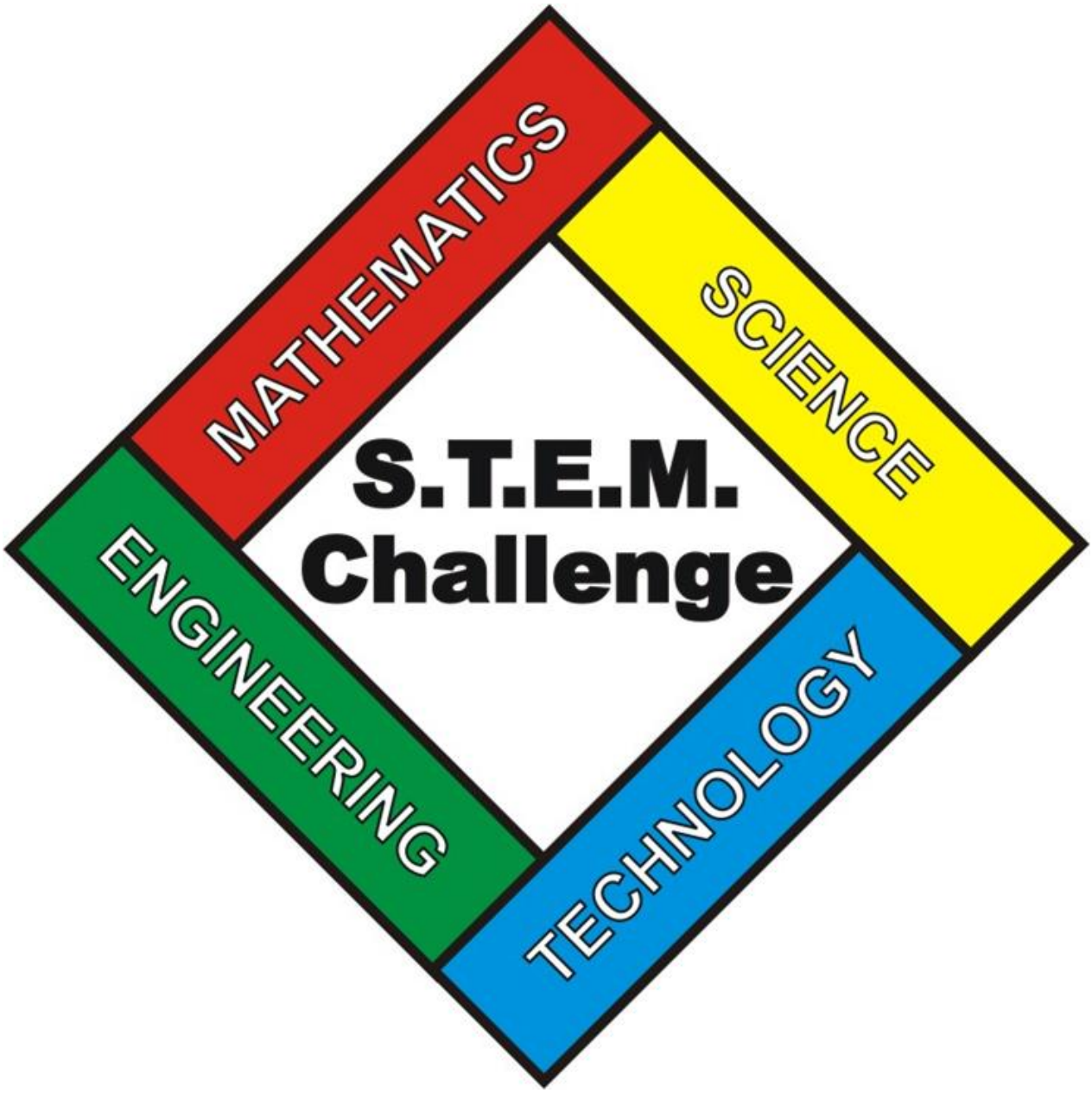
21st Century STEM Challenge



May 2, 2014

21st Century STEM Challenge

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Location of local competition – Magnet Cove High School Gym, Magnet Cove AR

Begins at 9:00 am

Pre-Challenge Meeting @ 8:45 a.m. in Hospitality Room

Registration, Engineering Notebooks, and Roller Coaster Measurements, Deadline: April 25, 2014

Make all payments to Dawson, 21st Century STEM Challenge
Late Fees will be charged on any registration received after April 25, 2014

Sponsored by
South Arkansas Math & Science STEM Center
& Dawson Education COOP

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Competition Structure: *The 21st Century STEM Challenge* is a competition that challenges students to use creativity and imagination along with science, technology, mathematics and mechanical ability to design and engineer an device that performs a practical function. The competition is open to all students in grades 5th – 12th. Each school is allowed to enter up to 3 individuals/teams per event per grade.

