as well as anything they felt would be helpful to them and other *FIRST* teams in the future.

3.4.1 ***FIRST* Team 2191**

The following is the history of *FIRST* Team 2191 Flux Core, as stated by their website.

"*FIRST* Team 2191 was founded in the 2006-2007 school year by Mr. Scott Innocenzi, a technology teacher at Nottingham High School in Hamilton, New Jersey.

Upon its foundation, *FIRST* Team 2191 attracted about 30 members. Although a Rookie in the *FIRST* Robotics Competition and ranking 51st in Qualifying Matches, *FIRST* Team 2191 was picked by an alliance of FRIST Team 177 Bobcat Robotics and *FIRST* Team 223 XtremeHeat to proceed to the Quarter Finals of that year's competition, Rack 'N' Roll. The alliance made it to the Semi-Finals before it was eliminated. *FIRST* Team 2191 won the Rookie Inspiration Award that year.

The 2007-2008 season was a crucial year for the team to gain its footing in the *FIRST* Robotics world. For the second year, the team managed to procure a donation from NASA to participate in the competition. After a too-short and sleepless build season, the team attended Overdrive with pride and confidence. Their members were still learning the basics of physics, however, and faced a problem with their robot being top heavy. The biggest success of the team's 2008 *FIRST* Robotics Competition was when the drivers were able to pick the robot up after it had fallen mid-match; and the team ranked 24th in Qualifying Matches. The team also learned a valuable lesson in Gracious Professionalism after accidentally destroying another team's drive train due to excessive pinning of that robot. In the future years, pinning would rightfully be strictly limited.

In the 2009-2010 season, Breakaway, *FIRST* Team 2191 learned the value of communication, after an embarrassing loss of two full weeks of the build season to an obsolete design. The team, after placing 51st in the New Jersey Regional, resolved to never again use chain and to always Keep it simple, stupid (K.I.S.S.).

2010-2011, Logo-Motion, was an enormously successful year for *FIRST* Team 2191, which placed 14th in Qualifying Matches and was captain of the 8th Alliance in the Quarter Finals. The build season ran smoothly, overlooking programming deficiencies due to too few experienced programmers. The robot itself was built to be both strong and functional, and by its final match was able to place full logs on the pegs. This was the team's *FIRST* use of Omni-wheels. The season ended in the team's highest ranking in history, with a surplus of funds. This was the *FIRST* year *FIRST* Team 2191 plans to participate in off-season events" (History).

3.5 Supplementary Survey

After reviewing the results of the survey and the focus group, the team decided that crucial unanswered questions still remained. The decision was made to conduct a supplementary survey, this time the survey was posted online allowing participants to take the survey at their convince. The survey was posted on Chief Delphi, a forum used heavily by *FIRST* participants. A copy of the supplementary survey can be found in the appendix under "supplementary survey".

3.5.1 Supplementary Survey Design

The supplementary survey consisted of five questions. The first question asked, "If a robotics curriculum were available online outside of the classroom, would you be likely to use it?" This question was designed to determine exactly whether or not students would be willing to use a new website geared towards helping them learn robotics.

The second question, "Aside from mentors, throughout a *FIRST* Robotics Competition what is your most influential source of information?" This question was a multiple choice question, the possible answers provider were internet websites, text books, and hands on learning. From the initial survey it was determined that in every category mentors were by far the most influential source. This question strayed away from asking again what was already determined and reached for the next source survey participants turn to.

The next question on the survey was, "Is there information online that you are unable to find elsewhere?" The purpose of this question was to determine if survey participants are finding information online that otherwise they would not have access to, proving the value of an online resource.

Fourth the survey asked, "Have you used internet resources to try and attain information on a particular robotics related topic with less than satisfactory results?" This question was meant to determine whether or not survey participants were looking for information online and being misled by sources that are already available.

The last question asked, “How many years have you been participating in *FIRST*?” This question was included to determine whether the survey participants were seasoned veterans, or rookie participants.

3.5.2 Administering The Supplementary Survey

The supplementary survey was administered via an online medium. The supplementary survey was posted in the Chief Delphi forum, Bill’s Blog edited by Bill Miller, the director of FRC at FIRST as well as emailed to WPI Robotics Engineering undergrads. This allowed for FRC participants who frequently use Chief Delphi to complete the survey at their convenience. Another benefit of posting the supplementary survey online was the ability to reach a greater audience from a more diverse group of FRC participants. The survey was created using a Google form.

4 Results

The information presented in this Chapter is all of the results from the survey and the supplementary survey that the team administered. The Chapter is broken up into two main sections, one for the survey and the second for the supplementary survey. The sections are further divided up into subsections that outline the results obtained from various questions on each survey.

4.1 Background Research

The background research covered 3 main topics;

- Evaluate websites frequently visited by FRC participants
- Analyze past FRC challenges
- Monitor the growth of FRC over the past 5 years

After analyzing the information gathered from the background research the findings were put to use in the creation of the survey, the topics discussed in the focus group, and used when determining the questions for the supplementary survey. From the background research the team selected the following 6 websites have questions associated with them on the survey;

1. Chief Delphi
2. WPI *FIRST* Resource Center
3. WPI Think Tank
4. Official *FIRST* Website
5. Team In A Box (Team 341)
6. RINOS Rookies In Need of Support (Team 25)

By examining past FRC challenges the team used this information when choosing the robotics related topics that participants would like to know more about. This same information helped guide the focus group discussion topics. For a more in depth analyses of past games see *FIRST* Robotics Competition Games in Chapter 1 Background or for a look at each year's challenge look at 9.3 *FIRST* Robotics Competition Games.

Further research into the growth of FRC over the past 5 years was conducted by the team. These findings have seen the number of participants increase from 32,500 students and 1,300 teams in 2007 to over 50,000 students with 2,073 teams in 2011. These results further proved that FRC is growing rapidly, and those new to the competition will continue to increase. For a further look at these finding, they can be found in section 1.4 The Impact of *FIRST* in Chapter 1 Background, and also section 9.4 *Participation to FIRST* in the Chapter 9 the Appendix.

4.2 Survey

The project team chose to administer a survey because; a survey could be targeted quickly and easily to a group of participants especially at an event run by *FIRST*. Surveys were distributed to individual participants, mentors, students and especially teams new to the competition.

4.2.1 Who Was Surveyed

The surveys were administered at four different robotics competitions, the Boston Regional, the *FIRST* Championship in St. Louis, Missouri, Monty Madness at Montgomery High School, Skillman, New Jersey, and WPI BattleCry at Worcester Polytechnic Institute, Worcester Massachusetts. A total of 92 individuals participated in the survey. Of the individuals surveyed, 70 of them were students and 22 were mentors (Figure 4-1). The majority of individuals surveyed were male with only 16 being female (Figure 4-1). Anyone willing to take the time to answer the survey was questioned, but special focus was given to “rookie” teams.

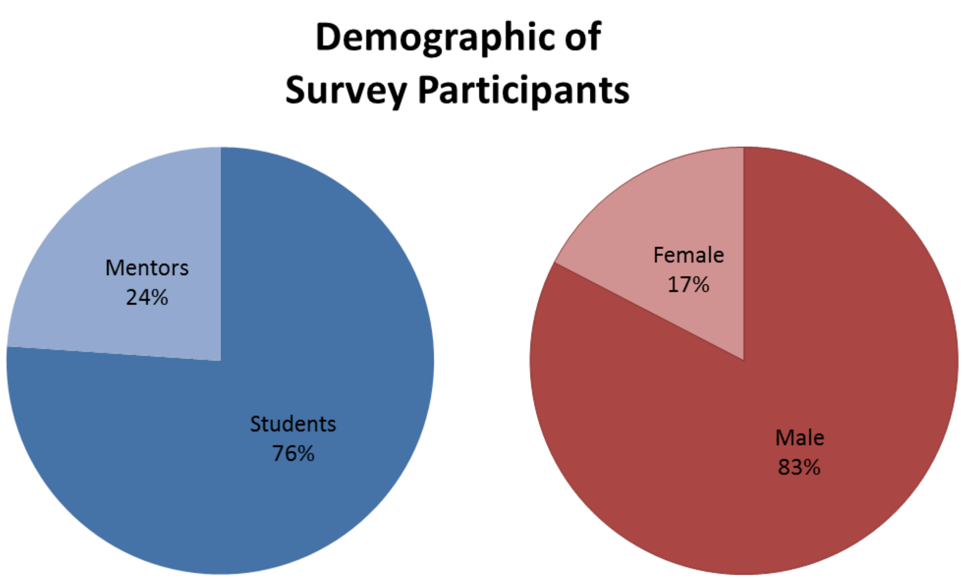


Figure 4-1: Demographic of Survey Participants (N=92)

4.2.2 Results of the Survey

The following sections present the results of the survey. First covered is the findings from the years participants have been involved with *FIRST* and their perceived knowledge in a given subject area. The following section displays where participants gained knowledge in, mechanical design, programing, electrical/wiring, and mechanical build. Presented next is the usefulness and accuracy, perceived by the participants, of certain websites that are frequently used by *FIRST* participants. The next section shows the results of what participants would like to have known more about, and the subsections of each category. The last section, from the surveys, discusses how participants would like to see information presented to them in an online medium.

It was found when comparing subject knowledge to years involved in the *FIRST* competition, that the students involved in *FIRST*, felt that their knowledge in both mechanical design and mechanical build was stronger after having participated in these competitions for many years (Figure 4-2). Ignoring slight inconsistencies, this was almost opposite of their self-assessment of their knowledge of both programming and electrical wiring; students felt less knowledgeable in the subject after having participated in the competition for an increased number of years.

Mentors followed a similar trend; individuals felt that their knowledge was stronger for both mechanical design and mechanical build having had more competition experience. The most striking part about this data was the extreme variance for both programming and electrical wiring. For mentors, this self-evaluation of knowledge changed drastically between the years with the greatest change being 4, more than half of the personal rating scale.

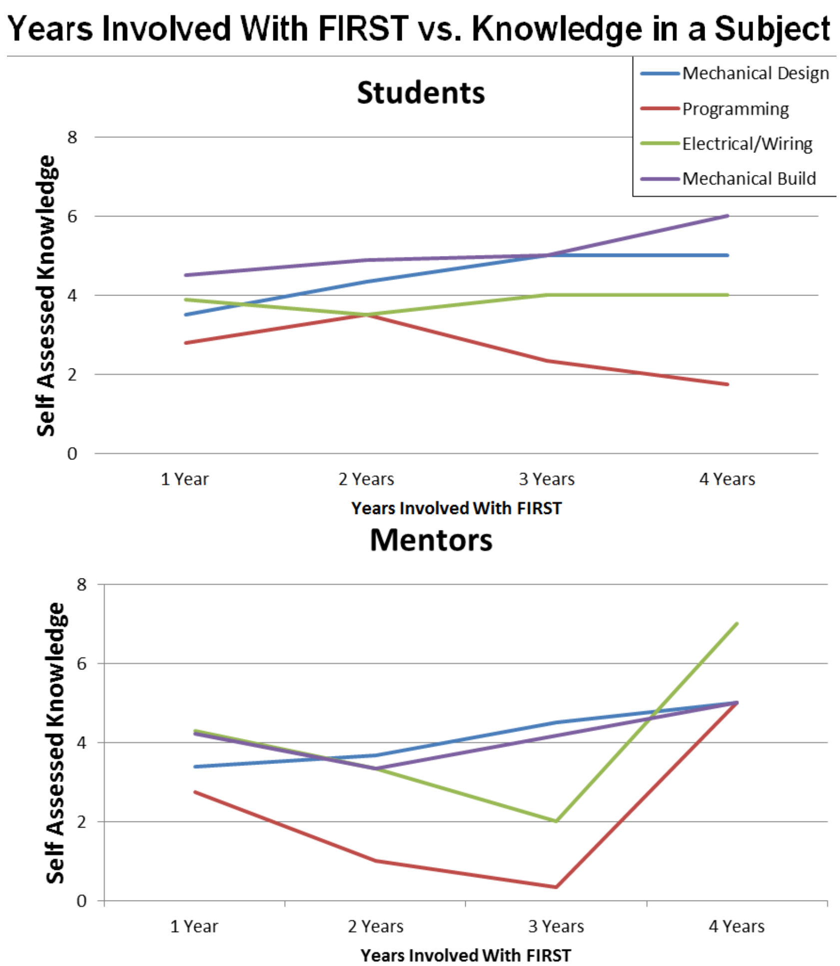


Figure 4-2: Years Involved With *FIRST* vs. Knowledge is a Subject (N=92)

The individuals being surveyed were asked to elaborate on how they learned their current knowledge, in an effort to better understand where teams would reach out for new information. Survey participants were asked to elaborate on their personal knowledge in a subject, giving a specific resource as to where they learned the majority of their background. The available selections provided for background knowledge included; Mentors, Internet, Other Teams, Other Team Members, and Classes in school, also survey participants were both given space and encouraged to elaborate on other sources. Each discipline had varied results and these results also differed between both mentors and students but the overall largest influence on prior knowledge was found to be mentors.

4.2.2.1 Mechanical Design

For the individuals surveyed the majority felt that their mentor was by far the biggest influence on their mechanical design knowledge (Figure 4-3). The second most important resource varied between students and mentors. Mentors felt that the internet was second most influential, while students felt other team members were.

