Popsicle Bridges:
How To Engineer
Bridges and Structures

IEEE ARIZONA SCIENCE LAB®
www.arizonasciencelab.org

Workshop Focus:

The workshop focuses on how bridges are engineered to withstand weight, while being durable, and in some cases aesthetically pleasing. Students work in teams of two to design and build their own bridge out of up to 200 popsicle sticks and glue. Bridges must have a span of at least 24 inches and be able to hold a fifty pound weight. Students are encouraged to be frugal, and use the fewest number of popsicle sticks while still achieving their goals. Students then evaluate the effectiveness of their own bridge designs and those of other teams, and present their findings to the class.

Workshop Synopsis:

The "Popsicle Bridge" workshop explores the four different forces that exist in structures: compression, tension, shear and torsion and how these forces influence the design of different types of bridges. The emphasis is on the solid beam and how that leads to the I-beam and truss beam that will be used in the design of the students' truss bridges. Students work in teams of two "engineers" to design and build their own bridge out of glue and popsicle sticks. They test their bridges using weights, evaluate their results, and present their findings to the class. Afterwards the workshop explores the other types of bridge: cantilevered, arch, and suspension and how engineering has impacted the development of bridges over time, including innovative designs and the challenge of creating bridges that become landmarks for a city.

Age Levels:

8-15 years (grades 4 to 8)

Objectives:

- Learn about compression, tension, shear and torsional forces
- Learn about stresses and strains in structures
- Learn about civil engineering
- Learn about engineering design
- Learn about planning and construction
- Learn about teamwork and working in groups

Anticipated Learner Outcomes:

As a result of this activity, students should develop an understanding of:

- structural engineering and design
- problem solving
- teamwork

Workshop Activities:

Students learn how bridges are designed to meet load, stress, and aesthetic challenges. Students work in teams to design and build a truss bridge out of up to 200 popsicle sticks and glue that can hold a standard weight. Teams test their bridge, evaluate their own results and those of other students, and present their findings to the class.

Alignment to Curriculum Frameworks:

Note: All Arizona Science Lab workshops are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principals and Standards for School Mathematics. They will also be modified as necessary to be aligned to the Next Generation Science Standards (NGSS) when they are released.

- **National Science Education Standards Grades K-4 (ages 4-9)**

CONTENT STANDARD A: Science as Inquiry As a
result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science
As a result of the activities, all students should develop an understanding of

- Properties of objects and materials

CONTENT STANDARD E: Science and Technology
As a result of activities, all students should develop

- Abilities of technological design
- Understanding about science and technology

CONTENT STANDARD G: History and Nature of Science
As a result of activities, all students should develop understanding of

- Science as a human endeavor

- **National Science Education Standards Grades 5-8 (ages 10 - 14)**

CONTENT STANDARD A: Science as Inquiry As a
result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science
As a result of their activities, all students should develop an understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology
As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives
As a result of activities, all students should develop understanding of

- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science
As a result of activities, all students should develop understanding of

- History of science

- **National Science Education Standards Grades 9-12 (ages 14-18)**

CONTENT STANDARD A: Science as Inquiry As a
result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science
As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology
As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives
As a result of activities, all students should develop understanding of

- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science
As a result of activities, all students should develop understanding of

- Historical perspectives

- **Standards for Technological Literacy - All Ages**

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology
- Standard 5: Students will develop an understanding of the effects of technology on the environment
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology
- Standard 7: Students will develop an understanding of the influence of technology on history

Design

- Standard 8: Students will develop an understanding of the attributes of design
- Standard 9: Students will develop an understanding of engineering design
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process

The Designed World

- Standard 20: Students will develop an understanding of and be able to select and use construction technologies

Internet Connections:

- TryEngineering (www.tryengineering.org)
- Sidney Harbor Bridge History (www.ourbridge.com.au/History.aspx)
- Building Big - Bridges (www.pbs.org/wgbh/buildingbig/bridge)
- ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org)
- National Science Education Standards (www.nsta.org)

Recommended Reading:

- Bridges of the World: Their Design and Construction (ISBN: 0486429954)
- Bridges: Amazing Structures to Design, Build & Test (ISBN: 1885593309)

Materials and Tools:

All materials and tools required for this workshop are provided by the Arizona Science Lab

Time Needed:

One four hour workshop (inclusive of lunch and restroom breaks).

ASL Staff Responsibilities:

The ASL staff is responsible for the conduct of the workshop:

- Setting up the workshop
- Presenting the lecture and teaching the science
- Performing the demonstrations
- Provisioning the materials and equipment to the student teams
- Supervising the construction project
- Supporting the students during the construction project
- Supervising the project testing
- Answering student questions about the science, the workshop, or any other related topic
- Cleaning up the workshop after the students have left

School Teacher Responsibilities:

- **Managing the students during the class and the lunch and restroom breaks, and imposing discipline as necessary**

    - The ASL staff is NOT responsible for the class management or for student discipline!
    - **The restroom breaks will require at least one male and one female teacher be present from the school**
- Assisting the ASL staff in the teaching of the science

    - This could comprise asking the students questions about what had just been explained, presenting what had just been explained in another fashion, and so on
    - The ASL staff are not necessarily trained teachers and the school teachers know their students very well, so they can provide valuable insights and help to the ASL staff
- Assisting the ASL staff during the project construction and testing