Individuals or teams can choose from eight different devices to design, engineer, and compete for best performance.

- Sailboat Competition
- Paper Airplane Competition
- Mousetrap Car
- Marshmallow Catapult
- Paper Roller Coaster Competition
- Paper Rocket Competition
- Egg Drop Competition
- Toothpick Bridges

General Rules

- ***Students*** must design and engineer all parts of the project being used for competition. All objectives must be met for each area of competition or disqualification will occur. (See guidelines for each device)
- The maximum number of participants per event is as follows:

Device	Number of Students Permitted
Paper Airplane, Paper rocket	1 Student per device
Toothpick bridge, Paper roller coaster	Up to 3 students per device– all grades
Mousetrap car, Sailboat, Egg drop& Catapult	Up to 2 students per device for Grades 5-6 Grades 7-12, individuals only

- Students may compete in more than one area of competition.
- A designated area will be set up for problem-solving and repairs that students may need to do. Help will be provided in this area and is designated for students only.
- There is a $5.00 registration fee for each student competing in the competition.
- There will be a $10.00 late registration fee per student if registration is not sent in by deadline.(If John Doe registers late; then $10.00 is due for him).
- Anyone other than the competitors must remain in the spectator area or the competitor will be disqualified.
- Awards will be given for first, second, and third place in each design challenge for these grade bands: 5^{th}& 6^{th}, 7^{th}& 8^{th}, and 9^{th} – 12^{th}.
- It is mandatory that if your school district is going to participate in the competition that at least one teacher from your school district attend a planning meeting or schedule a site visit. Please check the escWorks for the dates of these meetings. They will be listed as 21st Century STEM Challenge.
- All projects must have the following information visible on the project: Student or students' name, School name, Teacher name, and grade.
- Concession stand will be provided on site for meals and/or snacks. More information will be provided at a later date.

Engineering Notebook

One of the goals of *21st Century STEM Challenge* is to recognize the engineering design process and "the method" that an individual or team makes during the construction and testing of the device. Throughout the design and building of your device you will come across some obstacles, lessons learned, and the need to draw things out on paper. This is where you or your team will use an engineering notebook. These notebooks will follow you or your team from the first step throughout the building of the device to the competitions. Judges will review your Engineering Notebook to better understand your process, design, thoughts behind the design. Students must present their notebook to the judge prior to the event.

Type of Notebook: There are many different types to choose from, using the following criteria:

- Numbered pages are recommended (but not necessary) so that pages cannot be substituted or deleted.
- Only **one** Engineering Notebook will be required per team.

Notebook Guidelines: The Engineering Notebook is a complete documentation of your device design. This documentation should include sketches, discussions, design, evolution, processes, the "Aha's!", obstacles and each team member's thoughts throughout the process.

So here are the guidelines:

- Write NEATLY - anyone should be able to read it.
- Write down EVERYTHING AS IT HAPPENS.

  * If it is not documented, it did not happen

  * If you write it the next day, it did not happen.
- Date each entry in chronological order.
- Engineering Notebooks should be organized enough to have an outsider understand your design process.
- Start your notebook by introducing yourself or each team member with a brief biography of their name, age (or school year), school, and interests. ***Tip:*** *Pictures along with the bios would serve as a great visual for the judges to get to know you or the team.*
- All designs and changes to your design should be recorded directly into your notebook.
- The inclusion of all elaborate details and sketches are preferable. Notes and calculations should be done in your notebook, NOT on loose paper.
- In the case of an error, draw a single line through the incorrect data.
- Use both sides of a page.
- To insert pictures or outside information into your notebook, tape or glue the picture into your notebook and outline with permanent ink, to note that it was there in case it falls out.

Tip: Pictures or sketches of your of your designs are recommended as part of a thorough documentation.

**** Every notebook is a work in progress, forever changing and developing. Judges do **not** want to see a "final" copy notebook; they want the **real thing** complete with misspellings, stains, worn edges and wrinkled pages. ***Just remember to keep it real!***

Engineering Notebook Design Log (All notebooks that are to be graded according to the rubric prior to the competition and must be included within the notebook on the first page before the student biography.)