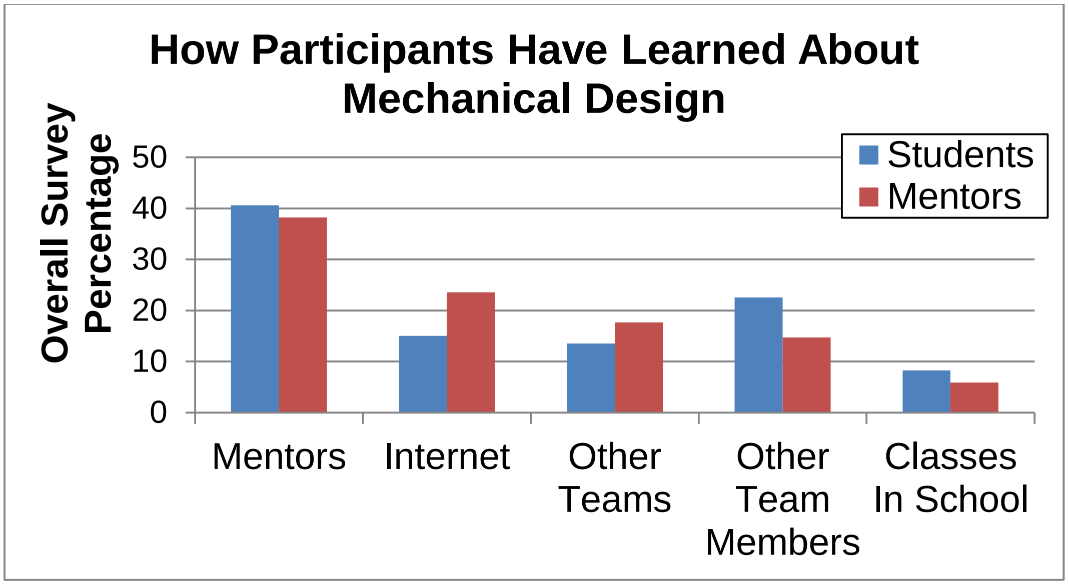


Figure 4-3: How Participants Learned About Mechanical Design (N=92)

4.2.2.2 Robot Programming

For programming design, the individuals surveyed felt that their mentor was by far the biggest influence on their knowledge and the second most important resource between both students and mentors was the internet (Figure 4-4).

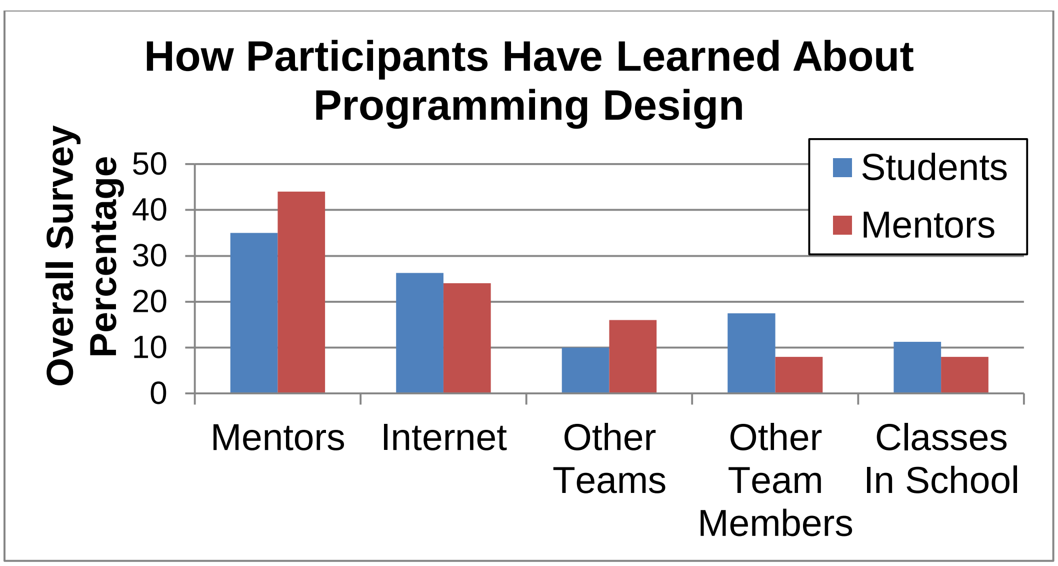


Figure 4-4: How Participants Learned About Programming Design (N=92)

4.2.2.3 Electrical/Wiring

For electrical wiring the majority felt that their mentor was by far the biggest influence on their knowledge and the second most important resource varied between students and mentors. For students other team members were the second most influential source, and both the internet and classes in school were equally important for mentors (Figure 4-5).

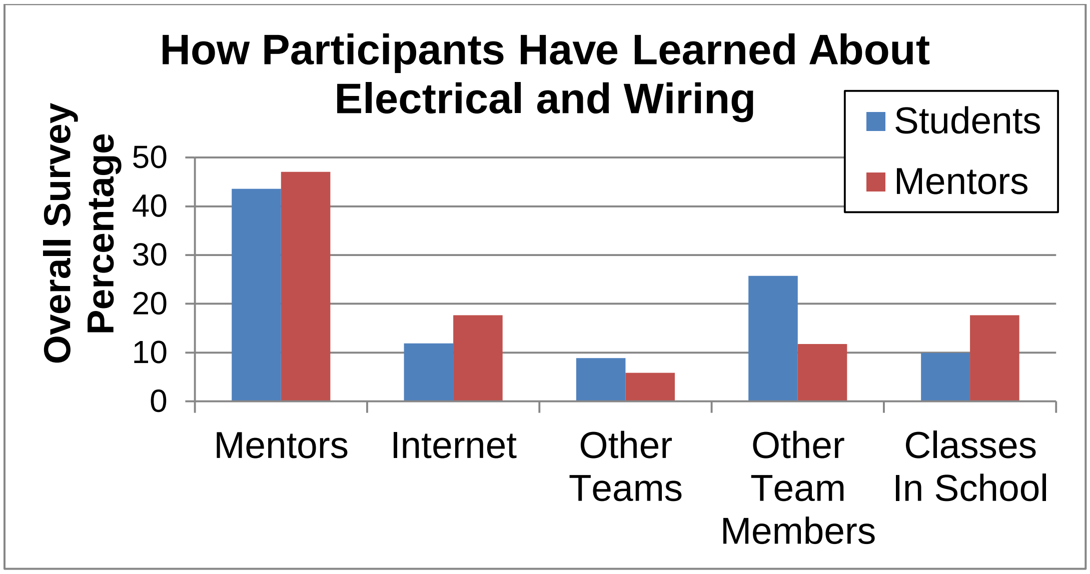


Figure 4-5: How Participants Learned About Electrical/Wiring (N=92)

4.2.2.4 Mechanical Build

For the individuals surveyed the majority felt that their mentor was by far the biggest influence on their mechanical build knowledge (Figure 4-6).The second most important resource varied between students and mentors, other team members, and other teams respectively.

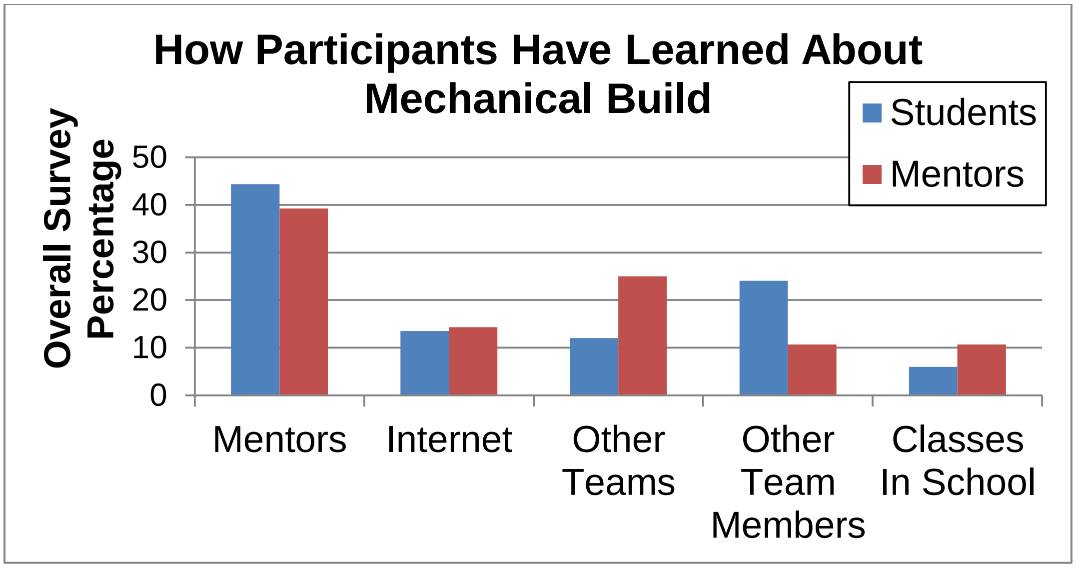


Figure 4-6: How Participants Learned About Mechanical Build (N=92)

4.2.2.5 Websites Used

On the survey, participants were asked to rate the usefulness of certain websites from one to seven, one being the least useful and seven being the most useful (Figure 4-7). The websites asked about were: Chief Delphi, WPI *FIRST* Resource Center, WPI Think Tank, the Official *FIRST* Website, and Team in a Box (Team 341), RINOS – Rookies In Need of Support (Team 25), and individual team's websites. The results were divided up between those surveys answered by students and those of mentors. The students' average rating of website usefulness and accuracy data shows that students use Chief Delphi the most. Chief Delphi is a forum for anyone involved with *FIRST* to go and ask questions, receive answers, and share general knowledge. The student-rated second most useful website is the Official *FIRST* Website. Available on that site is the challenge video, downloadable rules and instructional resources for various robotic systems. The third website used by students is Team in a Box, this a resource that schools can use to start a team. Team in a Box is a DVD that is a guide for rookie teams; the DVD is updated every two years and is currently in its fifth version. The other websites students were asked to rate were WPI *FIRST* Resource Center, WPI Think Tank, RINOS – Rookies In Need Of Support and Individual team websites. Students felt that the Official *FIRST* Website was the most accurate website. All the other sites asked about students felt were also very accurate.

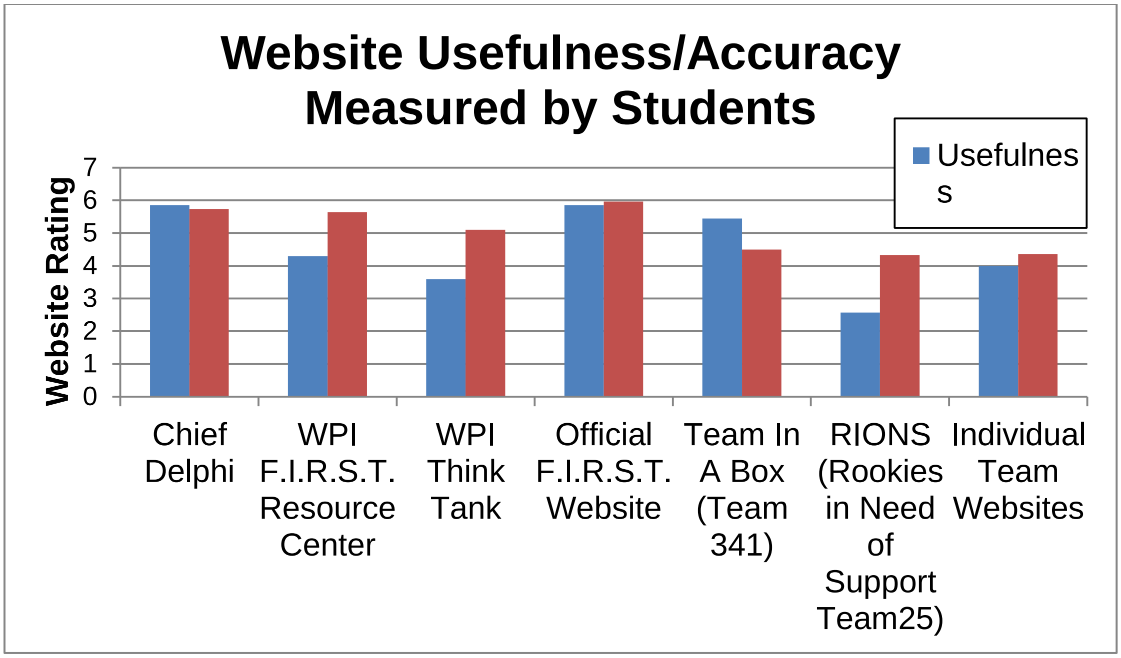


Figure 4-7: Website Usefulness/Accuracy Measured by Student (N=92)

Students and mentors agreed that Chief Delphi and the *FIRST* Resource Center were the most useful. The only difference between the students and mentors, was that the mentors felt the other websites not included in the top three were much less useful then that of the students. Mentors' responses to how accurate they felt different websites were varied from that of students (Figure 4-8). Mentors, on average, felt the Official *FIRST* Website and Chief Delphi were very accurate, while all the others were much less accurate. This contrasts the students who reported that all the websites were accurate.

