National Product Design Competition for High School Students

by

Lucas Hernandez-Mena

Submitted to the Department of Mechanical Engineering
in Partial Fulfillment of the Requirements for the Degree of
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ABSTRACT

Sir Ken Robinson said, "We don't grow into creativity, we grow out of it or rather we're educated out of it."[1] Throughout my education I have found this statement to be true especially in it's relation to high school education in America. This lack of creativity-based education is the inspiration for this thesis work. As a high school student I was able to participate in a few robotics competitions, such as FIRST Robotics Competition, that enabled me to begin thinking creatively about problems. These competitions were focused on allowing students to gain engineering experience and inspiring them to pursue a degree in a science or technology field. However, the competitions tended to primarily attract students who are already interested in these fields.

This thesis will propose and provide motivation for an Internet-centric, national product design competition for high school students that will teach and inspire the use of creativity for a wide range of students that have interests in many different fields. This document begins with highlighting and outlining the main competitions, programs, and classes that have been drawn on for the creation of this competition. Then, the main motivation and goals of the competition are outlined. Lastly the structure of the competition and the online community is described.

The competition proposed in this thesis is perhaps a utopian ideal structure that requires further development and consideration before it can be implemented in the high school setting. Some future development includes surveying high school teachers on the practicality of such a competition in relation to their personal experiences with the interest level and capabilities of high school students. Also a large a part of the future work would include the development and testing of the online community as a portal for high school students to learn and share about product design. Lastly, future work will involve an intensive analysis of the financial requirements incorporated with the implementation of a competition of this nature.

Thesis Supervisor: David Wallace
Title: Professor of Mechanical Engineering

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[1] "Ken Robison says schools kill creativity | Video on TED.com" TED Conferences, LLC. <http://www.ted.com>

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Table of Contents

1.0 Introduction

Sir Ken Robinson said "We don't grow into creativity, we grow out of it or rather we're educated out of it."[1] Throughout my education I have found this statement to be true especially in it's relation to high school education in America. This lack of creativity-based education is the inspiration for this thesis work. As a high school student I was able to participate in a few robotics competitions, such as FIRST Robotics Competition, that enabled me to begin thinking creatively about problems. These competitions were focused on allowing students to gain engineering experience and inspiring them to pursue a degree in a science or technology field. However, the competitions tended to primarily attract students who are already interested in these fields.

This thesis will propose and provide motivation for an Internet-centric, national product design competition for high school students that will teach and inspire the use of creativity for a wide range of students that have interests in many different fields. The hypothesis is that the highly interdisciplinary nature of product design, spanning from highly technical, to the arts, and business, can provide a stimulating, productive, and professional venue for an exceptionally diverse student population.

This document will begin with highlighting and outlining other competitions, programs, and classes that have been drawn upon for the creation of this competition. Then the main motivation and goals of the competition will be outlined. Then the structure of the competition and the online community will be described. Finally, the future work and development of the competition will conclude the document.

2.0 Background Research

2.1 FIRST Robotics Competition

The FIRST Robotics Competition (FRC) is a world-wide robotics competition for high school age students. FIRST, which stand for *For Inspiration and Recognition of Science and Technology*, strives to inspire young people to be science and technology leaders, by engaging them in exciting mentor-based programs that build science, engineering and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership.[2] Through increasing awareness and interest in science and technology, FIRST aims to increase college going and potentially a focus on science and engineering careers, and develop a set of attitudes and skills described by the program as "gracious professionalism" – the ability to work together within a team and to work cooperatively with those on other teams, including potential competitors.[3]

The FRC season officially starts the first week of January with the official webcasted Kickoff. For the teams that cannot make it to New Hampshire to see the event in person, most cities have local events to watch the live feed from Southern New Hampshire University. At the Kickoff that season's game is revealed for the first time in great detail along with that year's Kit of Parts, which varies slightly each year. The event in New Hampshire, along with the smaller local events, also act as ways for teams to meet each other, share tips and ideas, and get excited for the upcoming season. Also at most of these events, technical workshops are held to help teams learn some useful skills that they will need for that season. After the Kickoff, the teams have six weeks to design and build a robot that will effectively play that game that has been constructed for that year. At the end of the design/build period the robots are shipped to their regional events that take place in March and April. The winning teams from the regional events go on to the huge championship event held in the Georgia Dome in Atlanta, GA.