Think Award – it's all about the Engineering Notebook *We will award one notebook from each grade band with the* ***Think Award*** *for the best engineering notebook.*

1 Describe the Problem

- State what the product or system should be able to do and what problem/s need to be overcome.

2. Research and Gather Information

- What have others done?
- What are the sizes, stresses, loads, power requirements, appearance, and ergonomic factors?

3. Think of and Develop Possible Solutions

- There is no right or wrong answers.
- Describe ideas
- Articulate (sketch) the possible solutions in two and three dimensions

4. **Select the Best Possible Solution(s)**

- Determine which solution(s) best meet(s) the original requirements.
- Make a list of the pros and cons.

5. Construct the Device

- Keep a log of the steps necessary to build the devise.

6. Test and Evaluate

- Does it work?
- Can it be improved?
- Gather data/observations from the test.
- Write a description of what went right and what went wrong.

7. Redesign/Modify and Complete

- Overhaul the solution(s) based on information gathered during the tests.
- Compete in your school's competition.

Engineering Design Rubric

Category	Below Average 2 pts	Average 3 pts	Excellent 4 pts
Defining a Problem	Rephrases the problem with limited clarity.	Rephrases the problem clearly.	Rephrases the problem clearly and precisely.
Researching and Generating ideas	Contributes ideas, but without documented research. Produces incomplete sketches. Does not present a concept.	Contributes one plausible idea based on documented research. Produces marginally accurate pictorial and orthographic sketches of design concepts.	Contributes multiple plausible ideas based on documented research. Produces accurate pictorial and orthographic sketches of design concepts.
Brainstorming *Think of Possible Solutions*	Contributes few or implausible ideas.	Contributes a plausible idea.	Contributes multiple plausible ideas.
Exploring Possibilities –*Think of Possible Solutions*	Inadequately analyzes the pluses and minuses of a variety of possible solutions.	Satisfactorily analyzes the pluses and minuses of a variety of possible solutions.	Thoroughly analyzes the pluses and minuses of a variety of possible solutions.
Selecting an Approach - *Select the Best Solution*	Selection of solution is not based on consideration of criteria and constraints.	Selects a promising solution based on criteria and constraints.	Selects a promising solution based on a thorough analysis criteria and constraints.
Developing a Design Plan – *Draw, Plan & Select Materials*	Design plan is inadequate and lacking pertinent information.	Design plan is adequate, containing all pertinent elements.	Design plan is accurate and comprehensive.
Making a Model or Prototype - *Device*	Prototype meets the task criteria to a limited extent.	Prototype meets the task criteria.	Prototype meets the task criteria in insightful ways.
Testing and Evaluating the Design using Specifications	Testing and evaluation processes are inadequate.	Testing and evaluation processes are adequate for refining the problem solution.	Testing processes are innovative.
Refining the Design	Refinement based on testing and evaluation is not evident.	Refinements made based on testing and evaluation results.	Significant improvement in the design is made based on prototype testing and evaluation.
Competing	Finished solution (product) fails to meet specifications.	Finished solution (product) meets specifications.	Finished solution (product) exceeds specifications.

Sailboat Competition

Objective: Design and Engineer a **s**ail a boat of the heaviest mass that will travel a set distance in the shortest amount time.

Rules: You are pretty much free to make your boat out of whatever you want, just keep in mind the following rules:

- The boat may not be commercially made.
- The boat must be made out of materials found around the house.
- Maximum length 30 cm.
- Maximum width 15 cm for boat and/or sail.
- There is no height limit.
- Water depth of 10 cm.
- All projects must have the student name, teacher name, grade, and school name attached to them.

Methods & Analysis:

- The boat will be held in place until you are ready to compete.
- A fan will used as the source of energy to move the boat.
- Modifications may be made between the first and second trial.
- If the sailboat sinks; then it is automatically disqualified.

Scoring:

The winner will be the entrant that makes it completely across the trench with the lowest score based upon the following formula:

(1000/W) x T W= Mass of boat T= Sailing time

HINT: Notice in scoring that MASS counts

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Paper Airplane Competition

Objective: To create an airplane constructed of PAPER to fly the greatest distance through doorways.

Rules:

- Plane is to be constructed of ***paper*** only. (No tape, staplers, etc. to be used)
- The plane is to be no more than 46 cm long; 31 cm wide; and 5 cm from bottom to top of plane body section.
- The student will have two launches that will be a cumulative point value of both launches.
- The student will launch their rocket from behind a line. The competitor will not be allowed to step into the launch.
- The goal is for the planes to fly through 3 PVC doorways.

