Model Bridge Building Competition
An Outreach Project to get High School Students Involved in Engineering

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Abstract - Southwest Georgia Regional Model Bridge Building Competition is a co-operative endeavor of a group of engineers working in academia, R&D and private sector to motivate young high school students in rural Georgia interested in engineering career. The competition is sponsored by Georgia Space Grant Consortium, a NASA funded program, and takes place in Albany State University on last Saturday of every February since 2003. This paper summarizes the design specifications and rules of the competition, scoring mechanism and best scores attained in the past, the impact the competition had in the region in terms of generating excitement among the participating schools and indirectly in the enrollment figure of Albany State University's transfer engineering program.

Keywords: Model bridge building, outreach, high school, southwest Georgia

INTRODUCTION

Albany State University located in Southwest Georgia conducts a transfer engineering program with Georgia Institute of Technology which showed declining number and quality of incoming students around the year 2000. It has long been felt that there is a need to provide a forum for high school students in this predominantly rural area to get engaged in some form of hands-on activity based on easy to understand scientific principle that will possibly attract them to an engineering career. This activity has to be more structured than a science fair project and must engage students in critical thinking to fulfill a set of design requirements closely resembling realistic engineering project and yet allow them to be creative. After considerable discussion among the members of the Advisory Committee of the Engineering Program, it was decided a balsa wood bridge competition would be the ideal vehicle of capturing the imagination of young students and allow them to develop the skill set such as design to perform, work within constraints and team work which are so very prized in the real world. It was also decided that the competition will be held during the National Engineers Week. The primary goal was to create awareness among students, parents and science teachers in southwest Georgia about the challenges and opportunities in the engineering profession. A secondary goal was to hopefully increase the enrollment of Albany State University's engineering program. An existing award from Georgia Space Grant Consortium [1], a NASA sponsored program administered by Georgia Institute of Technology, could cover the cost of the competition and as such fund raising was not needed. During the early years no registration fee was charged but the contestants were required to pre-register. Recently a modest fee is charged primarily to avoid no shows. The first competition took place on last Saturday of February of 2003 and has happened ever since annually.

THE COMPETITION

In order to decide on the design specification and the testing rules, many of the ongoing balsa wood bridge contests [2, 3] rules were looked into. After considerable discussion and building of a few prototypes in-house designed with the help of a commercially available software [4], the committee members decided on a set of rules that will sufficiently challenge the contestants and yet allow them to build a simple model bridge without any previous knowledge or experience. The announcement of the competition along with all the relevant design and testing rules,

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and the results, photos and video of the past years competition is published on an ongoing basis in the Albany State University's Engineering website [5].

The object of the competition is to design and construct the most structurally efficient model bridge meeting the following specifications:

Design Specifications

Span	22 in. (55.9 cm)
Maximum Allowable Weight	1 oz (28.3 g)
Maximum Allowable Height (Overall)	10 in (25.4 cm)
Max Superstructure Height	6 in (15.2 cm)
Max Substructure Height	4 in (10.2 cm)
Minimum vertical clearance through the bridge	2 in (5.1 cm)
Minimum horizontal clearance through the bridge	2 in (5.1 cm)

The bridge must be made with balsa wood and glue without coating of any kind. Though the original intent was to foster teamwork and as such teams of 2 to 3 members were suggested working under the guidance of a teacher, in the past a few model bridges were made by one student only.

Testing Procedure

The bridge is supported on a test stand (Fig. 1) placed in between two tables and loaded with a wood block, threaded hook and nut, a bucket. Small glass beads are then poured slowly until the structural failure occurs. Collapse of the entire structure as well as deflection of any part of more than 2" vertically is considered to signify failure. The loading normally takes place at the middle of the span. However, loading was done at quarter span point in 2007 to create additional design challenge for the contestants. Both the weight of the bridge before starting the testing and the load that caused failure is recorded. The structural efficiency is measured by the ratio of the failure load to the weight of the bridge.

Figure 1- Model Bridge on the test stand with the loading attachments

The Event

The Bridge Competition takes place on the last Saturday of the month of February coinciding with the celebration of National Engineers Week. The competition is held at the basket ball court of HPER Gymnasium of Albany State University and starts at around 9 in the morning. The participants have to pre-register to be qualified for entering the contest. Registration form and the design specifications along with the past years' photographs and video are available at the website [5]. A modest registration fee is charged to keep no-shows on check. Any number of teams can participate from each school. Multiple bridges can be entered by the same team as long as the entries are separately registered. The entries are weighed, the participants' pictures taken and free T-shirts are distributed. Then the testing starts with the bridges placed on the test stand and loading achieved by slowly pouring glass beads into a bucket hung from the bridge by a threaded hook and wood block. A pointer attached to the hook tracks the vertical displacement. After the failure occurs, weight of the bucketful of glass beads with the loading attachments and the remains of the model bridge is recorded again. Once the efficiencies are calculated through a spreadsheet program, the winners are declared and prizes awarded. The event concludes with free lunch for everyone present (Fig. 2).