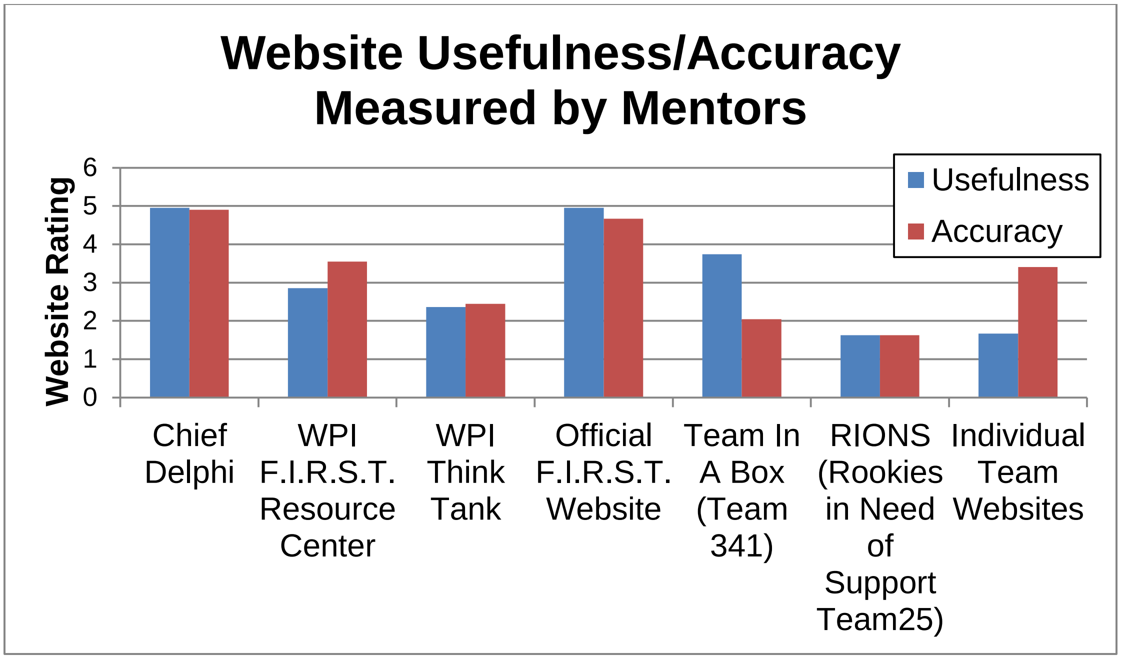


Figure 4-8: Website Usefulness/Accuracy Measured by Mentor (N=92)

4.2.3 Further Knowledge

Survey participants were asked to elaborate on the fields that they felt held their team back both during construction and competition. Teams' answers reflected that they would appreciate having a greater knowledge in all of the subjects that were in question (Figure 4-9). Perhaps due to the number of options and the small number of teams interviewed these numbers may be slightly skewed. However, although not completely even around the board it is clear that students and mentors alike are looking for a good resource for this information.

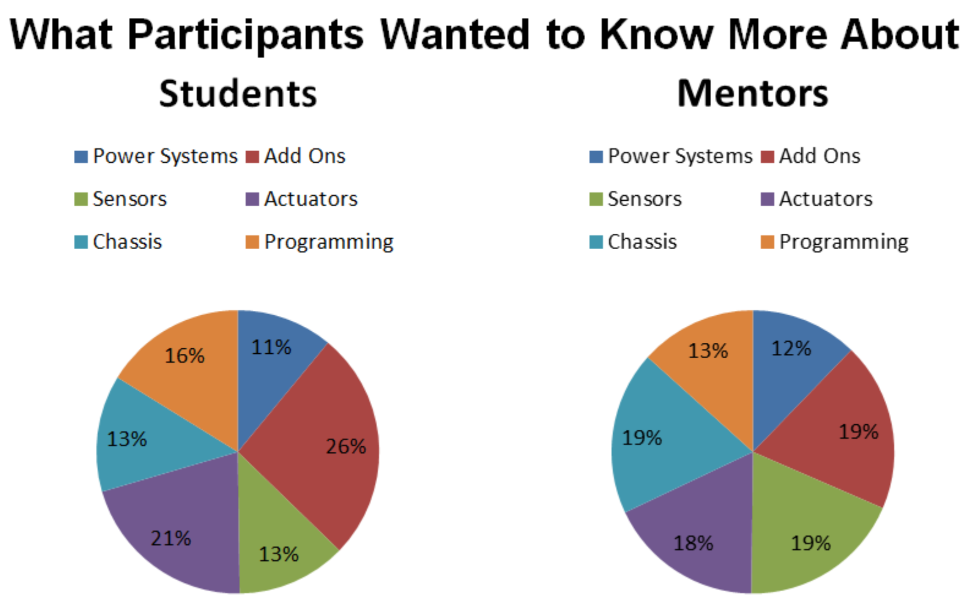


Figure 4-9: What Participants Wanted to Know More About (N=92)

4.2.3.1 Actuators

Under the actuators heading there was only two choices: DC Motors and Pneumatic Actuators. For both Students and Mentors, the vast majority chose pneumatic actuators over DC motors (Figure 4-10).

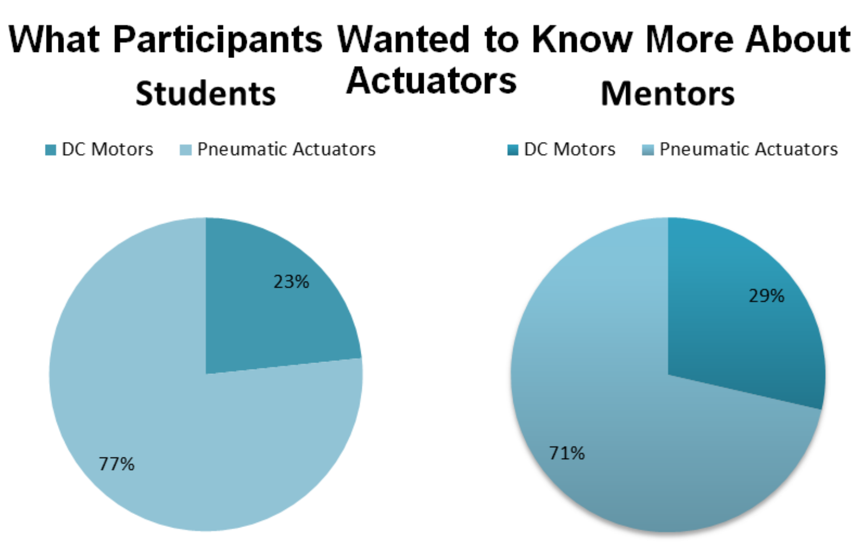


Figure 4-10: What Participants Wanted to Know More About – Actuators (N=92)

4.2.3.2 Add-Ons

In the add-on heading, students and mentors could choose from Manipulators (Arms/Claw), Lifting Devices, and Shooters. For both mentors and students manipulators received about half of the choices, followed by lifting devices and last were shooters (Figure 4-11). This could have been contributed to the nature of this year's competition; the challenge required robots to pick up and place objects, making manipulators the most relevant for this past season.

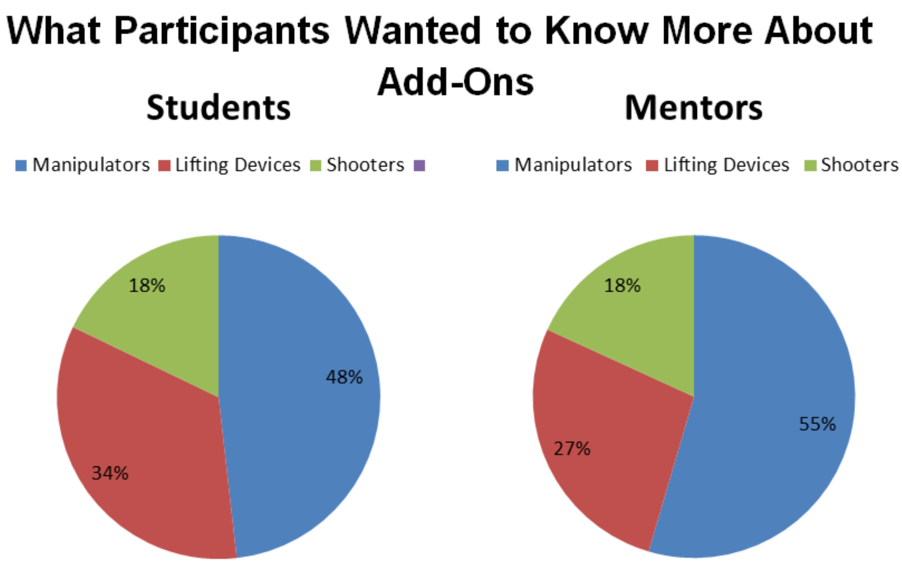


Figure 4-11: What Participants Wanted to Know More About - Add-Ons (N=92)

4.2.3.3 Chassis

For this section, Chassis, the answers for students and mentors varies greatly (Figure 4-12). Students felt that learning more about different wheel types was the most important, while mentors felt it was not very necessary ranking it second from the bottom. Also, mentors felt non-traditional drive systems were the most important, receiving just under half the choices, and students felt that to be the second least important. Neither students nor mentors put too much emphasis on learning more about two wheel drive. The other choices (four wheel drive and steering) both fell somewhere in the middle on both the student and the mentor responses.

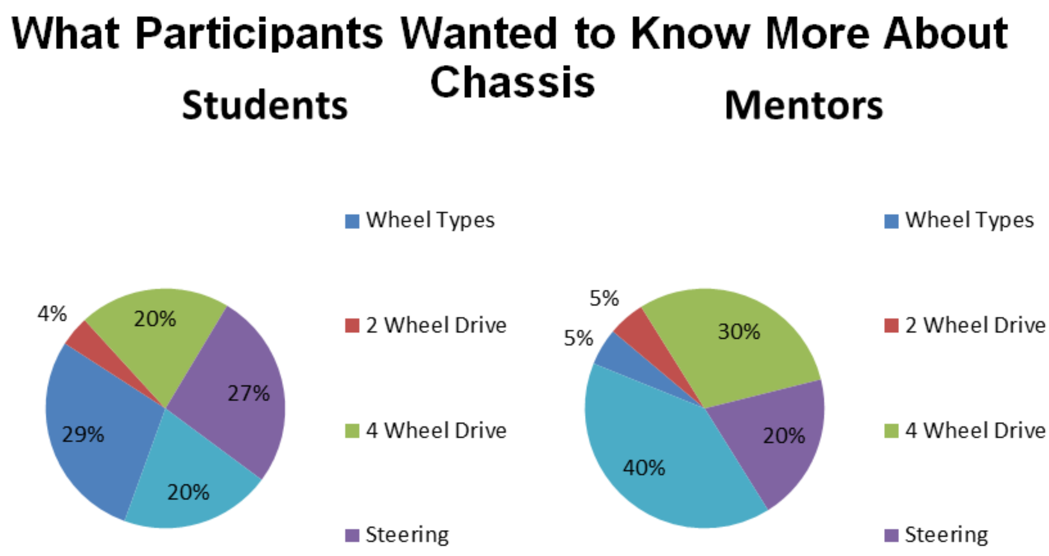


Figure 4-12: What Participants Wanted to Know More About – Chassis (N=92)

4.2.3.4 Power Systems

In the power systems category, the student responses and mentor responses were very similar. Having only four choices, both students and mentors put roughly a quarter of their responses into each category (Figure 4-13).

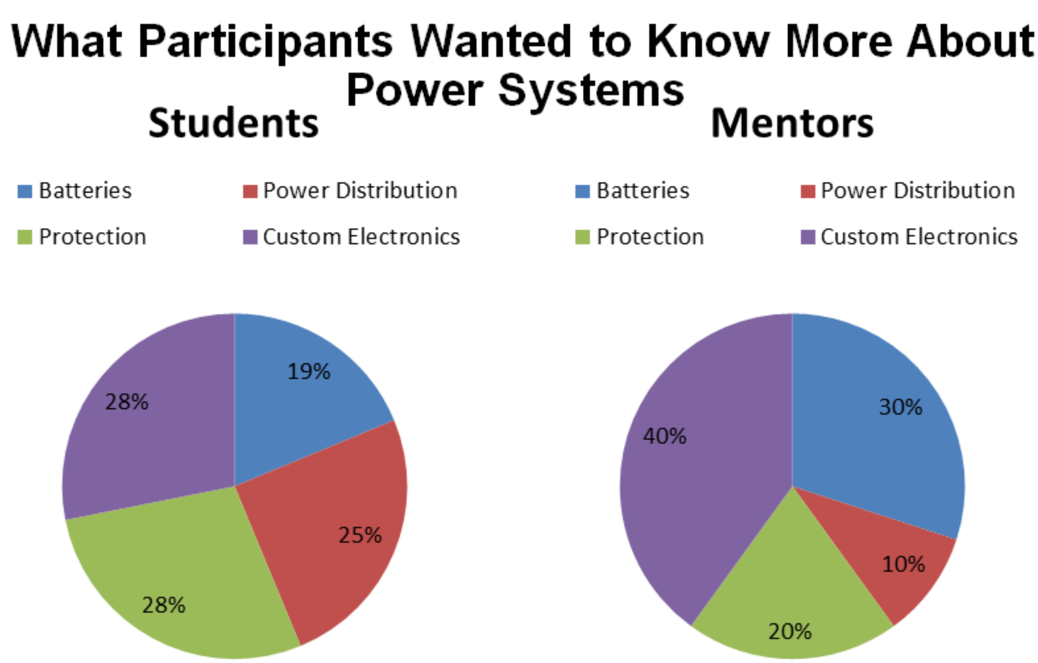


Figure 4-13: What Participants Wanted to Know More About - Power Systems (N=92)

4.2.3.5 Programming

The category with the most choices was the programming section. This section also saw some discrepancies between student and mentor responses (Figure 4-14). Students felt the most important topic that they wanted to know more about was being able to have their robot follow lines. All the other topics seemed to have about the same number of responses. In contrast mentors felt that giving robots the ability to drive straight was the most important topic. Turning and Operator Control were the two least chosen topics with programming sensors also towards the bottom of the responses. The other three choices all tied for second: following lines, color detection, and controller basics.