	Distance from throw line	Points
1st doorway	2.5 meters	1
2nd doorway	5 meters	2
3rd doorway	7.5 meters	3

- Each competitor may bring three airplanes.

Scoring: Planes will be scored by how many of the three doorways it travels through.

Ties will require a second throw.

Ruling of coordinator is final on all competition questions.

Mousetrap Car Competition

Objective: To design and engineer a vehicle, powered solely by the energy of one standard-sized mousetrap that will travel the greatest linear distance. Note: By definition, a vehicle is a device with wheels or runners used to carry something (e.g., car, bus, bicycle, or sled). Therefore, launching a ball (e.g., marble) from the mousetrap will be ruled illegal.

Construction:

- The device must be powered by a single mousetrap (1-3/4 inches x 3-7/8 inches).
- NO VEHICLES MADE FROM KITS.
- The mousetrap cannot be physically altered except for the following: 4 holes can be drilled only to mount the mousetrap to the frame, and a mousetrap's spring can be removed only to adjust the length of its lever arm.
- The device cannot have any additional potential or kinetic energy at the start other than what can be stored in the mousetrap's spring itself. This also means that the student cannot push start the vehicle.
- All parts of the vehicle must remain with the vehicle as it travels down the track and stops.
- The spring from the mousetrap cannot be altered or heat treated**. Do Not double wind the spring!**
- The spring cannot be wound more than its normal travel distance, or 180 degrees.
- The vehicle must steer itself; no outside forces may be used to guide it.
- The vehicle must be self-starting and may not receive a push in the forward direction or side direction.
- The judge has the final decision as to the appropriateness of any additional items that might be used in the construction of the vehicle.

Competition:

- The race track will be a smooth gym floor marked three meters in width.
- Distance will be measured from the edge of the starting line to the front of the vehicle after it stops or leaves the track way. (Even if the vehicle turns, the front of the vehicle is considered the starting point.)
- Each contestant will be given two attempts.
- Winner will be based upon the longest single run by a contestant.

Marshmallow Catapult Competition

Objective: To design and construct a catapult/trebuchet that will launch a large marshmallow at a circular standing target 6 meters from the launch pad. The goal is to accumulate as many points possible in two (2) trials.

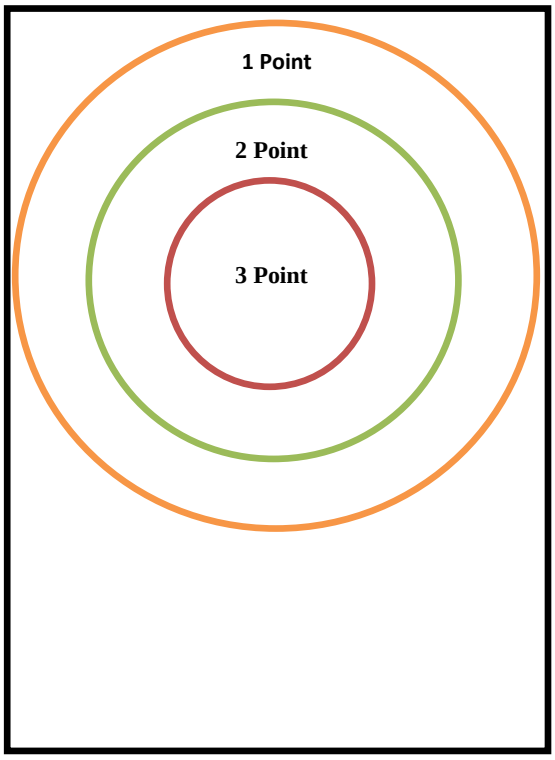
Rules:

1. The dimensions of the catapult or trebuchet will not exceed 30 cm high X 30 cm wide X 30 cm" deep in size for the base. The Lever arm may not exceed 60 cm. This will be measured from the fulcrum.
2. You may power your catapult by any means possible. Such as rubber bands, counterbalance weights, or elastic lever arms.
3. The device must have some type of trigger to set it off.
4. Each competitor will be given 2 trials (adjustments to the device may be made between attempts).
5. The winner of the throwing competition is the student that accumulates the most points by landing on a target.
6. In the case of a tie, there will an additional launch to break the tie.
7. The fairway will be 1.5 meters wide and follow a straight path 6 meters long to the center of the target.
8. All contestants will be given the exact same time frame to make adjustments before second launch. Students will be allowed 5 minutes at the Fix-It Shop.

