# MOREnet, MODOT and RoundTrips Present:
## *Building the Glasgow Bridge*
## *Design Processes: Looking at the Math*

**Date: February 20, 2009**
**Times: 9:00 a.m. to 9:55 a.m. and 10:00 a.m. to 11:00 a.m.**
**Grade Levels: 9-12**
**Cost: No Fee**

**Abstract:**
How do engineers create design plans for a new bridge? What factors impact their choices most? Go to the source. Interact with engineers to find out how they use math, physics and computer simulations in designing a bridge.

**Program Description:**

It's a pretty typical day in the office when the boss drops in and says, "Hey, the Missouri Department of Transportation has just informed us they've got a bridge over the Missouri River that needs replacing. We'd like to get that job. I've got the specs here on the location. Put your team together and come up with some preliminary design options we can send them for consideration." What do you do next? Where do you begin?

How do engineers create design plans for a new bridge? What factors impact their choices most? What do they need to know about math, physics, and materials? Go to the source. Interact with engineers to find out how they look at conflicting conditions, scientific principles, and crunching the numbers.

What is it like to apply the principles of engineering to the real world of designing a specific bridge? Join us for this program, the fourth 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, to learn the mathematics of bridge design.

**Program Objectives:**

1. The participant will explore the essential elements involved in basic bridge design.

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 of design process of a bridge—where an engineer begins the process to create a design and then explore the mathematics that determine load and stress on a simple span.

**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. The Stages of Design—Students will interact with engineers as they take them through the stages they followed in the design work done to create a bridge. Specific examples of decisions on the type of bridge to be used, load issues, easement issues, river traffic issues, environmental issues, deck structure, and substructure will be included. Students will have many opportunities to ask questions during the program. Websites included in the program's learning activities section can be used to help students develop these questions.

3. Math Behind the Process—Engineers will walk students through the process of determining the forces on a simple span. They will include the Algebra and Trigonometry involved in these calculations. They also will stress that although a computer can calculate quickly it is necessary to understand the equations used to know if the computer output is valid or garbage.

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 9- 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

**Show-Me Knowledge Standards (Math)**

**Measurement:**
Apply appropriate techniques, tools and formulas to determine measurements

Solve problems of angle measure, including those involving triangles or other polygons

**Geometric and Spatial Relationships**:
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Use trigonometric relationships to determine lengths and angle measures in all types of triangles

**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.

**Pre-Program Activity Suggestions:**

1. 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.

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. What questions do they have for engineers based on this experience?

3. Have students read the "Idea2Road" document published by the Missouri Department of Transportation that outlines the ten general steps followed in building a road. That document is included as a pdf with this program exhibit and is also available on our website at http://www.roundtrips.org. Would the steps be exactly the same to build a bridge? Would

additional steps be needed? What questions do these steps raise in their minds? What would they like to ask the engineers?

**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 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:**

**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.

**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.

**Substructure--**The understructure support of the bridge including foundation, piers, bents, caps, columns, footings, etc.

**Abutment--** Point of contact between two objects or parts

**Easement--**Right to use the land of another for a specific purpose, such as a right of way or utilities.