In order to start a FRC teams FIRST suggests a few engineers or other professional volunteers (3 to 6) encouraged by their company's senior management, 10 to 20 high-school-aged young people led by an adult mentor, ideally supported by the school and a group of parent volunteers,

and about $10,000 to participate in one Regional competition that is obtained from a single company, a group of companies and/or through school fund-raising efforts.[4] The $10,000 covers the entry fee for one regional competition, the Kit of Parts, and other expenses associated with the competition like building materials and travel to the competitions. Compared to other robotic competitions, the cost of FRC is quite large, but it allows the students to work with more rigorous technologies like pneumatic actuators, complex gear trains, and autonomous behaviors that require use of optical and tactile sensors. Also, the entry fee allows the FRC to hold the competitions in large venues that adds to the sense of excitement and intensity that is usually only found in sporting events.

Another factor that distinguishes FRC from most robotic competitions is the reliance on professional volunteers to mentor and guide the teams. Each year the games are designed so that the students will have to design fairly complex robotic systems to effectively score points. Since the design and build time frame is only six weeks, they must have the support of people who have engineering experience in order to create a working robot. The profession volunteers provide this support through teaching the teams about different technologies in the design phase, and teaching them about practical manufacturing techniques in the build phase. Besides technical support, the professional volunteers also act as career role models by sharing their real world experience with their teams. The active support of these professional volunteers has made FRC a successful program for inspiring students to pursue careers in engineering and science.

In 2002, FIRST commissioned Brandeis University to evaluate the impact that FRC has had on the academic and professional goals of the participating students.[5] They surveyed a diverse group FIRST alumni, including substantial numbers of students who are minorities, women, and from families with a limited educational background. The results of the survey are as follows: Almost all participants felt FIRST had provided them with the kinds of challenging experiences and positive relationships considered essential for positive youth development. Eighty-nine percent indicated they had "real responsibilities;" 76% felt they had a chance to play a leadership role; and 74% reported that students made the important decisions. Ninety-one percent felt they learned a lot from the adults on the team and 91% felt they "really belonged" on the team. Most participants also reported a positive impact on their attitudes towards teamwork, interest in

science and technology, and how they saw themselves. They reported an increased understanding of the value of teamwork (95%) and the role of "gracious professionalism" (83%). An increased understanding of the role of science and technology in everyday life (89%), increased interest in science and technology generally (86%), and increased interest in science and technology careers (69%). Students also reported increased self-confidence (89%) and an increased motivation to do well in school (70%). Along with these positive findings, the report showed that a large majority of FIRST alumni graduated high school and went to college at a higher rate than high school graduates nationally. Once in college, a substantial proportion of FIRST alumni took courses and participated in jobs and internships related to science, math and technology.

2.2 Lemelson-MIT InvenTeams

InvenTeams is an initiative created by the Lemelson-MIT Program that provides teams of high school students, teachers, and mentors with grants up to $10,000 to develop technological inventions that solve real world problems. Through InvenTeams, the Lemelson-MIT Program hopes to inspire a new generation of inventors by providing them the resources to cultivate their creativity and experience invention through hands-on problem solving. Each team chooses its own problem to solve and rely on life experience coupled with lessons from science, technology, engineering, and math (STEM) to develop invention prototypes.[6] This program is potentially more closely aligned with product development.

The InvenTeams grant cycle begins with an initial application that is submitted by the sponsoring teacher in mid March. At this stage student involvement is not necessary and only a proposal of invention idea needs to be developed. From these applicants up to 35 finalists are selected and the high school teachers are invited to EurekaFest, which is the culmination of the previous year's cycle and takes place in the summer. After this the teams spend the summer developing their idea further for the final application that includes a budget for the exact amount they are requesting, invention statement, and project organization with a development timeline. From these final applications up to 15 grants are awarded in the beginning of October. The teams spend the rest of the school year developing their invention as far as possible. Teams are required to manage their finances and submit reports through a private portal on the InvenTeam website. The teams are also required to submit a Mid-Year progress report that details process

and achievements during the first half of the cycle, plus plans for future development. At the end of the grant cycle the teams submit a Summary report which includes an executive summary, description of invention and design process.[7] Some teams decide to pursue their projects further and create a business plan, but this is not required. Also, at the end of the grant cycle all of the InvenTeams are invited to EurekaFest, a multi-day celebration of the inventive spirit that takes place at MIT. Each team is given a space to show off their invention to the general public and a few teams are invited to give a formal presentation describing their entire development process.