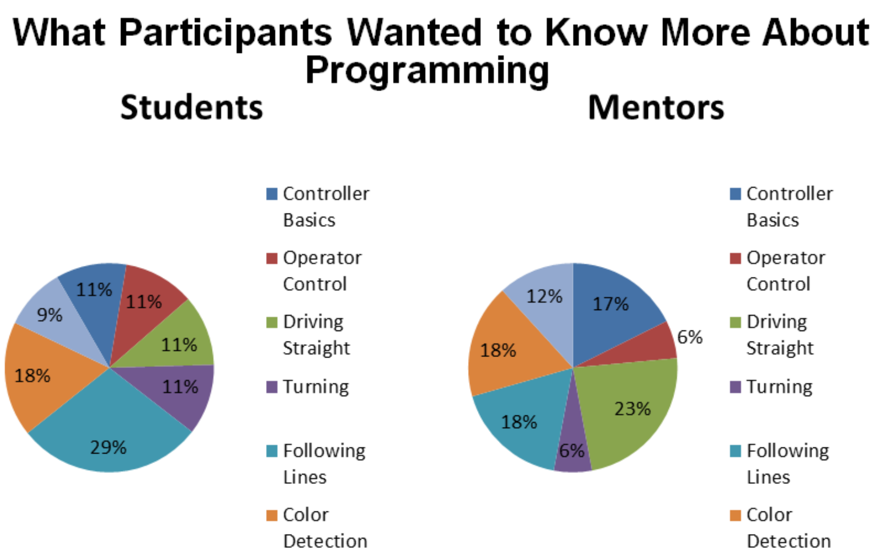


Figure 4-14: What Participants Wanted to Know More About – Programming (N=92)

4.2.3.6 Sensors

The last category asked about dealt with sensors; sensors had five sub categories, sensor types, contact sensors, ranging sensors, non-ranging sensors, and vision sensors. This section had varying responses between students and mentors (Figure 4-15). More than half of the student responses were for vision sensors, while mentors felt that vision and ranging sensors were equally important. Both students and mentors felt that second was learning more about sensor types. Least important was non-ranging sensors and contact sensors, this was true for both students and mentors.

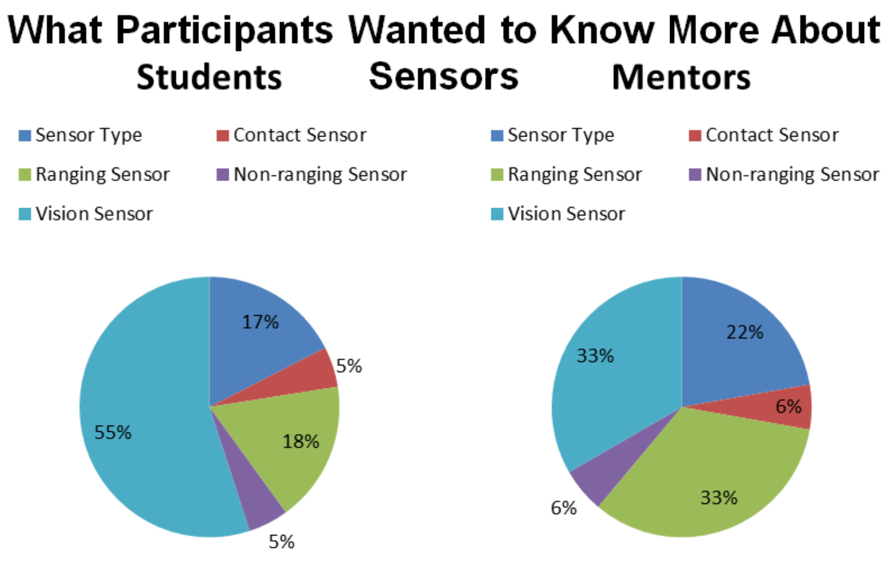


Figure 4-15: What Participants Wanted to Know More About – Sensors (N=92)

4.2.4 Outside Classroom Learning

Our last question on the survey asked students and mentors how they wanted to learn about robotics outside of the classroom. On the survey participants were given five choices; instructional videos, informative articles, PowerPoint Presentations, podcasts, and interactive multimedia (questions and answers). Also participants were given the option to select other, and write in a short answer. For both students and mentors the majority answers were instructional videos receiving nearly half the choices for both. Second for both students and mentors were informative articles and interactive multimedia. Podcasts and PowerPoint Presentations were about equal for third place with other coming in last with only vote (Figure 4-16).

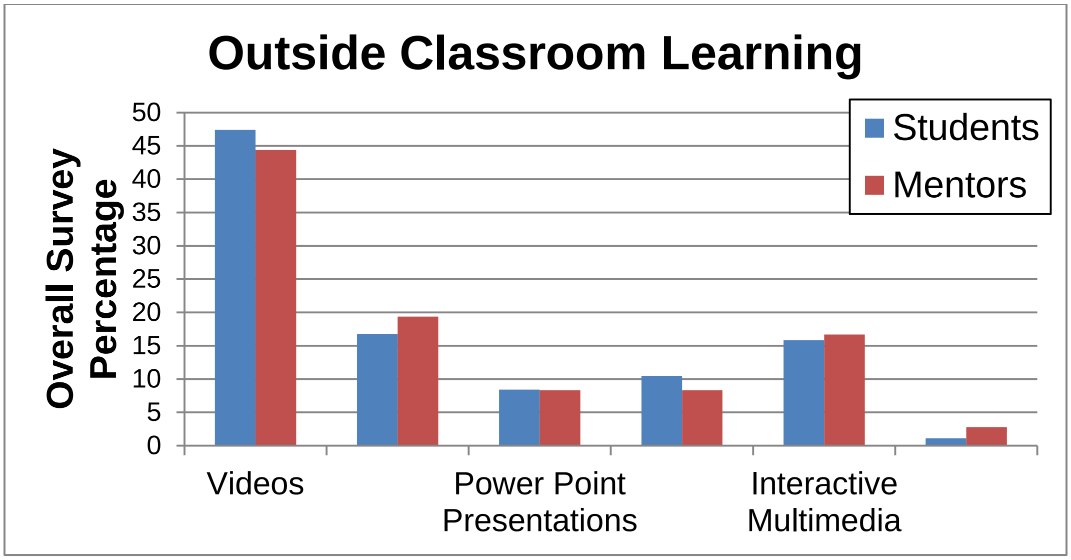


Figure 4-16: Outside Classroom (N=92)

4.3 Focus Group Results

Each of the main topics discussed during the focus group is analyzed separately to best determine how that topic impacts FRC participants. Those topics that were covered are;

- Power Systems
- Add-Ons
- Sensors
- Actuators
- Chassis
- Programming

Also discussed is after each of the above topic areas were covered the team was given the chance to discuss and any all other problems they have had over the years, as well as anything they felt would be helpful to them and other *FIRST* teams in the future.

4.3.1 Power Systems

Team 2191 had trouble in the past with their batteries, knowing whether or not the battery was fully charged, if dropping one damages the battery and how to know when a battery is bad and needs to be replaced. They went on to say that there is no real resource that explains the batteries used in the *FIRST* Robotics competition. Also they mentioned a desire for the kit of parts to come with charger or tester for the batteries. The team all agreed that power distribution and protection both had enough resources already available for their complexity level. With custom electronics the team agreed that their never seemed to be a need to build any for the competition, saying “everything is pretty much plug and play”.

4.3.2 Add-Ons

In the add-on section the team did not really have any desire for much in the way of new resources, saying “other teams post picture of their robots on Chief Delphi and you can pretty much backward engineer them from that”. One of the students did say that he would like to see some sort of data base that would have documentation of the winning team robots from each regional and championship.

4.3.3 Sensors

Team 2191 really has not used sensors to their liking in the past. The team attributes the lack of sensors to their failure to plan ahead, and what sensors they want to use, stating that “we always try to add sensors after everything else is done, but usually take them off *FIRST* thing when we are overweight.”.

4.3.4 Actuators

In regards to actuators Team 2191 has extensively used pneumatics and DC motors for numerous applications. The team feels they have a good grasp on the fundamentals of each, but fails to utilize formulas, and tends to do more of trial and error to see whether a motor or pneumatic cylinder will have the required power to perform the required action. Also the team stressed a desire for a conversion sheet, that lists all the different ways of measuring force, so that when a motor has once type of measurement and another has a different they can easily tell which motor to use. Also having an explanation about how gear ratios work and the formulas associated when them was something the team wanted to see explained in the most simplistic way possible so non-mechanically inclined students could understand and begin using those formulas.

4.3.5 Chassis

When the discussion led to Chassis the team did not have very much to say about it. The only real desire the team stressed about the chassis section is knowing more about the different types available, and how they work and are built.

4.3.6 Programming

What team members said about programming was an overall need for tutorials, and a collection of examples with descriptions of what each part of the code does and why they used that technique instead of other options that could have been taken. Also requested was a list of different programming languages that could be used for robotics, and a comparison of each, giving pros and cons and testimonials about what other people like or dislike about each language.

4.3.7 Open Floor

After the team covered all the topics that were on the survey, a broader approach was taken to the idea of a website geared towards students and mentors new to the *FIRST* Robotics Competition. Some of the different topics students had trouble with during past robotics seasons was when wiring.

4.3.7.1 Wiring Problems

FIRST Team 2191 wanted to know some tricks of the trade when it came to electronics. They felt as though when they crimped wires into connecters or plugged wire into different ports, they were having trouble keeping the wires from pulling out of the connector, or the port. Also students wanted to know how professionals kept a complicated wiring job from become a mess, how they can keep everything clean, neat and organized.

4.3.7.2 Finding Mentors

Another problem students felt strongly about was their need for mentors. They had suggested that as part of the proposed website, there should be a section devoted to finding mentors in their area. They wanted what they called a "craigslist" style mentor listing, where they could put in their area, and search for different people willing to put in time to volunteer, and be able to narrow that search to the categories they need help in, such as a new programming mentor. They also stressed the need for this mentor search engine to have some sort of selection process or rating system like that of www.ratemyprofessors.com.

4.3.7.3 Kit of Parts

The last thing that the students felt would be very helpful, especially to rookie teams, was some sort of description of each item in the kit of parts. The description would include not only what the item is, and how it works, but also the common uses for it. If the item was something that would need to be programmed, a sample program with an explanation of how the program works would need to be included.

4.4 Supplementary Survey Results

The next few sections present the results from the supplementary survey. The *FIRST* section covers who was surveyed, followed by how likely survey participants would be to use an online resource to learn more about robotics. The following section displays the results what participants felt was the most influential source of information aside from mentors. The last two sections covers the results that participants felt whether or not there was information online that could not be found elsewhere, and how successful participants have been with their online searches for robotics related information.

4.4.1 Demographics

The supplementary survey was posted on "Chief Delphi" a forum used by *FIRST* Robotics participants, as well as emailed to WPI Robotics Engineering undergrads. How many years survey participants have been involved with *FIRST* was asked and the majority of those who participated in in the survey have been involved for 5 or more years (Figure 4-17).

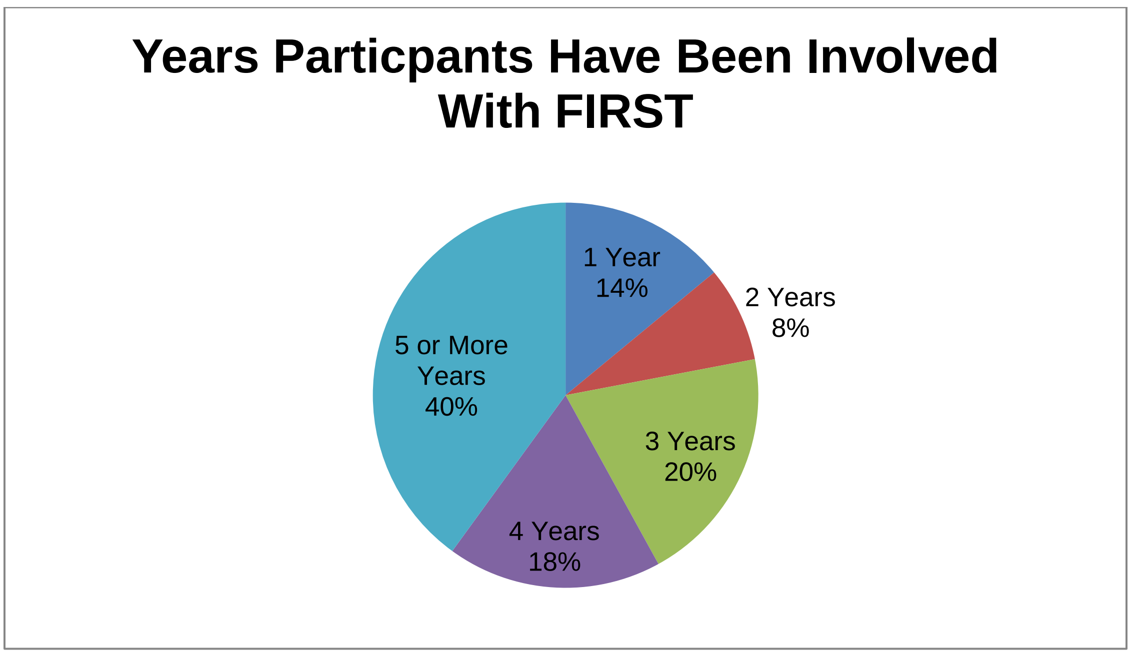


Figure 4-17: Years Participants Have Been Involved With *FIRST* (N=80)

4.4.2 How Likely Participants Would Use Website

The main focus of the supplementary survey was to ascertain how likely *FIRST* participants would use an online resource if it were made available to them. This question was a rating from 1 to 5, 1 being not at all likely to use the website and 5 being most likely. Out of those who answered the survey 44% of them chose 5 the highest rating. This trend continued with 4 receiving the second most votes followed by 3. The two lowest ratings for website use also received the two lowest percentage of votes (Figure 4-18).

