High School Engagement: The Iron Egg Launch Design Competition

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Abstract – This paper describes a university engagement activity designed to develop interest and excitement in science and technology through a non-athletic competition. This activity began with the design and implementation of an Iron Egg Launch Design Competition for teams of high school students in a two county area of the state. Since the start of this contest in 2004, the event has opened up to high school teams in thirteen counties in the state, has garnered financial support from local businesses, and has the potential to expand to ten locations through the state with a final grand champion competition to take place on the main campus of the university.

This university engagement activity provides many benefits and opportunities to those involved as it allows for the participation for students already interested in science and technology to have hands on experience; makes for an environment to entice new students to the areas of science and technology through competition; builds a partnership between the high schools and the university; strengthens relationships between classroom teachers and university faculty and staff; and provides an avenue into the classroom to continue to build interest for careers in the field of science and technology.

Keywords: engagement; high schools; competition

INTRODUCTION

With the competitive forces in the market place today it is extremely important for the economic development of the United States that a person be somewhat technologically literate. The International Technology Education Association has defined a technologically literate person as "a person that understands – with increasing sophistication– what technology is, how it is created, how it shapes society, and in turn is shaped by society." [1] In other words, a technologically literate person should be able to view something about technology and be able to analyze the context of the communication then draw a conclusion or opinion based on their thought and understanding. This process is important for students so they are able to understand why technology and its application is an important force in our economy. It also benefits students who choose careers in technology by

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giving them a jump start on their future [1].

By researching the number and types of technology competitions available to high school students, it is apparent that teachers are continually looking for ways of bringing the application and experience of technology to the classroom [2]. One competition, the FIRST Robotics Competition, reached over 30,000 high school students in 2006 [3]. Through the various available competitions, technological literacy is fostered by learning about engineering through a realistic, hands-on problem solving experience of creating systems that meet human needs with the use of math, science and technology [4].

COMPETITION BACKGROUND

The idea for hosting the Iron Egg Launch Competition was first suggested by members of the Industrial Advisory Committee for Purdue's Mechanical Engineering Technology (MET) program in Muncie, Indiana. This committee made up of representatives from area industries was asked to come up with ideas to help promote the Mechanical Engineering Technology program. It was decided that a design competition for teams of high school students would be a valuable tool in raising awareness about the MET program. The program was then updated to include Purdue's College of Technology programs at Anderson, Indiana, and Ball State University's Construction Management program. From these beginnings the first Iron Egg Launch competition was hosted in Muncie in April of 2004.

The basic premise of the competition is to have teams of high school students design and build a device that launches a container with an egg in it toward a target located 25 meters away and to have the egg survive the impact. The intent of the competition is two-fold. First, we wanted to get students interested in engineering technology by having them take basic science, math and technology principles (theory side of engineering technology) and apply them to a practical project (applied side of engineering technology). Second, we wanted to build relationships through engagement with high school students, high school teachers, universities and local industry. These relationships were (and still are) the main benefits to our Purdue programs. The relationships we have formed and continue to develop with the participating teachers are a top priority for us. These teachers have daily contact with students that are typical targets for engineering technology programs.

HOSTING THE COMPETITION

Work began on the competition in August of 2003, more than 8 months prior to the first event. The Advisory Committee members and Purdue faculty and staff met and broke the competition into various segments. Sub committees were formed to set the guidelines for each part of the segments. This information was then compiled and organized into the general guidelines and rules for the competition.

Once the general guidelines and rules were complete, the committee met to establish the target market for the competition. We originally targeted teachers from area high schools in math, physics and technology education subjects. The success we have had in attracting the teachers from the physics, technology education and engineering technology areas stems from the desire for student projects for which many of these teachers are looking.

The first communication is with the targeted teachers in a letter inviting them to consider entering teams of students in the competition. The letter gives a brief overview of the contest and gives contact information if they want to participate. The teachers can then request a copy of the general guidelines and rules for the competition. The contact information includes the judges and competition officials so that assistance is readily available throughout the time leading up to the day of competition.

GENERAL GUIDELINES AND RULES

Objective

The objective of this competition is to have teams of students use the knowledge they have acquired in a wide range of classes and apply it to a practical project. The project is to design a device that launches a container airborne at a specific target. The container must be designed to hold an egg and to preserve the integrity of the egg shell throughout the launch and landing sequence. In accomplishing this objective, teams will need to demonstrate the use of sound research, design, construction, and safety principles while working within the guidelines outlined [5].

Date
Here is entered a date for the competition. Also included is a specific "rain date"[5].

Time

Since the event is held on a school day, the starting time of the event must allow for the students to complete the competition, eat lunch, receive awards and get back to school in time to catch the bus home. Also, we include a specific time for a brief meeting with the Team Advisors [5].

Location

Normally, this competition has been held on the Ball State University campus in Muncie, Indiana. As the number of entrant locations grows, we will need to look at alternative locations [5].

Entry

An entry form is included with directions to make copies of it to use for additional teams entering from the same school. An entry form return by date is included [5].