Student response to the InvenTeams initiative has been very positive for many reasons. Michael Bogardus from Saratoga Springs High School said, "I love that we got to pick our own project. The fact that it was close to projects that real engineers do was very appealing. The number of life skills I developed is countless. I would do the whole thing over again in a heart beat." Fady Barsoum from Troy High School said, "The fact that we were helping people who don't normally receive help motivated us through the frustrating parts. We often had to scratch plans and rethink ideas that we had spent a lot of effort on. I learned quickly that complicated projects required the cooperation of many people with diverse strengths."[8] Since students choose their own projects they feel ownership over the idea in turn they are motivated to see it through to the end. Also they gain a sense of accomplishment because they are creating a real solution to a real problem.

2.3 2.009 Product Engineering Process

2.009, Product Engineering Process, is the semester long senior capstone design class for mechanical engineering students at MIT.[9] Teams of 15 to 19 students work together to design and build work alpha prototypes of new products that are unified each year by a central theme. The effort spans the early phases of product development, including: generating ideas; gathering customer and market data; selecting ideas, devising concepts and building sketch models; building and testing mockups; customer evaluation of mockups; embodiment design; and construction of a high quality functioning alpha prototype. The first half of the semester is dedicated to the development of the product idea and includes a few distinct milestones to aid the process. Each milestone requires the students to perform extensive research and design that translates into building quick mockups and prototypes that allow them to test their ideas. The second half of the semester is dedicated to the development of the final product idea into a

working prototype that is formally presented to an audience of approximately 150 practicing product designers and entrepreneurs at the end of the semester.

The class website describes the technical goals as the following:

i) improve creative-thinking capability, the ability to identify the most significant opportunities or issues and to develop appropriate solutions through a structured product development process.

ii) improving expertise in constructing models for reasoning about design alternatives. These include estimations, sketches, sketch models, spreadsheets, geometric models, mockups and prototypes.

Other less technical goals are:

i) to learn about and experience structured methods for working in large teams on a project that requires teamwork to be successful while improving presentation skills using a wide variety of media.

ii) to develop an understanding of, and enthusiasm for, the engineering activities involved with designing a new product and an appreciation for the significance of societal contributions that can be made as a technological innovator.[10]

2.4 2.00b Toy Product Design

2.00b, Toy Product Design, is a semester long project based design course at MIT that is intended to be an introduction to the product design process with a focus on designing for play and entertainment.[11] Its main structure and goals are similar to those of 2.009, but it is designed for students who have little to no mechanical engineering knowledge and experience. For these reasons, it serves as a good model for the development of a product design competition for high school students. Like 2.009 a large portion of the class is dedicated to the development of the final product idea with a few milestones along the way. After the theme for that year's class has been revealed, the first milestone is the Idea Presentation. Each team creates a poster and one minute pitch for four of their best ideas. After they receive feedback on their ideas, the next

milestone is the Sketch Model Presentation. Each team builds one sketch model for each of their four ideas that will allow them to quickly test questions about feasibility, ergonomics, or any other concern about the product idea. After they receive feedback on their sketch models, the teams choose one idea to pursue for the rest of the semester. The semester concludes with the Playsentations in which each team presents their toy product idea to the MIT community, professional designers, and Hasbro. Since 2.00b is not a required course for any major, it is a good model for the demographics of students who are interested in product design. Over the last four years the average percentage of female students has been 57.7%, significantly higher than the overall at MIT proportion (45.4%), and much higher than the percentage of female students in mechanical engineering (~35%). Also between 2006 and 2008, the average percentage of students in the class majoring in mechanical engineering or choose mechanical engineering as a major was only 62.2%. This shows that product design appeals to a broad range of students from different majors.

3.0 Motivation and Goals

The competition that is proposed in this thesis shares many of the same goals as the competitions and programs highlighted in the previous section. Like FRC it strives to promote the interest and exploration of technical fields by high school students. Also it aims to provide exposure to the process of solving real world problems like the Lemelson-MIT InvenTeams. Just like 2.009 and 2.00b it attempts to accomplish these goals through the education and hands-on experience of the product design process. This competition has two main facets that combine to separate it from the previously mentioned competitions, programs, and classes. These are the promotion of open-ended creativity at the high school level and the creation of multi-interest teams.

