MOREnet, MODOT and RoundTrips Present:
Why This Bridge Here

Date: January 30, 2009
Times: 10:00 a.m. to 10:45 a.m. and 11:15 a.m. to Noon
Grade Levels: 4-8
Cost: No Fee

Abstract:
Interact with engineers as you learn about the different type of bridge shapes and the forces that act upon them. Find out why different kinds of bridges are found in different places and what causes engineers to choose why this kind of bridge should go here.

Program Description:

When you travel you notice there are all sorts of different shapes to bridges that span rivers, gorges, and highways. Have you ever wondered "Why did they build that kind of bridge here?" This program is designed to help you and your students answer that question. We'll explore basic bridge shapes such as arch, beam, suspension, and cable-stayed. We'll look at the forces of tension, compression, torsion, bending and shear that act on those bridge shapes. We'll investigate how the purpose of the bridge, its geographic location, and materials used in its construction also help determine its final design. This is the second of our ten part series developed with the Missouri Department of Transportation as it builds a new bridge across the Missouri River at Glasgow, Missouri. Students will see examples of different types of bridges and engage in interactive discussion and activities with engineers who design and build bridges. We'll look at examples of bridges from around the world and the specifics of the new bridge being built at Glasgow.

Program Objectives:

1. The participant will explore the essential types of bridge shapes and the forces acting on them.

2. The participant will interact with experts involved in planning and executing bridge design and construction and learn about their occupations and work process.

3. The participant will gain knowledge about the engineering of bridges.

Program Format:
The program will focus on the different shapes of bridges and the forces that act upon them that dictate which shape is chosen for a specific location.

Program Order—The videoconference program will consist of the following segments.

1. Welcome and Introduction—Student groups and experts will be introduced and welcomed to the program. Information will be given on the series of interactive programs that will continue throughout the school year as the new bridge is constructed.

2. Why This Bridge Here?—the Big Picture—In this segment, students will engage in interactive conversation with the engineers as they participate in activities demonstrating why different shapes of bridges are used in different locales. Students will explore arch bridges, beam bridges, suspension bridges, and cable-stayed bridges. Some activities will be completed as students view images and video with the engineers, and some of these activities will be completed with hands-on materials used by students as the program proceeds. For a short description of these hands-on activities and the materials needed for them, refer to the Hands-On Activities section below.

3. Why This Bridge Here?—the Specifics of Glasgow, Missouri—In this segment, the engineers will apply the information learned by students in the previous segment and demonstrate how it impacted the choice of bridge shape for the new bridge to be built at Glasgow, Missouri. Students will again engage in interactive discussion and activities with the engineers to demonstrate why the shape chosen is the best one for that location.

4. Summary and Closing—We'll summarize the major concepts learned today, seek final questions from students, and invite participation in the school year series of programs that will follow the construction of the new bridge.

Featured National Standards: (Science)
From the Center for Science, Mathematics and Engineering Education
6.5 Science and Technology Standards
Grades 5- 12
Abilities of technological design
Understanding about science and technology

Featured State Standards (Missouri):
Schools from across the country are invited to join in the program. Missouri state standards are provided for Missouri schools since funding for this program comes from various Missouri organizations.

Show-Me Knowledge Standards (Science)
In Science, students in Missouri public schools will acquire a solid foundation which includes knowledge of:

2. properties and principles of force and motion

Missouri Grade Level Expectations
Strand 2 Force and Motion
Laws of Motion
Work and Simple Machines
Force, Motion, and Work

Interactions between Energy, Force, and Motion

Participant Preparation:

1. Participants should come to the program with an interest in bridges, engineering, math or science.

2. Participants should utilize preparatory materials provided for the program and other resources of their own to better understand the context of the program's subject and to think in advance of questions they wish to ask the experts. Any questions determined in advance, can be e-mailed to us prior to the program at roundtrips@clayton.k12.mo.us.

3. Participants should have pencil and paper ready to use during the program to jot down ideas and additional questions as they come to mind.

4. Participants should have the materials to be used in the hands-on activities in segment 2 of the program.

Pre-Program Activity Suggestions:

1. Talk to students about compression and tension. Slightly bend a piece of thin wood and describe the areas of compression and areas of tension. Help students understand that some materials are better than others. For example, concrete is great for compression but does not do well in tension, or how the steel strands in a suspension bridge work well under tension while they are not the best for compression. Give students dry spaghetti noodles to try compression and tension testing.

2. Have students explore the PBS website http://www.pbs.org/wgbh/nova/bridge/build.html and play the game to build the bridge they believe is best for the locations shown.

3. Have students explore the website http://science.jrank.org/pages/1036/Bridges.html to learn more about types of bridges and the forces that act on bridges. What seems clear to them and what needs clarification? Have students split up the task of exploring the site and explain to each other what they learned in their section and also share what they didn't fully understand in their exploration. Have students then develop questions on the topics they'd like the engineers in our program to answer to help clarify what they didn't understand. Send those questions to us in advance of the program by e-mailing them to roundtrips@clayton.k12.mo.us. We will forward them to the engineers joining us for the program so we can incorporate them into the program.

