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## Objective

Build a model bridge onsite with provided tools and materials within 2.5 hours and achieve the greatest support efficiency.

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## Location

### Science Center of Iowa

401 W. Martin Luther King Jr. Pkwy  
Des Moines, IA, 50309

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## Timeline

9:00-9:30 am	Check-In / Setup
9:45 am - 12:15 pm	Bridge Building
12:15-1:00 pm	Lunch*
1:00-2:00 pm	Load Testing
3:00 pm	Awards for all categories

\*Lunch is included with registration for each participant. Limited allergen/gluten-free options are available. Sack lunches are permitted. Each participant will receive one bottle of water and snack during the bridge-building time.

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## Categories

A team may consist of one to four people. All team members must be listed on the registration form. *ALL teams must provide their team name at time of registration.*

- Elementary (Grades 3-5)
- Middle School (Grades 6-8)
- High School (Grades 9-12)
- Family (Any combination – children, adults, seniors) – see Rule #13

**To register, call the SCI Sales Office at 515-274-6868 ext. 222.**

*Registration is limited to six teams per category. Registration deadline is November 2.*

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## Cost

**FREE!** Event includes a bridge material kit and a complete tool set provided to you at the workshop. Participation in the event *does include* entrance to SCI for the day for team members and one adult chaperone per team.

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## Awards

The following will be awarded in each category:

- Highest Structural Efficiency ( $E = \text{maximum load} / \text{bridge weight}$ )
- Most Innovative
- Truss Teamwork Award

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## Rules

# READY, SET, BUILD!

## *Central Iowa's Bridge-Building Challenge*

1. Teams will build a bridge within 2.5 hours at the competition site using a set of provided materials. Each team should build a bridge that is capable of supporting the greatest load per the bridge's weight. Each team will independently perform both design and construction. Teams may ask the judges for suggestions. No pre-constructed bridge components are allowed; however, written plans are permitted.
2. Each team will be provided a standard set of tools that will be turned in to the sponsors prior to leaving the build area for testing. Only tools provided by the sponsors may be used during the build. No tool, whole or in part, may be built into the bridge itself.
3. Bridges must be designed to accommodate the loading apparatus. The load will be suspended from an eyebolt attached to a ~6x1x1/8-inches thick plate from below at its center. The plate rests flat on the bridge deck while the load is applied downward from below. Care should be taken in the deck design to reinforce the area where the loading plate rests and the ends where the bridge rests on the test stand with bracing. The load, supplied and applied by the judges, shall hang from the bridge.
4. The weight of the bridge will be recorded after inspection by the judges and prior to testing.
5. The load weight shall be increased until the bridge fails. The maximum load that breaks the bridge will be recorded.
6. The bridge will be judged based on the highest support efficiency rating ( $E = \text{maximum load} / \text{bridge weight}$ )
7. The bridge span cannot be greater than 24 inches or less than 21 inches. Teams are provided a wood "fixture" used to model the test stand.
8. The bridge height cannot be greater than 9 inches above the deck or 9 inches below the deck. A combined total height above and below the deck cannot exceed 12 inches. Covered bridges are discouraged.
9. The bridge width cannot be greater than 6 inches or less than 4 inches.
10. The bridge deck must be able to support a weighted toy truck (~3x2.5 inches,  $\leq 5$  lbs.) as it is rolled across the entire length of the bridge. This is used to verify that the bridge acts as a bridge.
11. In the event of a support efficiency tie, the lightest bridge wins. It is up to the team to decide on the optimum balance between weight and strength.
12. The Judges are provided by the Iowa DOT, and all decisions by the judges are final.
13. Adults are encouraged to participate in the FAMILY DIVISION only. To ensure fairness throughout the different age categories, only Iowa DOT volunteers are to work with the teams outside of the FAMILY DIVISION. **Violators risk team disqualification.**

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### Modeling Tips

# READY, SET, BUILD!

## Central Iowa's Bridge-Building Challenge

1. Remember, for a real bridge, the important part is the steel and/or concrete structure that supports the deck the cars drive on, not the deck itself...
2. A bridge needs to have a solid, stiff shape along its height, length and width. The structure should not bend or twist when weight is placed on it. For example, a Popsicle stick is easier to bend along its flat side than along its edge.
3. A bunch of sticks glued together flat, like a raft, has very little strength and will sag during testing under very little load (a force/weight placed on it).
4. String as a structural piece should always be in tension. In other words, it should always be stretched.
5. The strongest structural shape is the triangle. A bridge which is made of a series of triangles will be very strong. (See page 5)
6. A bridge that is symmetrical is less likely to twist when loaded with a weight and will probably carry more.
7. A bridge built too tall will have a high moment of inertia, increasing stiffness and strength (a good thing). However, it may become unstable and topple when under a load (a bad thing).

### Idea Generating Guidelines

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1. Read this document thoroughly, and watch this video:  
<http://www.youtube.com/watch?v=gMgBjHBjcfo&feature=youtu.be>
2. Explore the internet for bridge-building tips and other bridge-building competitions.
  - The Bridge Site – <http://www.bridgesite.com/funand.htm>
  - Model Bridge Design – <http://www.garrettsbridges.com/category/popsicle-bridges/>
  - Independent Modeling Instructions – <http://www.instructables.com/id/Popsicle-Stick-Bridge/>
  - Independent Modeling Instructions – <http://andrew.triumf.ca/andrew/popsicle-bridge/>
  - West Point Bridge Designer 2012 – <http://bridgecontest.usma.edu/download.htm>
3. See pages 5-6 for bridge-building basics provided by the American Society of Civil Engineers (ASCE).
4. Observe real bridges while traveling!