Within the high school public education system in the United States, creativity education is not a major priority. In his talk at TED, Sir Ken Robison stated, "creativity now, is as important in education as literacy."[1] His contention is that in order for us to solve the complex problems that will face our society in the future, we will need to understand how to think creatively. Most classes consist students being taught a bunch of information, retaining it, and regurgitating it back out on a test. Some higher-level courses do require the students to learn the information

and make new connections to solve problems. These exercises take a certain amount of creativity but it does not require the students to create a completely original ideas. This type of creativity is only employed when one must solve an open-ended problem. The product design process requires this type of creativity because there is not one exact way to solve any specific human need.

Most competitions for teams of high school students bring together students with very similar interest and career goals. Since this is product design competition, students will be required to design a product that is functional and aesthetically appealing while having a distinct potential customer described through a preliminary business plan. This will require the students that form the team to not only be interested in engineering but also interested in art and business. Therefore, the successful teams will consist of students that do not usually interact and work together on a daily basis. Also it will expose a wide range of students to the industry of product design and promote the exploration of the field through their studies in college.

4.0 Competition Structure

4.1 Theme Based

The competition cycle will begin with the revealing of theme for that particular year. The teams will be challenged to research, design, and ultimately build an alpha prototype of a product that fulfills an unaddressed need or improves upon the current methods of addressing a need within the scope of the theme. An alpha prototype contains all the functional and formal design elements of the product and could be used as the base for creating the production model. Each year the theme will be carefully chosen to ensure that it is timely, socially relevant, and most importantly broad enough to allow open-ended creativeness while narrow enough to give the teams an initial focus.

There are many reasons that a team based competition was chosen. Each year teams will work on a completely new product that addresses a completely different need than the product they worked on the year before. This will enable them to learn about new customers, industries, technologies, manufacturing processes, and other related topics each year. This allows the team

members to gain exposure to a broad range of industries and markets that they may want to pursue a career in someday. Also the yearly themes will keep teams from getting bored of a certain product by forcing them to come up with new ideas every competition cycle. Sometimes when an InvenTeam is very successful with their invention, the public wants them to keep developing their idea far after the team wants to move on to new project. This can be frustrating to a team especially if most of the students who created the idea have graduated and moved on to pursue their degrees at college.

Since the teams will always be learning a lot of new skills for each competition cycle, younger or inexperienced members will not feel as intimidated about joining because no one on the team is an "expert." With most robotic competitions, each year the competition is basically the same with slight variations on the objects that are manipulated. For the most part the competitions involve building a base that can drive around the game area and the real challenge lies in designing a clever mechanism to grab/push the chosen object into some sort of scoring receptacle. Therefore team members with experience in these types of competitions have a good understanding of the concepts and technologies necessary to create a successful entry. This can be discouraging to inexperienced members as they may feel their knowledge will contribute little to the design. Since the teams will work on completely different projects each year, experienced and inexperienced team members will be required to learn new skills every year.

Because part a large part of the competition is the actual development of the product idea, all the team members will be able to feel ownership over the project. This will encourage younger students to join the team since they can take an active role in the team without having any previous knowledge of the competition. At the same time, since no team has a large advantage solely because of experience, new teams will have no hesitation about joining the competition.

The yearly theme will also help the competition to continually reach out to new industries for support and resources. This will ensure that no particular resource will be exhausted or feel over burdened. Also it will help in the promotion and spread of the competition since it will continually seek the support of new people. Each year a new panel of judges will be selected that will not only represent leaders in the product design but also leaders in the industries that

pertain to the theme for that specific year. Through this process the competition's support network will actively grow and expand each year.

Since the only criterion is to create a product within the realm of the theme, the competition is only indirectly competitive. Sometimes teams involved in engineering competitions become disheartened because they feel that they can never beat such and such team. Also because of outside factors like lack of resources or inadequate experience, some teams feel like they'll never get to experience the final event festivities. This competition eliminates these notions because every team who works hard throughout the competition will get to participate in the final event and feel the same sense of accomplishment.

4.2 Time Scale and Milestones

Each year the competition will start at the near beginning of the school year and end in the summer after most school years end. This is similar to the InvenTeams time cycle because like that program, these teams will be need a good amount of time to fully develop their ideas into a functional product. Since product design is an iterative process it is necessary for the teams systematically analyze their design designs and receive feedback throughout the development of their ideas. Therefore, like 2.009 and 2.00b, each team will be required to submit a presentation and design materials for milestones at specific times in the competition cycle.