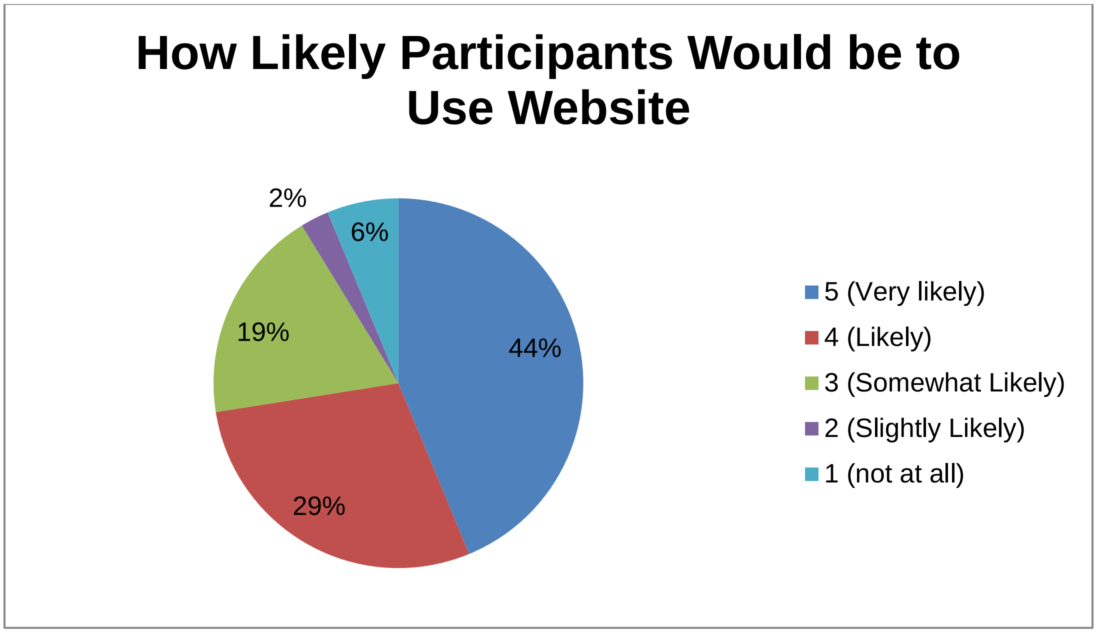


Figure 4-18: How Likely Participants Would be to Use Website (N=80)

4.4.3 Most Influential Source of Information

For this question participants were asked aside from mentors what was the most influential source of information. It was attained from the previous survey that mentors were by far the greatest source of information in every category that was asked about. To avoid having a repeat question, mentors was excluded and the choices given were Internet Websites, Hand on Learning, and text books. The vast majority of participants responded by saying that Hands on Learning was the most influential source of information with 65% of the responses going to this category. Second was Internet websites with 34%, and the remaining 1% was text books (Figure 4-19).

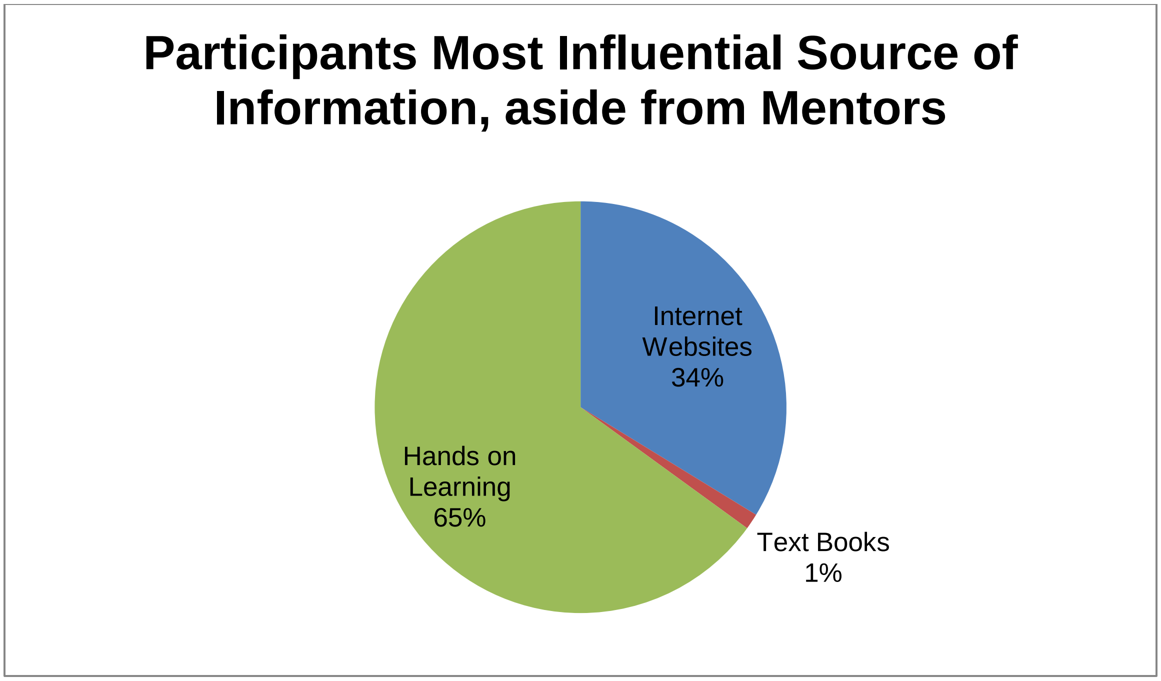


Figure 4-19: Participants Most Influential Source of Information, aside from Mentors (N=80)

4.4.4 Information Only Found Online

Survey Participants were asked if there existed information that they were only able to find online. This was a simple yes or no question, with the majority answer being yes, that there is information online that they cannot find elsewhere (Figure 4-20).

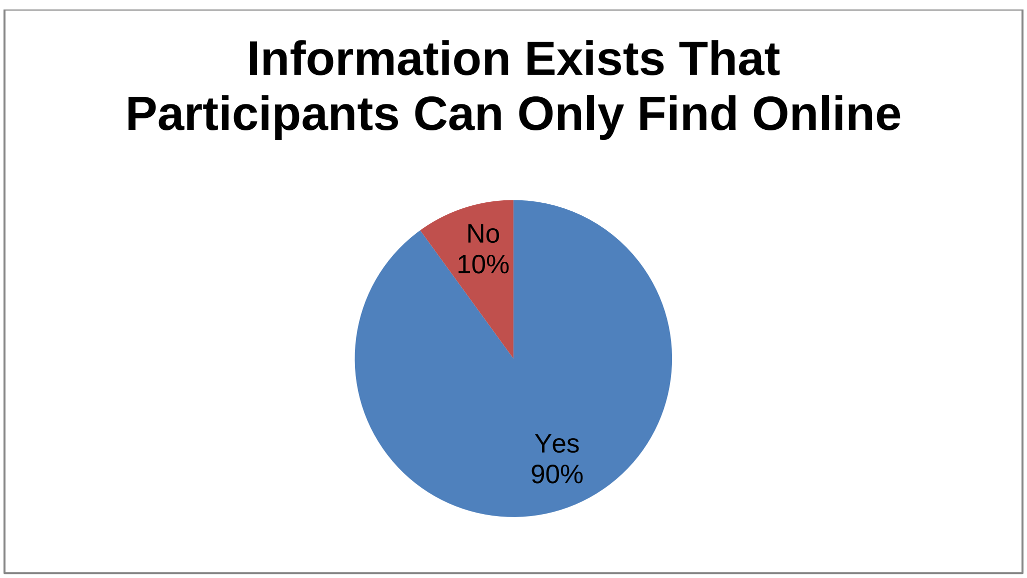


Figure 4-20: Information Exists That Participants Can Only Find Online (N=80)

4.4.5 Ability to Find Information Online

Survey participants were asked about their experiences with trying to find information online. This question asked participants, “Have you used internet resources to try and attain information on a particular robotics related topic with less than satisfactory results?” The possible choices for this question were “No, I always find what I Need”, “Yes, but did not find what I wanted”, “Yes, but the information was inaccurate”, and “No, I don’t use the internet”. From these possible responses 59% said that yes they used the internet but were unable to find what they wanted. The second most popular choice was “No, I always find what I need” receiving 32% of the total. Third was “Yes, but the information was inaccurate”, and only 1% said they did not use the internet.

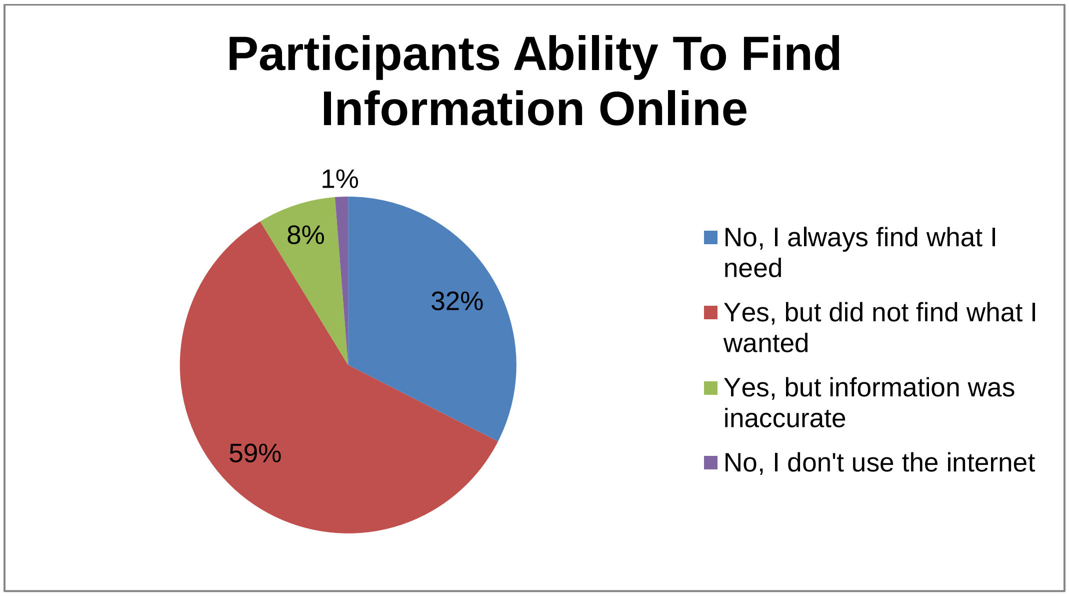


Figure 4-21: Participants Ability To Find Information Online (N=80)

5 Discussion

5.1 Survey Analysis

Assuming inconsistencies within an individual's ability to assess their own knowledge accurately and suggesting that an average of these self-assessments accounts for this difference, the most logical trend assessed from this data is that team members feel, as they spend more time with robotics, their knowledge and understanding of mechanical systems increases. Considering the data further, it is interesting to note that both mentors and students feel that at one year of experience they have an average understanding of both programming and electrical systems, and that after years of experience, individuals suggest that they might not know quite as much. Unfortunately the large discrepancy within the self-assessed knowledge of the mentors may be attributed to the fact that there were very few mentors interviewed and a wide spread of choices. This produces a standard deviation that encompasses half of the overall range tested and therefore no solid conclusions can be made. This can be further analyzed as experienced mentors having a better understanding of the complexity of both electrical and programming systems, and the vast information available. This also could suggest that, new mentors feel overconfident in their abilities, or new mentors joining the competition having a stronger overall background with these systems.

The data acquired in this survey did not mirror the expected outcome. It was expected that teams would feel more confident in their abilities as they increased in experience. This is both discouraging for teams who are new to the competition but also for teams that have been competing for years because it is clear that they do not feel confident in 2 very essential portions of this competition and are looking for a medium with which to learn.

Individuals today have so many resources available to them and each person has very different learning styles, therefore it was important to this investigation to determine which styles would reach out best to the teams. Both students and mentors were asked to elaborate on where they learned the information pertaining to their project; through their mentors, the Internet, other teams, other team members, or in school. The overwhelming majority in every category was from their mentors. In contrast the least selected option was classes in school. This shows the value of the *FIRST* programs approach of using mentors, and the necessity to provide a resource that both students and mentors can both benefit from.

5.2 Focus Group Analysis

Each of the main topics discussed during the focus group is analyzed separately to best determine how that topic impacts FRC participants. Those topics that were covered are;

- Power Systems
- Add-Ons
- Sensors
- Actuators
- Chassis
- Programming

Also discussed is after each of the above topic areas were covered the team was given the chance to discuss and any all other problems they have had over the years, as well as anything they felt would be helpful to them and other *FIRST* teams in the future.