## BRIDGE INSPECTION CHECKLIST

Criteria	Acceptable
Bridge Length: 21 inches (min.) to 24 inches (max.)	
Bridge Height: ≤ 9 inches above deck, ≤ 9 inches below deck, ≤ 12 inches total	
Bridge Width: 4 inches (min.) to 6 inches (max.)	
Bridge Span: ≥ 18 inches	
Decking across the entire portion of the bridge span	
Deck capable of supporting weighted toy truck	
Assembly area clean / Tools and materials turned in	

## Tools List

1. 1/2" round file
2. Mini pliers with wire snaps
3. 8" triangle carpenter square
4. Pencil and graph paper
5. Tape measure
6. Nitrile (non-latex) gloves
7. Coping saw
8. Hot glue gun and two glue sticks
9. Clothespins (~30 per team)
10. Cutting board
11. Wood fixture (test stand model)

## Materials List

1. String (small ball) and floral wire available
2. Masking tape (available upon request)
3. Bridge decking (poster board)
  - 1 – 21" x 3 1/4"
4. Popsicle sticks (to be issued in manufacture's package)
  - ~120 – 5 7/8" x 3/4" x 1/16"
  - ~80 – 4 1/2" x 3/8" x 1/16"
5. Round wooden dowels
  - 2 – 36" x 1/8"
6. Square wooden dowels
  - 2 – 36" x 1/4"

## Bridge Types

Tied Arch



Arch



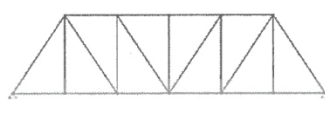
Basket Handle Arch



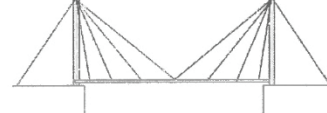
Suspension



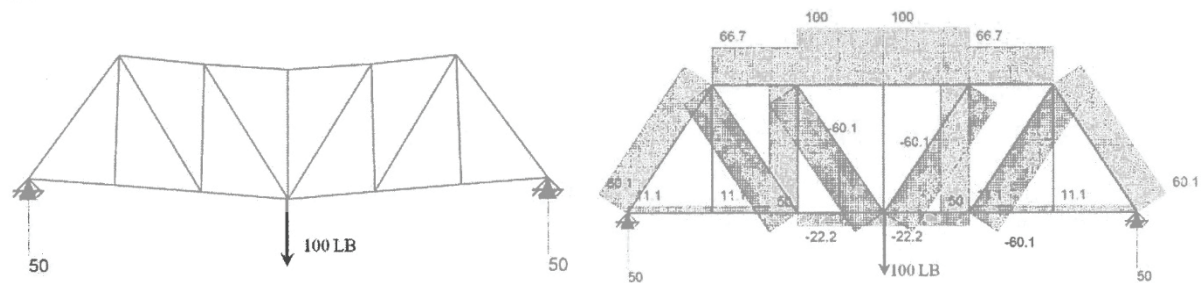
Truss



Cable Stay

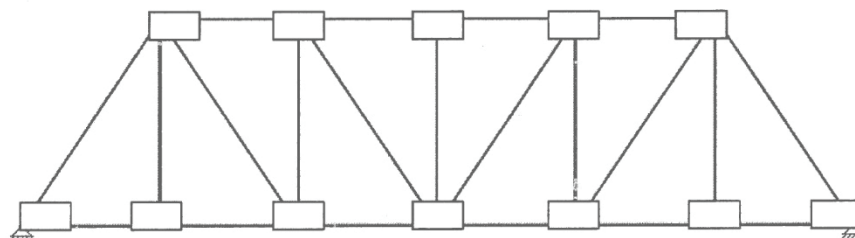


## Load Path



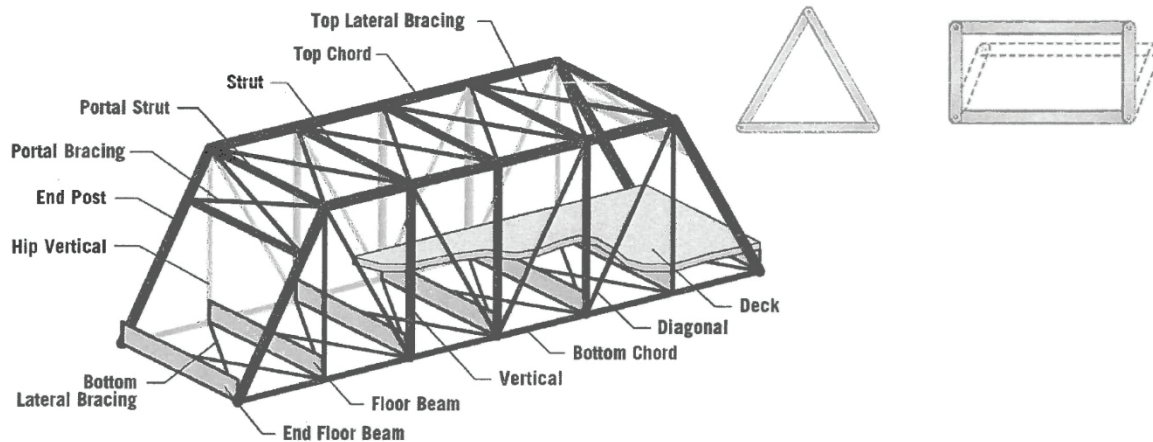
- Strengthen areas where loads are connected

## Connections



- Reinforce joints, because bridges are only as strong as their connections

## Stability



- Use triangular shapes to prevent rectangles from leaning/deforming
- Members in compression, such as the Top Chord, will try to buckle sideways during loading and can be prevented by using Top Lateral Bracing
- Some bridges will twist along their length during loading and can be prevented by using a “closed” shape, such as a box or triangle, as opposed to an “open” U-shape.

## Truss Types