The first milestone will be the Ideas Presentation and will occur a month after the theme has been revealed. Teams will spend the first month conducting brainstorming sessions to think of as many product ideas as they can that fit within the theme. For the actual milestone they will submit a poster and a one minute "elevator speech" to pitch three of their best ideas. For each idea they will specify the key product features, potential market or customer, and main technical challenges. Within two weeks they will receive feedback from design professionals that will not specify a certain idea but instead help them narrow their focus onto one specific area within the competition theme.

The second milestone will be the Sketch Model Presentation and will occur about a month and a half after the Ideas Presentation. After receiving feedback on their initial ideas, the teams will do

more brainstorming and choose three ideas to further develop. These ideas can either be from the Ideas Presentation or completely new ideas. In many cases the more time the teams spend thinking about the theme, the better ideas they will discover. At this stage the teams will begin performing "bench level" tests and mockups while doing research to answer some of the key challenges and questions that surround their ideas. Bench level tests consist of simply constructed apparatuses that are used to answer general feasibility questions. For the milestone they will submit a 3-minute presentation with a slide show for each idea that clearly explains the questions they tried to answer and the methods they used to answer these questions. Within a month they will once again receive feedback from design and industry professionals that will help them to ultimately choose one final idea to pursue for the rest of the competition.
The last milestone will be Technical Model Presentation and will occur about halfway through the second semester. After deciding on one idea to pursue the teams will begin tackling the technical challenges they need to overcome in order to fully realize their idea into product form. They will perform more tests and build multiple prototypes to test their designs of the key modules. Their work will culminate in a 10-minute presentation that clearly illustrates how they overcame the key technical challenges, a rough idea of the final form, and usage story for their product. About a month after the milestone the teams will receive their final round of feedback from design and industry professionals along with feedback from their potential customer market. This will help them in the final design decisions and allow them to create a clear focus for their product.

The teams will then have until the Trade Show in the summer to refine their design and build an alpha prototype of their product. All the teams that have satisfactorily completed all the milestones will be invited to the Trade Show. This multi day event will allow the teams to come together and show off their products to the general public. The first part will be like a trade show in which each team designs a booth to demonstrate their product, its design features, and how it was developed. Representatives from academia, industry and the general public will be invited to come to explore each teams' products and provide any feedback. In the second part, each team will give a presentation to explain their product's design features, potential market, and the development process in a formal manner. The trade show and the presentation will give the teams real world experience about the process of marketing and generating interest in a product.

Also it will be a great way for them to celebrate all their hard work throughout year and meet all the other students in the competition.

Possible Competition Calendar:
Late Sept./Early Oct. - Theme Revealed
End of Oct. - Ideas Presentation
Mid December – Sketch Models Presentation
Mid March – Technical Model Presentation
Summer – Trade Show!

4.3 Teams

The teams will ideally consist of students from all high school grade levels who have a variety of interests and career goals. Professional product design teams consist of multi-disciplinary members that have different educational backgrounds and focus on specific aspects of the development. While each person acts as "expert" of their aspect, they all work together to create one clearly designed product. This type of team structure will be mirrored in the competition teams. Some possible roles could include electrical engineering, mechanical engineering, industrial design, human factors, business, branding and communications.

Each role will have distinct responsibilities that will vary depending on the product requirements. For example, electrical engineering team members will work on any hardware or software features the product may have. They will work closely with the industrial design and mechanical engineering teams throughout the development process to decide things like product size. The mechanical engineering team members will focus on things like material choice, product architecture, manufacturing, and assembly. They will work closely with the industrial design team to create a product form that will instruct the function and direct the use while being mechanically feasible. The industrial design team members will mainly work on the overall aesthetics of the product like the form language while keeping in mind the user interface. They will work closely with the branding and human factors teams. The human factors team members will be concerned with how the user interacts with the product and how the design considers the needs of the user. The branding team members will mainly work to make the product

recognizable within its specific industry. Also they will make sure the product's use and distinguishing features are quickly and easily understandable. They will work with the business team to create a clear market for the product and with the communications team to create the marketing language. The business team members will first benchmark their product against others within the industry. Then they will work to create a business model that identifies the market share they hope to capture with their product. The communications team members will be responsible for documenting the product development in pictures, videos, and words. Most importantly they will work to bring together the entire team's work into clear, detailed presentations and reports. Depending on the team size, many of these roles may be combined or restructured.