5.2.1 Power Systems

One of the items team members seemed adamant about were batteries, this was in great contrasted to the survey results that put batteries towards the bottom of the power section. Team 2191 had trouble in the past with their batteries, knowing whether or not the battery was fully charged or not, if dropping one damages the battery or not and how to know when a battery is bad and needs to be replaced. They went on to say that there is no real resource that explains the batteries used in the *FIRST* Robotics competition, they also mentioned a desire for the kit of parts to come with charger or tester for the batteries. The team all agreed that power distribution and protection both had enough resources already available for their complexity level. With custom electronics the team agreed that their never seemed to be a need to build any for the competition, saying “everything is pretty much plug and play”. If there was to be a resource that covered custom electronics, First it would need to show examples of devices that could improve their robots performance in competition, then go on and explain in a very simplistic manner how to go about building the device. This explanation also should cover where to buy parts, and basic techniques in installing them (soldering mounting ext.).

5.2.2 Add-Ons

In the add-on section the team did not really have any desire for much in the way of new resources, saying “other teams post picture of their robots on Chief Delphi and you can pretty much backward engineer them from that”. One of the students did say that he would like to see some sort of data base that would have documentation of the winning team robots from each regional and championship. This would involve taking the picture on Chief Delphi one step further and organizing them for easy access.

5.2.3 Sensors

Team 2191 really has not used sensors to their liking in the past. The team attributes the lack of sensors to their failure to plan ahead, and what sensors they want to use, stating that "we always try to add sensors after everything else is done, but usually take them off *FIRST* thing when we are overweight." The team has a general lack of knowledge on sensors and their abilities. In regards to sensors, any resource needs to not only list different sensor types but give examples of practical applications related to *FIRST* competitions. For teams to take the necessary time to plan on using sensors, the resource should stress the added benefits of using sensors.

5.2.4 Actuators

In regards to actuators Team 2191 has extensively used pneumatics and DC motors for numerous applications. The team feels they have a good grasp on the fundamentals of each, but fails to utilize formulas, and tends to do more of trial and error to see whether a motor or pneumatic cylinder will have the required power to perform the required action. The need is there for a collection of formulas as well as the explanations about how and when to use what formulas. Also the team stressed a desire for a conversion sheet, that lists all the different ways of measuring force, so that when a motor has once type of measurement and another has a different they can easily tell which motor to use. Also having an explanation about how gear ratios work and the formulas associated when them was something the team wanted to see explained in the most simplistic way possible so non-mechanically inclined students could understand and begin using those formulas.

5.2.5 Chassis

This past season was the *FIRST* year that *FIRST* Team 2191 used a drivetrain other than tank drive, opting instead to use holonomic drive train. The team loved how their new drive train performed. The only real desire the team stressed about the chassis section is knowing more about the different types available, and how they work and are built. Until last season when they saw another team's robot with the holonomic drive they had no clue that such a drive train existed.

5.2.6 Programming

The team's programmer was not able to attend the session, so the feedback on this section was rather limited. What the other team members did have to say about programming was an overall need for tutorials, and a collection of examples with descriptions of what each part of the code does and why they used that technique instead of other options that could have been taken. Also requested was a list of different programming languages that could be used for robotics, and a comparison of each, giving pros and cons and testimonials about what other people like or dislike about each language.

5.2.7 Open Floor Discussion

After we covered all the topics that were on the survey, we took a broader approach to the idea of a website geared towards students and mentors new to the *FIRST* Robotics Competition. Some of the different topics students had trouble with during past robotics seasons was when wiring.

5.2.7.1 Wiring Problems

FIRST Team 2191 wanted to know some tricks of the trade when it came to electronics. They felt as though when they crimped wires into connecters or plugged wire into different ports, they were having trouble keeping the wires from pulling out of the connector, or the port. Also students wanted to know how professionals kept a complicated wiring job from become a mess, how they can keep everything clean, neat and organized. This would greatly help the students troubleshoot when something did not work right, such as wires pulling out of ports and crimps.

5.2.7.2 Finding Mentors

Another problem students felt strongly about was their need for mentors. What makes *FIRST* different from other robotics competitions is how much they stress the importance of mentors and professionals to help the students learn. Team 2191 has had some mentors come and go over the years, both good and bad, and are currently finding themselves without as many mentors as they would like. They had suggested that as part of the proposed website, there should be a section devoted to finding mentors in their area. They wanted what they called a "craigslist" style mentor listing, where they could put in their area, and search for different people willing to put in time to volunteer, and be able to narrow that search to the categories they need help in, such as a new programming mentor. They also stressed the need for this mentor search engine to have some sort of selection process or rating system like that of www.ratemyprofessors.com.

5.2.7.3 Kit of Parts

The last thing that the students felt would be very helpful, especially to rookie teams, was some sort of description of each item in the kit of parts. The description would include not only what the item is, and how it works, but also the common uses for it. If it's something that would need to be programmed a sample program with an explanation of how the program works.

5.3 Supplementary Survey Analysis

The results from the supplementary survey give clear indication that students are using the internet to find information online, and the majority of them are not able to find what they are looking for. Also survey participants said the internet provides information that they would otherwise not be able to find. With regards to if an online robotics resource were available survey participants indicated that they would use this resource, with over 70% of participants rating their likeliness over half the total scale.

6 Recommendations

6.1 Recommendations for Website Content

From all the results gathered during the course of this project it is clear that students and mentors alike are looking for a new resource for information on robotics. The results from the survey and the focus group indicated that all the topics that were mentioned on the survey and discussed were all important to FRC participants. Those who gave feedback felt that all topics needed to be addressed in more clear, accurate and organized fashion. Those topics that FRC participants felt they would like to know more about are;

- Power Systems
  - Batteries
  - Power Distribution
  - Protection (relays/fuses)
  - Custom Electronics
- Add-Ons
  - Manipulators (arm/claw)
  - Lifting Devices
  - Shooters
- Sensors
  - Sensor Types
  - Contact Sensors
  - Ranging Sensors
  - Non-ranging Sensors
  - Vision Sensors
- Actuators
  - DC Motors
  - Pneumatic Actuators
- Chassis
  - Wheel Types
  - 2 Wheel Drive
  - 4 Wheel Drive
  - Steering
  - Non-traditional Drive Systems

- Programming
    - Controller Basics
    - Operator Control
    - Driving Straight
    - Turning
    - Following Lines
    - Color Detection
    - Programming Sensors

In addition to the topics that were covered on the survey, the focus group voiced their desire for;

- Kit of Part descriptions
- Wiring Techniques
- Information on Finding Mentors

In order to provide sufficient information on the kit of parts, the website would have to go into detail on the more sophisticated devices. This would include what the device is, where you can purchase more, what the primary use is, how to properly install or program the device, and some common uses for robotics applications of the device.

6.2 Recommendations for Website Layout

Part of the project was to produce a list of recommendations for the proposed website. These recommendations are broken down into general topic areas; information, forum, and contact us. Below Figure 6-1shows a simple hierarchy chart of how the proposed website would be set up. Each topic in the chart refers to different areas of robotics. The topics that would be presented on the proposed website comes from the for mentioned survey results.

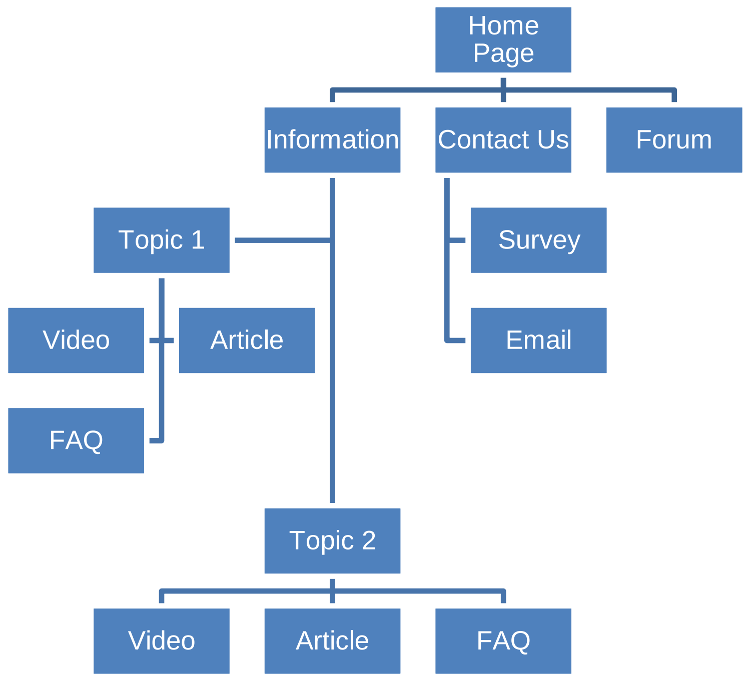


Figure 6-1: Website Hierarchy

6.2.1 Information

For each topic for students to best understand, there should be not only videos but also articles and FAQs. Some students might not want to spend the time to watch and pay attention through the entire video. Having articles along with videos gives students a second option, and by having FAQs, we can address any areas of that topic that may be "tricky". FAQs can be something added over time to supplement the videos and articles, and to address any questions about the topic that are posted either in the forum section or in the contact us section, survey or email.

6.2.2 Forum

By adding a forum section to the site, we hope that more and more people will visit the site and improving the site by sharing their own personal experience and knowledge. From the survey it was determined that one of the most frequently visited and highest ranking websites for individuals to procure information about robots was Chief Delphi, a forum site based around the contributions of the people that visit it.

6.2.3 Contact Us

The "Contact Us" section of the website would encourage teams to be able to get in contact with site moderators giving these competitors the opportunity to request more information in a specific topic or leave feedback on how the information is organized. In addition to providing a contact email address, a simplified survey could be used to continue to poll students for specified data geared towards improving and evolving the website to better serve the teams using it as well as constantly keeping it updated.

7 Conclusion

Through the various methods used to attain information regarding the needs of *FIRST* Robotics Teams; especially those new to the *FIRST* Robotics Competition; there exists a clear desire for a complete and accurate source of information. From gathering surveys, to talking with individuals involved with *FIRST*, a majority felt that existing sources of information is not enough to gain all the knowledge required of the *FIRST* Robotics Competition. By providing a source of information in the form of an online medium, that *FIRST* participants can access from anywhere at any time, more teams will be able to acquire the necessary knowledge they seek to be competitive. With more teams being able to be more successful in competition the likelihood of those teams returning each year will increase. In addition, the likelihood of more new teams joining *FIRST* will increase, with more schools feeling that they too will be successful in *FIRST*.

8 Bibliography

(n.d.). Retrieved September 2011, from Chief Delphi Portal: http://www.chiefdelphi.com/forums/portal.php

(n.d.). Retrieved September 2011, from Think Tank Portal: http://thinktank.wpi.edu/

(n.d.). Retrieved September 2011, from Team 341 Miss Daisy: http://www.team341.com/tiab/

(n.d.). Retrieved September 2011, from RINOS Rookies In Need Of Support : http://rinos.raiderrobotix.org/

(n.d.). Retrieved September 2011, from WPI *FIRST* Resource Center: http://*FIRST*.wpi.edu/

(2007). *Rising Above The Gathering Storm.* National Academies Press.

FIRST At A Glance. (n.d.). Retrieved October 2011, from *FIRST*: http://www.us*FIRST*.org/aboutus/*FIRST*-at-a-glance

FRC 20th Season. (n.d.). Retrieved July 2011, from *FIRST*: http://www.us*FIRST*.org/roboticsprograms/frc/frc-20th-season

History. (n.d.). Retrieved August 2011, from Team2191: http:www.team2191.com/history.html

Impact. (n.d.). Retrieved October 2011, from *FIRST*: http://www.us*FIRST*.org/aboutus/impact

Robotics Programs. (n.d.). Retrieved October 2011, from *FIRST*: http://www.us*FIRST*.org/roboticsprograms

Scholarships. (n.d.). Retrieved October 2011, from *FIRST*: http://www.us*FIRST*.org/aboutus/scholarships

Vision. (n.d.). Retrieved October 2011, from *FIRST*: http://www.us*FIRST*.org/aboutus/vision

9 Appendix

9.1 Survey

Assessing Educational Needs of *FIRST* Robotics Competition Rookie Teams

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study. This study is being conducted to gain further knowledge into what *FIRST* rookie teams deem as important information that will better help them be successful, as well as the means best to acquire this knowledge. All records will be kept confidential, and no record will in any way be traced back to the participant. (Disclaimer: The questions you will answer come from standardized questions measuring different aspects. These questions do not in any way represent any values or attitudes for *FIRST*.)