Scoring:

Score will be the number of points earned by the marshmallow going through or hitting the center target. The center of the target earns 3 points, the next ring earns 2 points, and the final ring earns 1 point

Catapult target – Same as airplane doorway with 3 different sized hoops.



Paper Roller Coaster Competition

Objective: You and your team will design and construct a paper roller coaster using templates that are available by request. You must use paper products only to construct the roller coaster (no poster board allowed) in its entirety.

Rules:

- You must use paper products only and clear packing or clear tape. No duct tape or wooden sections of roller coaster allowed.
- Each roller coaster must include five design elements and they must be labeled:
  1. Incline that is not a part of any other element.
  2. Vertical Loop
  3. Wide turn
  4. Vertical Double loop
  5. Narrow turn
- All other design elements are optional.
- The coaster will be tested using a glass cat-eye marble launched from the highest point of the coaster.
- The total length of the coaster track must be a minimum of 3 meters and a maximum of 6 meters. ***Length should be premeasured and included in the Engineering notebook and on the nametag and*** **included with registration.**
- Contestants cannot hold any part of the track during the competition.
- Include the length for the rollercoaster along with student name, teacher name, grade, and school name attached roller coaster base.

Methods and Analysis:

- The length of time that it takes the marble to travel the coaster will be recorded.
- The speed of the marble will be calculated using distance/time and the highest speed calculation will be the winner.
- In the event of a tie; a larger marble will be used and the same information will be recorded.

Paper Rocket Competition

Objective: To construct a model rocket of original design, with certain criteria, that will launch into the air using a launcher and land on a target located 20 meters from launch pad.

Rules:

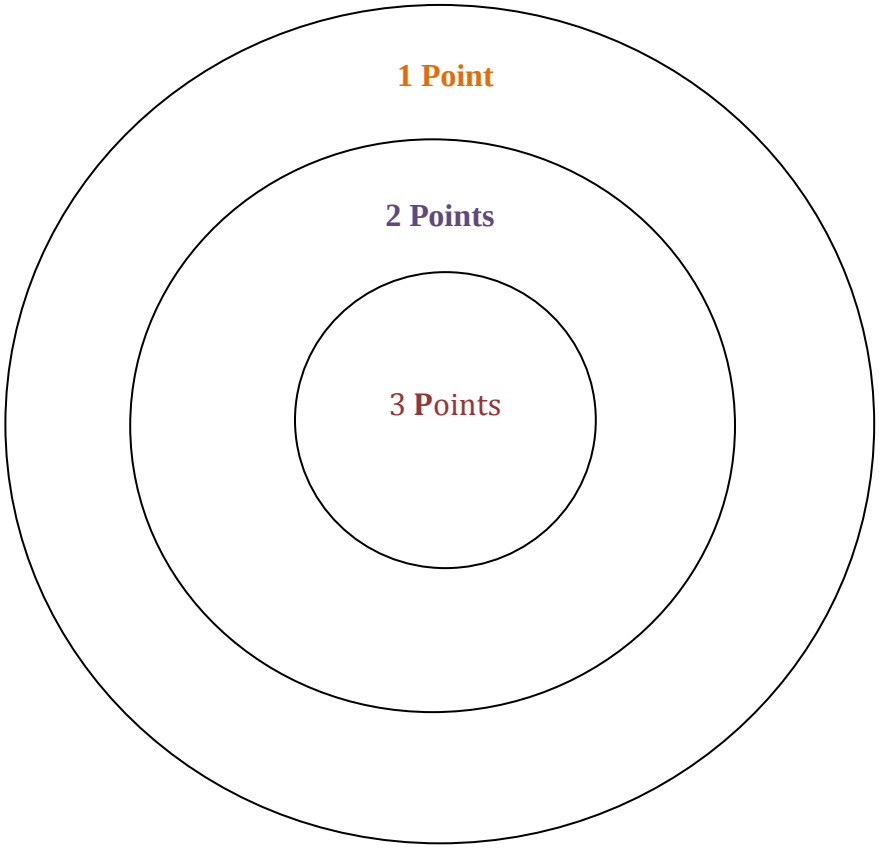
- The rocket may be constructed from paper, poster board, or pipe insulation (gray or black in color). You may use a combination of these for one rocket.
- The rocket can be held together using (clear) tape only.
- The diameter of the inside of rocket must be able to slide onto a ½ inch PVC pipe.
- The minimum length of rocket is not to be less than 20.32 cm long or 8 inches.
- The maximum length of rocket is not to exceed 60.96 cm or 24 inches.