Even though some of the team roles may work completely independent of one another, in order to create a fully integrated product all the roles must stay in close communication. The students will quickly learn the importance of effective, clear communication and how to run efficient team meetings.

4.4 Industry Mentors

Like FIRST, the teams will be highly encouraged to seek out industry mentors that will provide financial support and most importantly guidance throughout the design process. The mentors' real world experience in engineering, design, and business will be an invaluable resource to the teams as they make decisions about their direction and designs. For the Ideas Presentation the mentors will help to facilitate the brainstorming and idea generation sessions. They will teach effective brainstorming methods such as defer judgment, encourage wild ideas, challenge all assumptions and build on others' ideas. Also they can teach the teams other useful idea generation and evaluation methods such as association mapping and Pugh charts. For the Sketch Model Presentation they will help their team to focus on exploring the major challenges and concerns surrounding the product ideas. Also they will teach the common modeling methods such as using foam and how to effectively create bench level tests. For the Technical Model Presentation the mentors will first help their team to decide on an idea that is feasible and marketable. They will also provide the necessary technical expertise to help the teams figure out how to create their product. Design wise they will provide support with CAD modeling and how

to design for manufacturing. For the Trade Show, the mentors will use their real world experience to help the teams create an alpha prototype and market their product to their chosen market. They will help the teams find the resources they need to machine or have made the parts to build their prototypes. Also they will provide guidance with effective presentation and marketing practices.

5.0 Online Community

The competition website is an integral part of how the competition will function and be structured. The main purpose of the website is to have a place for the teams to submit their milestone materials. Each team will have their own page in which they will post photos, videos, and report for each milestone. Though this is the primary function of the website, the ultimate goal is to create an online community site for students interested in product design. The design of the website will be like other Web 2.0 sites in which active user participation is highly encouraged.

The home page will contain pertinent competition info like announcements and a calendar of upcoming milestones and events. It will have a place for community members to login to their accounts. This will allow them to access their personal homepage that they can customize along with their profile and privacy settings. Also on the homepage will be a highlight from a team's blog, some sort of daily design inspiration, and a Twitter stream of all the team's streams. The home page will directly link to the Teams, Resources, About, and Forum sections, as well as the competition's own Twitter[12], Flickr[13], YouTube[14], and Facebook[15] pages.

The Teams section will be organized graphically by region or state allow the user to visit any of the teams' page. Each team will be given a base template for their page that will include a blog, roster, and milestone submissions section, as well as link to their team Twitter, Flickr, YouTube, and Facebook pages. Also the team pages will have a private section that only the team members can access and will be used for internal team organization and communication. The team blog will serve as a way for the team to document their work throughout the competition, and as a way to advertise/market themselves to the general public. As the teams post pictures to

Flickr and videos to YouTube, they will be able to post it to their blog and share it with the rest of the community. This will allow them to get feedback on their ideas and designs between milestones from other students and design enthusiasts. The team roster will provide a link to the profile of each student and mentor on that specific team. Each member will be able to control the information that appears on their profile and if they choose they can link to their personal online pages. The milestone submissions section will be where the teams post their materials for each review process. Anybody will be able to access this section but only community members will be able to submit a review of the work in order to ensure that the comments are constructive in nature. Also this will be the interface in which the official competition reviewers will view the work and give feedback to the teams.

The Resources section will contain information and links to help the teams with the competition itself and with the design process in general. Instead of sending the teams a large packet of information detailing the requirements for each milestone, how to use the website, and other important competition material, the Resources section will allow them easy access to all of this information. This also allows for easy updates and additions to competition structure throughout the years without any confusion between certain editions of the official documents. Along with competition information, the Resources section will also contain useful links to tutorials, prototyping shops, design blogs, and other useful online material that will help them be successful in the competition.

The About section will contain administrative information related to the competition. This includes the main goals of the competition, who the participants are, who runs the competition, and how to join. The competition administrator page will contain links to the profile pages of each administrator that will link to their personal online pages. The Forum section of the site will be a place for students to come together and share information about product design. It will be similar to forum hosted by Chief Delphi FIRST team[16] that has become one of the best online resources for FRC teams. Teams will be able to use the forum to ask for help on specific problems or discuss general design issues. This will also be the place to ask the competition administrators questions so that if other people have the same questions, they can all be answered at once instead of being flooded with multiple emails about the same thing.