- Please circle the number of years that **you** have been involved with F.I.R.S.T. Robotics

  1 2 3 4 5+

- Please indicate **your position** on your *FIRST* team: If mentor please indicate what areas you helped students in: (circle all that apply):

  Mechanical-Design Robot-Programming Electrical/Wiring

  Mechanical-Build

  Other:________________________________

- For the following questions, we would like you to think about a topic and then indicate the amount of knowledge you feel you have in that topic:

1. Mechanical Design

   (Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)

   1b) How have you been learning about Mechanical Design? Circle all that apply:

   Mentors Internet Other Teams Other Team Members

   School

(Have Not Learned About Topic Yet) Other:

____

2. Robot Programming

(Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)

2b) How have you been learning about Robot Programming? Circle all that apply:

Mentors Internet Other Teams Other Team Members School

(Have Not Learned About Topic Yet) Other:

____

3. Electrical/Wiring

(Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)

3b) How have you been learning about Electrical/Wiring? Circle all that apply:

Mentors Internet Other Teams Other Team Members School

(Have Not Learned About Topic Yet) Other:

____

4. Mechanical Build

(Very Little Knowledge) 0 1 2 3 4 5 6 7(Exceptional Knowledge)

4b) How have you been learning about Mechanical Build? Circle all that apply:

Mentors Internet Other Teams Other Team Members School

(Have Not Learned About Topic Yet) Other:

____

- For the following questions please rate the **usefulness** of the each website:
    1. Chief Delphi

       (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use
    2. WPI *FIRST* Resource Center

       (Not Useful) 0 1 2 3 4 5 6 7(Very Useful) Did Not Use

3. WPI Think Tank

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

4. Official *FIRST* Website

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

5. Team In a Box (Team 341)

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

Continue on other side

- For the following questions please rate the **usefulness** of the each website:

6. RINOS - Rookies In Need Of Support(Team 25)

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

7. Individual Team Websites

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

- For the following questions please rate the **accuracy** of the information found on the following website:

1. Chief Delphi

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

2. WPI *FIRST* Resource Center

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

3. WPI Think Tank

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

4. Official *FIRST* Website

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

5. Team In a Box (Team 341)

(Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

Did Not Use

6. RINOS - Rookies In Need Of Support(Team 25)

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

7. Individual Team Websites

   (Not Useful) 0 1 2 3 4 5 6 7(Very Useful)

   Did Not Use

- Please list any other websites that you found helpful, that were not listed above:

____

____

____

____

- Please list anything you liked in particular about any of the websites you used during the robotics season:

____

____

____

____

- Please indicate areas of robotics that you feel would have made your team more successful this past robotics season: circle all that apply:

Power System	Sensors	Chassis	Programming
Batteries	Sensor Type	Wheel Types	Controller Basics
Power Distribution	Contact Sensor	2 Wheel Drive	Operator Control
Protection (relays/fuses)	Ranging Sensor	4 Wheel Drive	Driving Straight
Custom Electronics	Non-ranging Sensor	Steering	Turning

Add On Vision Sensor Non-traditional-

Following Lines

Manipulators (Arms/Claw) Actuators -Drive Systems

Color Detection

Lifting Devices DC Motors

Programming-Sensors

Shooters Pneumatic Actuators

- Outside of the classroom what would be the best way for you to learn about robotics: circle all that apply:

Instructional Videos Informative articles Power Point Presentations

Podcasts

Interactive Multimedia (Question and Answer) Other:

____

Gender (please circle): Are you a (please circle): Ages (in years) *FIRST* Team Number

Male Female Student Mentor ____________

____

9.3 *FIRST* Robotics Competition Games

Year	Name	Description	Game Piece	Finale	Terrain
2011	Logomotion	Playing pieces are inner tubes shaped like the components of the *FIRST* logo. The primary objective of the game is to place them on racks to gain points. In the endgame, robots deploy mini-bots to climb a tower. Mini-bots must be made from the *FIRST* Tech Challenge kit of parts.	Inflatable Inner tubes (square, triangle, circle)	Mini-bot climb pole	Carpet
2010	Breakaway	Robots direct soccer balls into goals, traverse "bumps" in the field, suspend themselves and each other on towers, and/or go through a tunnel located in the center of the field.	Soccer ball	Suspend from arena or climb onto platform	Carpet
2009	Lunacy	The goal of the game is to score as many of the game pieces in the opposing side's trailers as possible.	Moon Rocks (hollow balls created by semi collapsible rings)	Human players deliver the “super cell”	Glasliner FRP “Regolith”
2008	*FIRST* Overdrive	Teams competed to complete counterclockwise laps around a central barrier while manipulating large 40 in (1 m) diameter "Trackballs" over and under overpasses to score additional points.	40 in (1m) diameter inflated balls called “Trackballs”	Place the “Trackball” on the “overpass” at the end of the match	Carpet

2007	Rack ‘n Roll	Teams compete to score points by placing inner tubes on “the rack” additional points can be scored at the end of the match by lifting teammates above the field	Inflatable Inner tubes (circle)	Lift teammate robots 4 in or 12 in off the floor	Carpet
2006	Aim High	The competition involved teams competing to gain points by delivering balls into goals and positioning their robots in certain positions on the playing field.	Blue/Red balls	Climb ramp	Carpet
2005	Triple Play	The primary game pieces were called "Tetras”. The game was played on a field set up like a tic-tac-toe board, with nine larger goals, also shaped as tetras in three rows of three. The object of the game was to place the scoring tetras on the larger goals, creating rows of three by having a tetra of your alliance’s color at the highest point on the goal.	"Tetras" which are tetrahedral made from 1.25 in (31.8 mm) PVC pipe 30 in (762 mm) long.	Park robots behind end zones	Carpet
2004	*FIRST* Frenzy: Raising the Bar	In Raising the Bar, teams could score by having their human player score purple balls in any of the goals, capping the goals with a multiplier ball, or hanging their robot suspended from the 10-foot (3.0 m) high 'chin up bar'.	Small purple ball Large yellow ball	Cap goals, and suspend themselves	Carpet

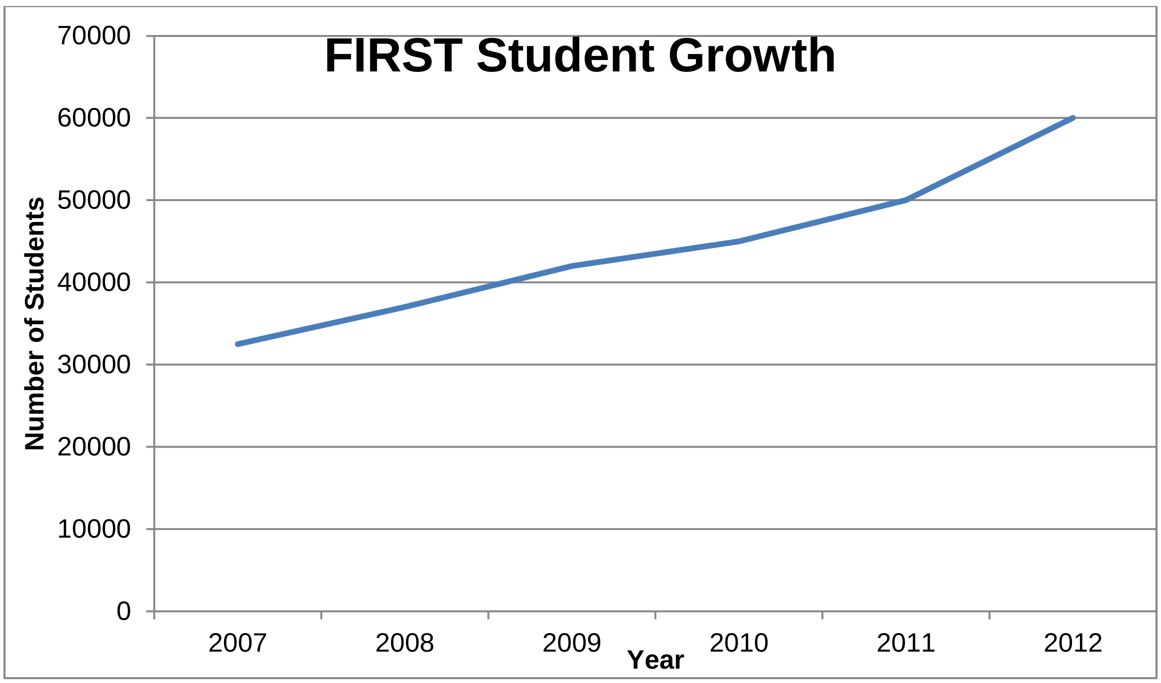
2003	Stack Attack	In Stack Attack, two teams of two robots each attempt to win by moving large Sterilite bins into their zone and arranging them into stacks.	Plastic containers approximately 24-1/4” long x 17-1/4” wide x 15-3/4” high.	Park robot on top of ramp at end of match	Carpet
2002	Zone Zeal	In it, robots playing in alliances of 2 competed to move goals and balls into various zones within the playing field.	Orange and Yellow soccer ball	Move goal into your zone	Carpet
2001	Diabolical Dynamics	Alliances score one point for each small ball in the goal, ten points for each large ball in the goal, ten points for each robot in the End Zone, and ten points if the stretcher is in the End Zone.	Small and large balls	Parking in the end zones	Carpet
2000	Co-Operation *FIRST*	Alliances receive one point for each yellow ball and five points for each black ball in their goal, and not in contact with their robot. Robots that are completely on the ramp each earn five points for their alliance. A robot hanging from the horizontal bar connecting the two goals earns ten points for its alliance.	Yellow and Black balls	Suspend themselves	Carpet
1999	Double Trouble	Teams compete to hang floppies above the playing floor, with additional points for hanging them 8 feet or higher off the floor.	"Floppies" (light-weight, pillow-like objects with Velcro-loop material located in its center and around its	Climb onto and position the puck on teams side	Carpet

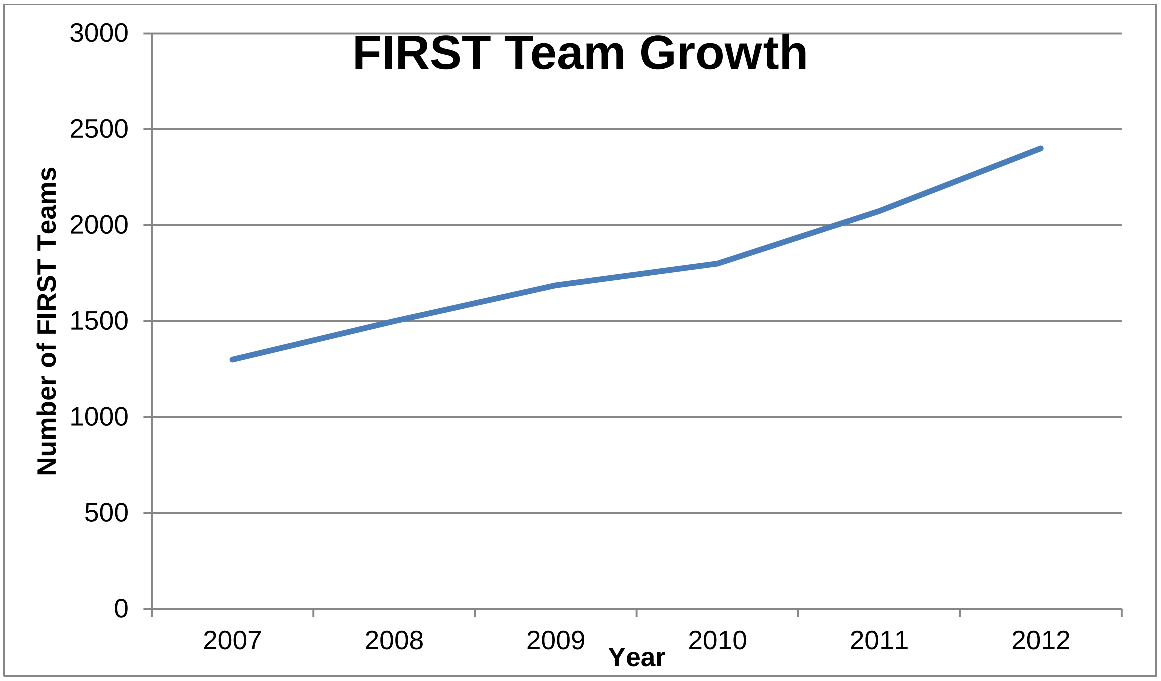
			perimeter) "puck" (octagonal platform that rolls freely on castor wheels)		
1998	Ladder Logic	Three robots and human players score points by putting rubber balls into the center goal and along the rails. The balls are color-coded to identify team ownership.	Rubber Ball	None	Carpet
1997	Toroid Terror	Three robots and human players score points by placing the inner tubes onto pegs on the goal, or around the top of the goal.	Inner Tubes (circle)	None	Carpet
1996	Hexagon Havoc	Three robots, with their human partners, scored points by placing the balls in the central goal. The balls were carried, pushed or thrown into the goal by the robots	8 in diameter ball 24 in diameter ball	None	Carpet
1995	Ramp 'n Roll	Teams competed to lift smaller balls over a field goal and larger ones through the goal	24 in diameter ball 30 in diameter ball	None	Carpet
1994	Tower Power	Three teams competed to place the 12 balls of their team color inside either the high goal, worth 3 points per ball, or the low goal, worth one point per ball.	Soccer Ball	None	Carpet
1993	Rug Rage	Teams competed individually to score small balls in their goal and lift big	13 in diameter ball 6 in diameter water filled ball	None	Carpet