Safety

Safety is our number one concern. The competition officials reserve the right to disqualify any team's project at any time due to safety concerns whether directly addressed in the guidelines or not. No explosive material is allowed. Safety glasses are also provided to the launch team for use during the launch [5].

Assistance

Included in the information package is a list of people who have agreed to serve as resources for the student (contestants) and teachers (advisors) involved in the competition. They include individuals from Purdue University's College of Technology and members of the Industrial Advisory Committee. Their names and email addresses are included so the students and teachers can contact them directly with questions that may come up in any phase (research, design and construction) of this project. In addition to contacting the resource individuals with questions it is also possible to arrange for one or more of them to visit the school to work directly with the students for a class period or two to help them with the design and construction phases of the competition. We also have a couple of table top models that we can take to the school to help students with possible design ideas. We strongly encourage the teams to take full advantage of the assistance offered. Through this project we are building relationships between our programs and the participating students, teachers and schools that extend beyond this competition [5].

Cost

There is no entry fee. Cost associated with the design and construction of the launch device and container is the responsibility of each team. (See the "Penalties" section for more cost guidelines [5].)

Awards

Plaques will be awarded to the three overall top teams. In addition, the overall top team will receive the Iron Egg Launch traveling trophy to be displayed at their school until the next competition. The top scoring team on the performance portion and the report portion of the contest will also receive a plaque. An additional award will be given to the team with the most "original" design [5].

Scoring

The scoring of the event is broken down into two main areas. One is the performance of the team's device the day of the competition. The other is the report that each team must submit a week before the contest day. Judges assemble one day during the week leading up to the contest and score the reports. The judges are assigned one category of the report to score. They then judge the same category on each report to insure a certain level of consistence in the scoring. The report judging takes approximately a half of a day to complete. Each judge and official are then assigned certain tasks

the day of the competition. It takes about 15 judges and officials to make the day of the competition run smoothly [5].

Performance Points Breakdown

Bull's Eye		35 points
Lands in 1st Ring from Bull's Eye		28 points
Lands in 2nd Ring		21 points
Lands on Target Square Outside of Rings		14 points
Successful Launch (airborne minimum of 5 m) Missing Square		10 points
Container Performance		
Egg shell not compromised (unbroken/no cracks)		-0 points
Egg shell is cracked but no leaks		-5 points
Egg shell is cracked and leaks		-10 points

After each launch, the egg will be inspected by the judges.

Each team has 3 launches. Points are awarded for each launch.

Report Points Breakdown

Section 1: Project Scope		10 points
Section 2: Scale Drawing, Diagram or Sketch		15 points
Section 3: Formulas/Calculations		20 points
Section 4: Testing Data (Spreadsheet)		15 points
Section 5: Bill of Materials with cost		5 points
Section 6: References		5 points
Overall Written Presentation (neatness, spelling, thoroughness, etc.)		15 points
Oral Presentation		10 points
Total Report Points		95 points
Penalties		
Total Project Costs < $100.00		- 0 points
$100.01 -$110.00		-2points
$110.01 - $120.00		- 4 points
$120.01 - $130.00		- 6 points

Failure to include a Bill of Materials showing the project cost will result in a 40 point deduction. Any other missing report section will result in a 10 point deduction.

General Scoring Breakdown

Performance Points Possible		
Report Points Possible		105
Total Points Possible		95
		200

DESIGN, CONSTRUCTION AND LAUNCH RULES

Teams

Members include 4 to 6 students per team from each representative school. There are 1 or more teachers per team from each represented school. Schools may enter more than one team and teachers may serve as advisors for more than one team [5].

Launch Order

To be determined by random draw the day of the event [5].

Launcher Setup

Teams have 10 minutes to assemble their launcher in a designated assembly zone. They are allowed to use typical hand tools (non powered) furnished by the team. After assembly, the team will move the launcher to the designated holding zone. The launcher must be able to be moved by hand and only team members (no advisors) may assist in moving it from one zone to another (no motorized power of any kind). The cost of any equipment (cart, etc.) used in moving the launcher counts in the total project cost and must be included in the Bill of Materials section of the report [5].

Holding Zone

Teams wait with their launcher in the designated holding zone. Judges will be in the holding zone with each team. While in the holding zone, the teams will give the oral presentation. A safety inspection will also take place at this time so teams must delegate one or more team members to work with the inspector while other team members conduct the oral presentation. Advisors may assist team members with the safety inspection but not the oral presentation as we are looking to see what students learned from this project [5].

Launching Zone

Teams move their launcher into the designated launching zone from the holding zone. The launching zone is a 3 meter square area. The base of the launcher must all fit within the zone (this includes any braces or balance devices that are grounded.) We allow 10 minutes to conduct 3 launches [5].

Launch Procedure

The team places a grade A large egg, provided by the officials, into the egg container and loads the container into/onto their launcher. They then arm the remote trigger and leave the launch area and wait in the observation area. A contest official will actuate the remote trigger from outside the launching zone. The launcher must release the container through the air toward the target, being released from the launcher within 3 meters of the front edge of the launch zone. Contest officials record the container landing for each of the 3 trials. Contest officials evaluate the egg status after each trial with cracked eggs being replaced before the next launch. The contain must only be able to travel down range upon launch, If necessary, safety features must be included in inure the container cannot travel in any direction other than down range [5].