The purpose of the competition itself having active Twitter, Flickr, YouTube, and Facebook pages is to allow the teams to keep up to date with any updates, create a sense of openness between the teams and competition admins, and actively promote the competition through these forms of mass communication. The instantaneous nature of Twitter allows for whoever is following the competition to become immediately aware of any changes made to the competition structure, website announcements and updates, or anything else noteworthy. Creating and posting often to the competition's YouTube channel and Flickr account will promote the sense that the competition administrators are there to help them succeed and allow them to get to know the people working who are for them. Also it will be a good example of how the teams should use their pages to archive their work. The Flickr, YouTube, and Facebook pages will also act as the main marketing and promotional tools for the competition itself. Effective use of these tools will allow the competition to reach the new generation of Web 2.0 users through some of their main sources of communication.

6.0 Conclusion and Future Work

In summary, this national product design competition will challenge high school age students to use their creativity to develop, design and build a product with viable market potential. Each year the products will be unified by a central theme and the students will be required to submit materials for distinct milestones throughout the competition cycle. These submissions will be through the competition website that will also function as an online community for all high school students to learn about product design and share ideas. The teams will be closely mentored by design and industry professionals who will share their experience in order to enable the students to create real, working prototypes within the short time frame.

This competition exists in a discrete cross section between engineering-based competitions and design or art based competitions. It will actively facilitate creativity and design education with a focus on developing products for use by a specific customer base. Also, it will encourage and attract the creation of a multi-interest team that will be necessary in order to ensure the highest

level of success within the competition. Students focused on art will join together with students taking high level physics and math classes, to create a novel, marketable product.

The competition proposed in this thesis is the ideal structure that requires further development and consideration before it can be implemented in the high school setting. Some future development includes surveying high school teachers on the practicality of such a competition in relation to their personal experiences with the interest level and capabilities of high school students. Their thoughts on which parts of the competition might need revising or restructuring are invaluable insights that will help the competition function as it is intended. Other useful work will be conducting design exercises with high school students to discover how to best teach them the design process and which specific resources will be most important to help them succeed in the competition.

A significant component the future work will include the development and testing of the online community as a portal for high school students to learn and share about product design. Besides being functional, the website design needs to be engaging so that it will encourage active participation and foster the community growth. Creating a website of this caliber requires a large amount of testing and iteration. Lastly, there must be a thorough analysis of the financial requirements incorporated with the implementation of a competition of this nature. This will require talking to other well-established competitions about their financial structures and detailing the necessary resources to actualize this competition.

7.0 References

1. "Ken Robison says schools kill creativity | Video on TED.com" TED Conferences, LLC. http://www.ted.com/index.php/talks/ken_robinson_says_schools_kill_creativity.html
2. "Vision," Who We Are. US FIRST. <http://usfirst.org/who/default.aspx?id=34&LinkIdentifier=id>
3. "Gracious Profesionalism," Who We Are. US FIRST. <http://usfirst.org/who/content.aspx?id=36s>
4. "How Does FRC Work," What We Do: FRC, US FIRST. <http://usfirst.org/what/frc/content.aspx?id=364>
5. "FIRST Robotics Competition Evaluation: Executive Summary," Center for Youth and Communities, Brandeis University, April 2005
6. "About Lemelson-MIT InvenTeams," Lemelson-MIT Program. 2008 <http://web.mit.edu/inventeams/about.html>
7. "InvenTeam Grant Cycle," Lemelson-MIT Program. 2008 <http://web.mit.edu/inventeams/cycle.html
8. "The InvenTeam Experience," Lemelson-MIT Program. 2008 <http://web.mit.edu/inventeams/experience.html>
9. "2.009 Product Engineering Process," MIT, 2008 <http://web.mit.edu/2.009/www/>
10. "Course Description," MIT, 2008 <http://web.mit.edu/2.009/www/courseinfo/CourseDescription.html>
11. "Toy Product Desgin" MIT, 2008 <http://web.mit.edu/2.00b/www/>
12. http://twitter.com/
13. http://www.flickr.com/
14. http://www.youtube.com/
15. http://www.facebook.com/
16. http://www.chiefdelphi.com/forums/portal.php