Methods and Analysis:

- The angle, force, and direction may be adjusted by the competitor,
- Two launches for each rocket.

Scoring: Students will be given 3 trails to land on the target that is 20 meters from the launch. The points from the three trails will be totaled for an average score.

In the event of a tie the rockets will be launched again; until there is a clear winner.



Egg-drop Competition

Objective: The objective is to ***design and engineer*** a device, with minimum mass, so that a raw egg will not break when dropped from a height of 10 meters.

Rules:

The following are the only items that may be used in the construction of the device. Some or all of them may be used.

Materials List:

1. 10 (or less) Popsicle sticks OR tongue depressors
2. 10 (or less) toothpicks
3. 10 (or less) drinking straws
4. 3 (or less) pipe cleaners
5. 24 cm (or less) string or yarn
6. 24 cm (or less) masking tape (must not be attached to egg in any way)
7. White glue for gluing things together (must not stick to egg)
8. 3 (or less) 3″ rubber bands

Analysis:

Any structure that does not adhere to the materials list will be automatically disqualified. The last egg surviving the “CRASH LANDING” without cracks or being broken will determine the winner.

Toothpick Bridges Competition

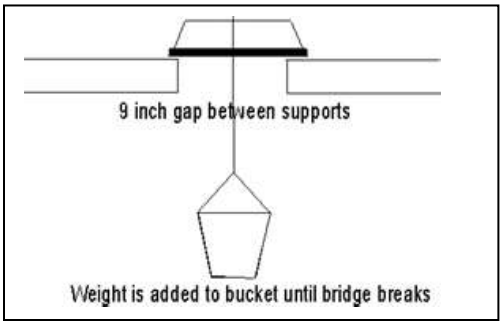
Objective: Design and engineer the lightest weight bridge that has the best design efficiency without deflecting more than ¼".

Materials: Materials used to construct your bridge are restricted to the following:

- Standard round/square wood toothpicks (unlimited number)
- White glue (not hot glue).

Bridge Building Guidelines

Dimensions of the bridge MUST be as follows:
Length: (45 cm)
Width: Minimum – (5 cm)
Maximum –(10 cm)
Height: Must not exceed (20 cm)
Span: (30 cm)
Total Weight: Must not exceed. (150 grams)



The bridge may be of any design but MUST conform to the specifications stated above. If the bridge does not meet the specifications, it will be disqualified from the competition. The toothpicks are to be the primary stress (load) carrying elements. The glue is to be used only to transfer stress (load) between toothpicks.

"Painting" or "dipping" the bridge with multiple layers of glue such that the glue is a primary stress carrying element will be grounds for disqualification. It is recognized that the construction of some bridge types, such as box girders that require toothpicks to be placed side by side, requires extensive use of glue. This is acceptable provided the bridge is not painted by brush or other means with glue or dipped in glue. Judge's decision will be final. The bridge must be free standing with no external anchors.

Judging

Prior to the testing, each bridge will be inspected, weighed, and initialed by the judges to indicate compliance with contest construction specifications.

An individual or team may register only one bridge. After inspection by the judges, the bridge shall be placed on designated staging tables. Each individual or team is responsible for the security of their bridge. **Decision of judges, during all phases of competition, will be final.**

Scoring

Points will be awarded to the top three in each division that have the largest efficiency rating. This will be determined using the following formula:

$$\text{Design Efficiency (DE)} = \frac{\text{Maximum Load (lb)}}{\text{Mass of Bridge (g)}} \times k$$

Where k = .035 (efficiency constant)

RESOURCES

The Pitsco Bridge Book
PitscoCopy Right 1989

Building Toothpick Bridges Grades 5-8
Dale Seymour Publications
ISBN # 0-86651-266-7

Explore large structures and what it takes to build them with **BUILDING BIG™**, a five-part PBS television series and Web site from WGBH Boston. Here are the main features of the site:
http://www.pbs.org/wgbh/buildingbig/

Lesson Plans for building a Paper coaster:
http://www.mrwaynesclass.com/ProjectCoaster/Lab/index.html

http://paperrollercoasters.com/

http://bridgecontest.usma.edu/

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Pop_Rocket_Launcher_Directions.html

http://www.ehow.com/how_6737513_build-styrofoam-sailboat.html