4. Students should explore the Missouri Department of Transportation website dealing with building the new Glasgow Bridge. That website can be found at http://www.modot.mo.gov/northcentral/glasgowbridgeproject.htm. The site includes information about the original bridge, plans for the new bridge, and a web cam showing current work on the bridge. Students should develop questions about what they read to ask during the program or to send to us in advance of the program at roundtrips@clayton.k12.mo.us. Teachers might want to divide the class into groups and have each group investigate a specific part of the website to

explore in depth. Students can then share their learning with the rest of the class and present the questions they have developed to ask of the program's experts.

Post-Program Activity Suggestions:

1. As a follow up to this program and as a lead in to the other programs in the upcoming series, have students create a list of questions they have about "what happens next" in the construction of the new bridge. Send those questions to us at roundtrips@clayton.k12.mo.us for MODOT experts to answer and reply to your students.

2. Have students create a list and describe objects they have seen in compression or tension.

3. Have students tell about bridges they have traveled. For example, tell about where the bridge location and what kind of bridge it is. Have them speculate why the engineers chose this type of bridge.

4. Have students share what they found most interesting and potentially frustrating about the careers they saw today. What would they like or dislike about being an engineer or bridge builder?

Vocabulary:
Tension—In physics, tension is the magnitude of the pulling force exerted by a string, cable, chain, or similar object on another object.

Compression—Physical compression is the result of the subjection of a material to compressive stress, resulting in reduction of volume. The opposite of compression is tension.

Bending—In engineering mechanics, bending (also known as flexure) characterizes the behavior of a structural element subjected to an external load applied perpendicular to the axis of the element. A structural element subjected to bending is known as a beam. A closet rod sagging under the weight of clothes on clothes hangers is an example of a beam experiencing bending.

Torsion—In solid mechanics, torsion is the twisting of an object due to an applied torque.

Shear—A shear stress is defined as a stress that is applied parallel or tangential to a face of a material, as opposed to a normal stress which is applied perpendicularly. In other words, considering that weight is a force, hanging something from a wall creates a shear stress on the wall, since the weight of the object is acting parallel to the wall, as opposed to hanging something from the ceiling which creates a normal stress on the ceiling, since the weight is acting perpendicular to the ceiling.

Arch Bridge--The main supporting structure in an arch bridge is one or more curved elements. The dead and live forces that act on the arch bridge are transmitted along the curved line of the arch into abutments or supporting structures at either end. These abutments are sunk deep into the ground, into bedrock if at all possible.

Beam Bridge--The simplest type of bridge consists of a single piece of material that stretches from one side of a barrier to the other side. That piece of material—called a beam or girder—rests directly on the ground on each side or is supported on heavy foundations known as piers.

Suspension Bridge--In a suspension bridge, thick wire cables run across the top of at least two towers and are anchored to the shorelines within heavy abutments. In some cases, the roadway is supported directly by suspenders from the cables. In other cases, the suspenders are attached to a truss, on top of which the roadway is laid. In either case, the dead and live loads of the bridge are transmitted to the cables, which, in turn, exert stress on the abutments. That stress is counteracted by attaching the abutments to bedrock.

Cable-Stayed Bridge—A cable-stayed bridge is a bridge that consists of one or more columns (normally referred to as towers or pylons), with cables supporting the bridge deck.

Live Load--The force exerted on a bridge as a result of the traffic moving across the bridge.

Dead Load--The force exerted by a bridge as a result of its own weight.

Dynamic Load--The force exerted on a bridge as a result of unusual environmental factors, such as earthquakes or strong gusts of wind.

Truss--A structure that consists of a number of triangles joined to each other.

Cantilever--A cantilever bridge is a variation of the simple beam bridge. A cantilever is a long arm that is anchored at one end and is free to move at the opposite end. A diving board is an example of a cantilever.

Hands-On Activities:

1. Building a Bridge with Paper—Students will utilize the materials below. They will fold the paper in thirds lengthwise and stretch it between the two books. They will use the paper cup and coins to add weight to the bridge. Specific distances between the books will be given as they do the activity during the program. Based on your classroom setup, please determine if you want the students to do this activity individually, in small groups, or have one group demonstrate for the others in front of the class. The amount of materials needed will depend on how you divide your class.

Materials Needed Per Group:
One sheet of typing paper
Two books of the same size
A Styrofoam or paper cup (just be sure each student has the same kind)
A roll of pennies
Meter stick or ruler

2. Comparing Shapes for Strength—Students will utilize the materials below. Students will compare a four-sided shape to a three-sided shape to demonstrate why trusses have triangles. The straws and paper clips will be used to create the shapes. Specific instructions will be given during the program. Based on your classroom setup, please determine if you want the students to do this activity individually, in small groups, or have one group demonstrate for the others in front of the class. The amount of materials needed will depend on how you divide your class.

Materials Needed Per Group:

4 plastic straws (like those from a fast food restaurant)

4 paper clips