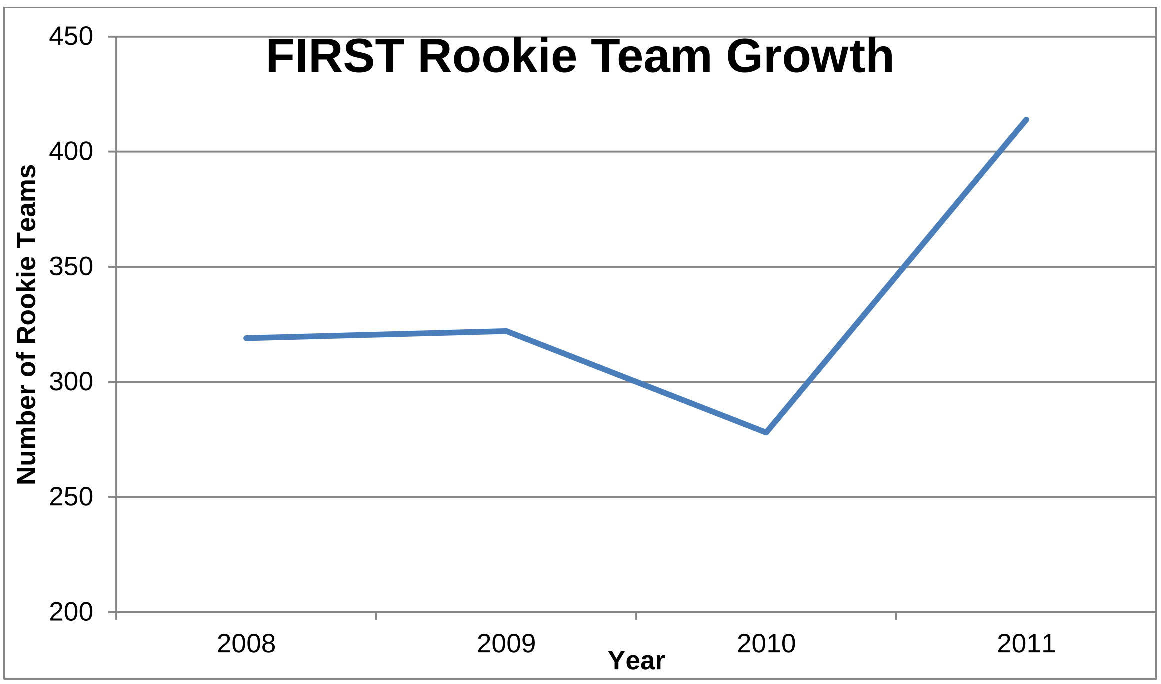
		balls over the top and into their goal			
1992	Maize Craze	This game was played by four individual robots trying to collect tennis balls into their starting base. An impediment to the robots was that the entire playing field was covered in a layer of corn 1-2 inches thick.	Tennis Ball	None	Corn

9.4 ***Participation to FIRST*** **Robotics Competition**

Year	Students	Teams	Rookie Teams
2012	60,000	2,400	NA
2011	50,000	2,073	414
2010	45,000	1,800	278
2009	42,000	1,686	322
2008	37,000	1,500	316
2007	32,500	1,300	NA




FIRST Team Growth
Number of FIRST Teams
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
Year


FIRST Rookie Team Growth
Number of Rookie Teams
450
400
350
300
250
200
2008
2009
2010
2011
Year

9.5 *FIRST* Build-Season Timeline

Day 1

- Review Game
- Analyze Game by determining all available options to play the game
- Decide how we want to play the game

Week 1

- Individuals sketch ideas
- Mentors help break down the ideas and determine the possible success of each
- Decide on drive system
- We usually have a mentor that kind of settles into their part of the robot. For instance, we had a mentor that helped the kids with the lift system. We had one that helped with the elevator for tube placement, and we had two that really just focused on the drive system the whole time. Of course we have our electrical and programming mentors as well.
- Mockups
- Prototyping

Week 2

- Frame Design
- CAD Designs of Individual Components
- Optimization of Designs
- Constraining Each Component (Weight, Size)
- Continued Game Analysis
- Frame Manufacturing
- Drive Prototype Done

Week 3

- Part Manufacturing
- Drive Assembly (Depending on drive, could be later)

- Manipulator Assembly
- Refining Parts and CAD Drawings

Week 4

- Component Testing
- Robot Assembly
- *FIRST* drive test
- Usually completely taking half the robot off and putting it in the dumpster and redesigning it. Usually the most crucial component...
- Driver practice near end of week if lucky

Week 5

- Programming optimization
- Programming of the individual components
- Driver Practice
- Fixing problems

Week 6

- Fixing
- Optimizing
- Practicing
- Shipping
- Finally, sleep... But probably not.

9.6 IQP Timeline

April 8th, 2011

- Administered Initial Survey at Boston Regional

April 27th-30th, 2011

- Administered Initial Survey at *FIRST* Championship held in St. Louis

May 21st, 2011

- Administered Initial Survey at Monty Madness, Montgomery High School, Skillman, New Jersey
- Administered Initial Survey WPI BattleCry, Worcester Polytechnic Institute, Worcester, Massachusetts

July 28th, 2011

- Focus Group with *FIRST* Team 2191

October 5th, 2011

- Administer Supplementary Survey via email

9.7 Supplementary Survey

Assessing Educational Needs of FIRST Robotics Competition Rookie Teams

You are being asked to participate in a research study. Before you agree however, you must be informed of the purpose of this study. This study is being conducted to gain knowledge into what FIRST rookie teams consider important information that will help them compete more successfully, as well as the means by which to best provide information to all teams. All records will be kept confidential, and no record will in any way be traced back to the participant. (Disclaimer: The questions you will answer come from standardized questions measuring different aspects. These questions do not in any way represent any values or attitudes of FIRST.)
* Required

If a robotics curriculum were available online outside of the classroom, would you be likely to use it? *
This resource would not have formal assignments and would be considered an introduction to robot design and construction

- 5 (very likely)
- 4
- 3
- 2
- 1 (not at all)

Aside from mentors, throughout a FIRST robotics competition what is your most influential source of information? *

- Internet websites
- Text Books
- Hands on learning

Is there information online that you are unable to find elsewhere? *

- Yes
- No

Have you used internet resources to try and attain information on a particular robotics related topic with less than satisfactory results? *

- No, I always find what I need
- Yes, but did not find what I wanted
- Yes, but the information was inaccurate
- No, I don't used the internet

How many years has you been participating in FIRST? *

- 1 year
- 2 years
- 3 years
- 4 years
- 5 or more years

Submit

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9.8 List of FRC Rookie Teams

The following list includes Teams that joined FRC in the past 4 year and were accessible to the project team for administering the surveys;

Boston Regional		April 7th-9th
Team #	Years	Location
2349	4	Wayland, MA
2423	4	Watertown, MA
2497	4	Natick, MA
2523	4	St. Johnsbury, VT
2593	4	Peabody, MA
2648	4	Messalonskee, MR
2713	3	Melrose, MA
2871	3	Roxbury, MA
2876	3	Burlington, MA
2877	3	Newton, MA
2888	3	Chestnut Hill, MA
3148	2	Dorcester, MA
3173	2	Rochester, NY
3236	2	Franklin, MA
3280	2	Providence, RI
3466	1	Westford, MA
3479	1	Everett, MA
3597	1	Kittery, ME
3609	1	South Portland, ME

FIRST Championship		April 27th-30th
Team #	Years	
2338	4	Oswego, IL
2342	4	Merrimack, NH
2359	4	Edmond, OK
2415	4	Atlanta, GA
2437	4	Honolulu, HI
3358	2	Petach Tikva, Isreal
3393	2	Puyallup, WA
3397	2	University City, MO
3456	1	Pocatello, ID
3462	1	Toluca, ME
3467	1	Windham, NH
3477	1	Chula Vista, CA
3478	1	San Luis Potosi, SL, Mexico
3481	1	San Antonio, TX
3487	1	Plainfield, IN
3492	1	Winfield, WV
3504	1	Pittsburgh, PA
3526	1	Saltillo, CO, Mexico
3528	1	Kansas City, MO
3574	1	Burien, WA
3588	1	Renton, WA
3596	1	South Milwaukee, WI
3616	1	Lafayette, LA
3645	1	Forest Hills, NY
3694	1	Atlanta, GA
3704	1	Chula Vista, CA
3747	1	Mankato, MN
3748	1	Ellicott City, MD
3766	1	Bet-shean, Isreal
3780	1	Providence, RI
3784	1	Verona, MO
3792	1	Columbia, MO
3799	1	Elmira, NY

			Monty			
2471	4	Camas, WA	Madness			May 21st
2472	4	Circle Pines, MN	Team #		Years	
2481	4	Tremont, IL		1989	5	Vernon Township, NJ
2486	4	Austin, TX		2016	5	Ewing, NJ
2512	4	Duluth, MN		2180	5	Hamilton, NJ
2543	4	Chula Vista, CA		2285	5	Irvington, NJ
2556	4	Niceville, FL		2344	4	Yonkers, NY
2641	4	Pittsburgh, PA		2495	4	Hamilton, NJ
2655	4	Colfax, NC		2753	3	Bridgewater, NJ
2660	4	Tulalip, WA		3231	2	Clifton, NJ
2662	4	Tolleson, AZ	BattleCry			May 20th-21st
2665	4	Dayton, OH	Team #		Years	
2702	3	Kitchener, ON		1991	5	Hartford, CT
2761	3	Freson, CA		2168	5	Groton, C
2783	3	Crestwood, KY		2342	4	Merrimack, NH
2797	3	Clermont, FL		2370	4	Rutland, VT
2815	3	Columbia, SC		2648	4	Oakland, ME
2826	3	Oshkosh, WI		2713	3	Melrose, MA
2949	3	Batavia, IL		2791	3	Latham, NY
2990	3	Turner, OR		3044	3	Ballston Spa, NY
3009	3	Boulder City, NV		3074	3	Kennebunk, ME
3010	3	Centerburg, OH		3125	2	Hartford, CT
3017	3	Fresh Meadows, NY		3273	2	Springfield, MA
3103	3	Houston, TX		3280	2	Providence, RI
3158	2	Metepec, ME		3555	1	Storrs, CT
3160	2	Grove, OK		3780	1	Providence, RI
			Ready			
3172	2	Salina, KS	Reserves			
3242	2	Ocala, FL		2067	5	Guilford, CT
3284	2	Camdenton, MO		2079	5	Millis, MA
3322	2	Ann Arbor, MI		2262	5	Holliston, MA

3337	2	Baton Rouge, LA
3344	2	Fayetteville, GA
3351	2	Beer-Sheva, Isreal
2523	3	St. Johnsbury , VT
2836	3	Woodbury, CT
3525	1	Waterbury, CT
3566	1	Southborough, MA

9.9 IRB Form

WORCESTER POLYTECHNIC INSTITUTE
Institutional Review Board
Study Modification Form

WPI USE ONLY
IRB # ________
Date: ________

1. WPI IRB #: 2009-037
2. PI Name: Jeanine Skorinko
3. Title of Study: Social Networking in FIRST
4. Contact Person for Amendment: *(include Telephone/Email/Fax)* Jeanine Skorinko

Tel No: x5451 E-Mail Address: skorinko@wpi.edu Fax No: ________

5. Proposed Amendment(s) involves changes to: *(Please check (✓) all appropriate boxes)*

☐	Age range of subjects	☐	Consent/reconsent processes	☐	Sample size
☐	Cohort or sources of subjects	☐	Personnel	☐	Grants/Sponsors
☐	Recruiting/advertising	☒	Principal Investigator	☐	Study sites – Domestic *(Specify)*
☐	Remuneration for subjects	☐	Procedures/Methodology	☐	Study sites – International *(Specify)*
☐	Confidentiality statement	☒	Research Instruments	☐	Translations/Language
☐	Other:				

6. Reasons for the proposed amendment(s):
We are running a new survey to understand what resources FIRST participants would like to have to increase their knowledge base to socialize and learn. The new survey is attached. In addition, I would like to add Taskin Padir as a Co-PI to this IRB

7. How does the amendment(s) change the risk/benefit analysis of this protocol and to what degree?
Does not.

8. You must attach documents to support your amendment request: *(Please check (✓) all appropriate boxes)*

☐	Grant applications that WPI IRB does not already have	☐	New/revised internet consent form(s)
☐	IRB approvals of letters of support	☒	New/Revised research instruments
☐	Training documentation for new personnel		
☐	Other forms or materials – Describe:		

PI Signature: ______________________ Date: 4/7/2011

Please return a signed hard copy of this form to the WPI IRB c/o Ruth McKeogh 2nd Floor Project Center
If you have any questions, please call (508) 831-6699.

WPI INSTITUTIONAL REVIEW BOARD
revised 11/12/2009

9.10 IRB Modification

100 Institute Road
Worcester, MA 01609-2280, USA
508-831-5000, Fax: 508-831-6090
www.wpi.edu

Worcester Polytechnic Institute IRB #1
IRB 00007374

19 April 2011
File: 09-037M

Worcester Polytechnic Institute
100 Institute Road
Worcester, MA 01609

RE: Modification to IRB #09-037, "Social Networking in FIRST"

Dear Prof. Skorinko,

The IRB has reviewed the modification submitted to application #09-037 "Social Networking in FIRST", dated January 6 , 2010, and approves the modification regarding the addition of a new survey to understand what resources FIRST participants would like to have to increase their knowledge base to socialize and learn.

The modification also involves the addition of a co-investigator, Taskin Padir.

The period covered by this approval is from 19 April 2011 to 18 April 2012 unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

If the research is to continue past 18 April, 2012, a renewal application must be filed with the IRB in sufficient time for approval before April 18.

Please contact the undersigned if you have any questions about the terms of this approval.

Sincerely,

Kent Rissmiller

Kent Rissmiller
WPI IRB Chair