Launch Removal

After the 3rd launch, the team moves their launcher to the display area [5].

Target Zone

The dimensions of the target are 7m by 7m plane laying flat on the ground. The bull's eye is a 1 m diameter circle in the center of the square plane. The 1st ring is a 3m circle and the 2nd ring is a 5m

diameter circle, both concentric about bull's eye center. The center of the bull's eye is 25 meters from the front edge of the launching zone. Any container traveling more than 50 meters in the air on any single launch will result in immediate disqualification of that team's entry [5].

Egg Container

The container should be designed to protect the integrity of the egg's shell. The shape and material are up to the team to determine. However, any leakage from the egg should be kept within the container and not splattered on the target plane. Also, remember that each team has 10 minutes to perform their 3 launches and the egg must be inspected after each launch. It is important to make sure the access to the egg is easy enough to be done quickly after each launch [5].

REPORT GUIDELINES

General Format

The report must contain all 6 sections as outlined. Each section should be clearly marked and the report enclosed in a cover of the team's choosing. Due to time considerations the day of the competition, the reports are asked to be mailed by a specific date so they may be judged prior to the launch event. The reports are to be typed. We also found it useful to remind students who their audience is for this part of the competition. We tell them that when preparing the written presentation to remember the audience is engineering and technical professionals and they only want essential information [5]. The judges don't score on weight!

Section 1: Project Scope

The project scope should state how the project works and the major mechanical principles believed to be important in determining how to design and build the apparatus [5].

Section 2: Project Drawing

The drawing can be a CAD, board or hand sketched diagram, to scale, of the apparatus showing dimensions and labeling all major parts. The diagram may be done on either B sized paper or A sized paper [5].

Section 3: Formulas and Calculations

List and give a general explanation of the various mathematical and mechanical formulas/calculations that the team used and believed were important and germane to the design of the project. Also, include a detailed description of the formulas/calculations and the iterative process used to determine the final design parameters for at least one major design feature of your project (for example, the force required to propel the egg to various distances) [5].

Section 4: Test Data

Using a spreadsheet format, show the results of test launches (including egg container performance) and the adjustments made before each test. A graph would be a nice addition to this section [5].

Section 5: Bill of Materials

List the materials used in the final version of the project and their costs. Remember that equipment used to move the project between zones the day of the competition must be included in this section along with the cost of that equipment. Small items like nuts and bots, etc., can be included together on a miscellaneous hardware line. Items that are donated at no cost to the project must be included on the Bill of Materials and have a cost assigned to them just as if they were purchased. "Scrap" items must be included here with a cost just like donated items [5].

Section 6: References

List the sources that your team used for information on the idea, design and construction of the project, for example, books, websites, individuals, etc [5].

GROWTH OF THE PROGRAM'S ENHANCEMENTS

As with any successful endeavor, growth of the contest has led to several changes that have enhanced the affects of the total activity.

For the third year of the competition, we were able to secure financial assistance in the form of corporate donations and a grant from the DJ Angus Scientech Educational Foundation. This not only defrayed the cost of the box lunches supplied for the participants, but allowed for the addition of t-shirts for all participants. The design of the shirt was made similar to rock group touring shirts with the Purdue University logo and the names of the donors. The financial support also allowed for a drawing for prizes for the students and teachers. Student winners received a 1 GB USB drive and the advisor winners received things they could use in the classroom with the Purdue University logo, for example, clocks and insulated coffee mugs. This enhancement provides the ability to promote our location and programs throughout the participating high schools and the community in general. It also promotes the philanthropic aspect of the donor companies.

During the third year, there were 18 teams representing 14 schools in a 2 county area with a total of 98 students in competition. This year, the event is including another Purdue Statewide Technology location. Expectations are that the 4th year event will host around 25 teams representing 20 schools with a total of 120+ students. This expansion will also tap additional donors in the new area and set the stage for future discussions with those businesses for future scholastic endeavors.

As with all continuous improvement processes, the guidelines and rules are massaged each year to bring out the best efforts of the student contestants. This year, the addition to the written report will include computer graphics students for the design of a sales and marketing brochure for their high school teams' entries. This will increase participation by including another niche of students and teachers.

Another change involves the registration process on the day of the competition. Students now register for door prizes, filling out an entry form that provides us with their address, telephone number, and area(s) of interest. This information is then used to mail the potential student degree information which is then followed by a personal telephone call from one of our location's professors.

We have found that students tend to spend less time on the written report and more time on building and practice launching their device. Changing the point mix and offering technical assistance from the faculty and staff has begun to make this aspect of the competition more meaningful to the student.

The

CONCLUSION

This event has proven valuable to our statewide technology location. Students with different technology interests come together to produce a product from scratch. They can see the fruits of their efforts while deciding on their future careers. Teachers can see that what they do really counts. Local area businesses can contribute to the future of their communities. The College and the Faculty have an opportunity to engage themselves with their future students.

This is a valuable learning experience where a good time is had by all!

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