Figure 2 – Contestants waiting for their bridge to be tested and at the lunch table

The Awards

The bridges are ranked according to the efficiency. The top 3 teams are awarded prizes. During the first 4 years, cash prizes were awarded, $100 for the first, $75 for the second and $50 for the third placed team. Since 2007 contest, various trophies are awarded to the winning team members in lieu of cash as they are considered to be a permanent symbol of the students' achievements. Besides a trophy and plaque for the winning school is also awarded (Fig. 3). The plaque is kept by the school for a year and records all the previous years winning schools names. All participants (students, teachers and judges) get free commemorative T-shirts.

Figure 3 – Plaque and trophy awarded to the winners

Results from Past Years

As is clearly evident from the Tables 1 and 2 that although there is a waning of interest as seen by the lower number of participating teams and schools, the best structural efficiency has however steadily increased over the years. This is primarily due to the fact that students have learnt to perfect their design and construction technique over the years by studying the best designs of the previous years available on the website [5]. Also of interest is the unusually high number of participants in 2006 which can be attributed to one of the teachers assigning participation in the bridge competition as a required project for her entire class. Noteworthy is also the fact that only 3 schools have participated in the competition throughout its history – one is a local high school and the other two are located about two hours drive from the Albany metro area.

Year	No. of Schools	No. of Teams	No. of Students
2003	7	16	42
2004	5	12	25
2005	4	21	43
2006	5	43	86
2007	3	15	34

Table 1. Student Participation from the Previous Years

Year	Bridge Weight (gm)	Breaking Load (gm)	Structural Efficiency
2003	28.1	10276	365.7
2004	25.6	5789	226.1
2005	22.8	10197	447
2006	17.5	9488	542
2007	23.7	13253	559

Table 2. Relevant Data of Best Bridges from the Previous Years

Different Categories

In order to create more excitement among participants and allow more students to win prizes, the competition was expanded to include a new compact bridge category in 2005 which was transformed to the long span bridge category in 2006 and 2007. In case of compact bridges, the overall height was restricted to 3" with no change in the weight limit or other requirements. Additionally, in case of long span bridges, the span was increased from 22" to 33" with the weight limit raised to 50 gm. As expected the efficiency for the long span bridge was found to be significantly lower and the best bridge in that category recorded an efficiency of only 194 compared to 559 for the standard 22" span bridge. Neither of these new categories became popular with the students and it was decided to be dropped from the next year's competition.

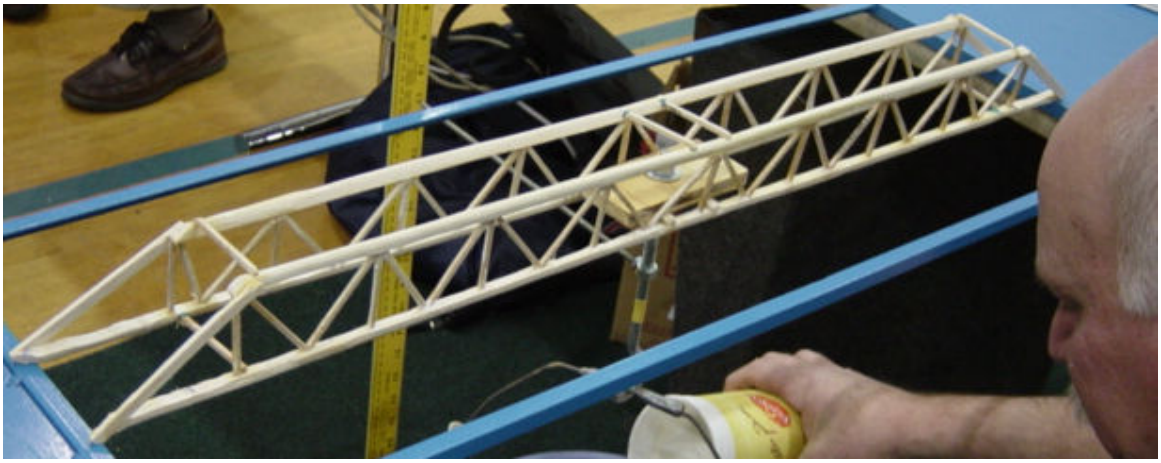

Fig 4. Long Span Bridge (33" Span) being tested

LESSONS LEARNED

Project Goal

It is undisputedly true that the Bridge Competition has generated significant level of excitement among the students of the high schools that have been participating in the competition regularly since its inception. Many of the students have returned to the competition 3 years in a row. Their word of mouth testimony will make more of their friends to participate in the coming years even after they graduate from high school. It is also true that the individual science or technology teachers are the key to create and sustain interest within the student body in project oriented activity that leads to participation in the Bridge Competition. The high schools that have participated in the competition continuously owe that distinction to their science or technology teachers who have kept the students interested even before next year's competition was announced. However, teachers who do not share that passion in project oriented activity may bring a few teams one year and then may loose interest in Bridge Competition due to many competing group of activities.

Impact on ASU Engineering Program

Though it is hard to show a direct co-relation, the Bridge Competition has undoubtedly created awareness in Albany State University's engineering program as is reflected in the increasing trend of incoming freshmen students.

Academic Year	Incoming Freshmen	Total Number of Engineering Students
2001-02	12	57
2002-03	19	54
2003-04	21	54
2004-05	19	43
2005-06	15	43
2006-07	34	52
2007-08	27 (as of now)	68

Table 3. Overall View of Albany State University's Engineering Program

Addressing Diversity

As African-Americans are the largest demographic group in Southwest Georgia, it is natural to expect them to participate in larger numbers in this competition. Actual number of African-Americans participating in the competition varied from 19% to 47% during these years which is better than most other competition of this nature. It is also very heartening to see that one of the three schools that continuously participated in the competition for all these years is an inner city high school with majority African-American student population. Teams from this school not only earned a place in the winners circle on three different years, in 2006 they won all but one of the top 6 places in two categories including the two first prizes. Similarly, the female students entries compared very well with their male counterpart as 6 girls and 8 boys shared the first places during last 5 years of competition.

Organizing the Event and Follow Up

The most difficult aspect of organizing the event is to get the word out to the students. Various methods have been tried over the years. In the first year a letter of invitation along with the rules of the competition was mailed to the science department chairpersons of 37 public and private high schools in the southwestern quadrant of the state of Georgia. This was followed by newspaper announcement and advertisement in the Cable TV channel 19 operated by ASU Mass Communication department. Personal phone calls were made whenever a teacher was identified who may be interested in the competition. On one occasion a live TV interview was also broadcast by a local TV station before the competition to encourage students to participate. A website [5] was established shortly after the first year's competition which was continuously updated with new announcement and photos, results and video of the competition of earlier years. Video footage is generally also broadcast on the night of the competition each year in few of the local TV stations as well as shown periodically on channel 19.

In order to attract more schools to participate, the competition has been expanded this year to include middle schools which will form a separate category. Accordingly, 63 public and private, high and middle school principals were sent invitation to participate in next year's competition. An additional opportunity of publicity of the event came up this year through an invited presentation in Georgia Technology Student Association's Fall 2007 leadership conference.

CONCLUSION

The Southwest Georgia Regional Model Bridge Building Competition has provided high school students in rural Georgia an opportunity to explore their creative instinct by applying science and mathematics knowledge through hands-on activity. Participation in the competition reinforces problem solving skills and teamwork which is highly prized qualities in the work environment as well as for the first time introduce students to the challenges and rewards of completing an engineering project successfully. The competition also has increased the interest in Albany State University's transfer engineering program as reflected in higher level of freshman enrollment. With the expansion of the competition to include middle school students, it is expected that larger number of teams from more and more schools will participate in the coming years with progressively better designs.

REFERENCES

[1] **Georgia Space Grant Consortium, http://www.ae.gatech.edu/organizations/gsgc/**

[2] **Illinois Institute of Technology, International Bridge Building Contest, http://www.iit.edu/~hsbridge/**

[3] **North Carolina Department of Transportation Bridge Building Competition, http://www.ncdot.org/about/kids/BridgeComp**

[4] **Pre-Engineering Software, http://www.pre-engineering.com**

[5] **Albany State University's Engineering Program – Bridge Building Competition, http://www.asurams.edu/coshp/naturalsciences/engineering/bridge/Synopsis.htm**

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Atin Sinha received his Ph.D. from the University of Tennessee Space Institute in Aerospace Engineering in 1984 and worked in Learjet and Honeywell before moving to academia. He joined the Albany State University in 1999 as coordinator of the transfer engineering program and teaches freshman and sophomore level courses in engineering. His current research interest is rapid prototyping and reverse engineering. He is also engaged in motivating students in inquiry based learning in engineering problem solving through laboratory experimentations.