TEACHERS GUIDE

SPAGHETTI BRIDGE PROGRAM

ENGINEERS
GEOSCIENTISTS
MANITOBA

SPAGHETTI BRIDGE PROGRAM

FOR K-12

The Spaghetti Bridge program is rich in opportunities to achieve science outcomes from Kindergarten through Grade 12.

EASY TO RUN

The program will help you introduce engineering to students in a fun and easy way:

- This Teachers Guide will provide you with step-by-step instructions to run your program
- Engineers Geoscientists Manitoba will arrange for volunteers in the engineering profession to visit your school to help you introduce and set up your program upon request

THE BASIC STEPS

1. Build your bridges
2. Test them to destruction at the annual Spaghetti Bridge Competition in Winnipeg

SPAGHETTI BRIDGE BUILDING

OBJECTIVES

- Show the creative power of brainstorming
- Work effectively within a team, or individually, on a single task
- Work within limitations (weight and dimensions)
- Explain the use of different structural designs

MATERIALS

Each group of students will need:

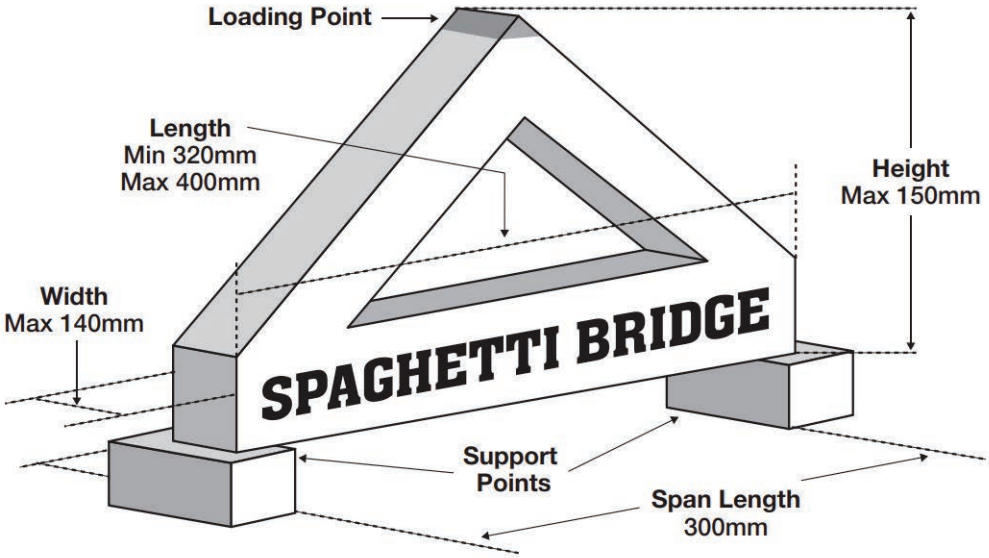
- Regular length spaghetti
- White or wood glue that is white or yellow in colour - other glue types such as polyurethane (found in brown wood glue), epoxy, or cyanoacrylate (Crazy Glue) may cause damage to the bridge breaking machine
- Access to a scale and ruler to ensure the structure weighs less than 350 grams and is within the specified dimensions

PROCEDURES

1. Register your students for the Spaghetti Bridge Truss Strength Competition by visiting **www.EngGeoMB.ca/SpaghettiBridge.html**. School groups can pre-register for a designated time slot to have their bridges tested. Check online for this year's dates and locations.

2. Break the class into small groups (max 3 students per group) and hand them their materials.

3. Tell the groups how much time they will have to design and build a bridge that weighs less than 350 grams and within these dimensions:



4. Take a picture of each bridge (optional).

5. Let the glue fully dry (1-2 days).

6. Test the bridges to destruction at the Spaghetti Bridge Truss Strength Competition.

7. Watch for updates of the strongest bridges. Final winners will be announced following the last of the competition entries.

8. Discuss the different strategies students came up with for their bridge designs:
   - What ideas did they abandon and which ones did they pursue? Why?
   - How do the different bridge designs compare? (Photos will be useful here if any bridges are destroyed beyond recognition)
   - What improvements or changes would they make if they were to repeat the exercise?

9. Challenge the students to (optional):
   - Identify the internal forces acting on your bridge such as compression, tension, shear, torsion
   - Predict the location and failure mode of your bridge
   - Determine the efficiency of your bridge by comparing its mass with the mass of the load it supports

ENTER THE COMPETITION

SPAGHETTI BRIDGE COMPETITION

AN ENGINEERING EVENT FOR WINNIPEG HARVEST

PLEASE VISIT

WWW.ENGGEOMB.CA/SPAGHETTIBRIDGE

FOR

- COMPETITION DATES
- OFFICIAL RULES
- ENTRY FORM

BRIDGES MUST MEET WEIGHT AND LENGTH REQUIREMENTS TO FIT ENGINEERS GEOSCIENTISTS MANITOBA'S TESTING EQUIPMENT AND BE ELIGIBLE FOR PRIZES.

SAFETY PRECAUTIONS AND HAZARDS

1. Bridge building can be messy. Students will need to wash the glue off their hands.

2. During testing the spaghetti will break and possibly scatter:
   - Keep a safe distance from the test frame (2-3 metres)
   - Wear safety glasses if you are standing less than 2 metres away

3. Keep your hands far from the bridge breaker during testing

DISPOSAL METHODS

Bridges may either be kept by their creator(s) or thrown in the garbage. Please notify competition staff if you wish to keep your creation.

SCIENCE OUTCOMES

This is a sample of some of the outcomes that can be reached:

KINDERGARTEN – SKILLS (CLUSTER 0)

K-0-4B: Construct an object to solve a problem or meet a need.
GLO: C3

K-0-4C: Identify, with guidance, improvements to an object with respect to predetermined criteria.
GLO: C3

GRADE 1 – SKILLS (CLUSTER 0)

1-0-4A: Follow simple directions while undertaking explorations.
GLO: C2

GRADE 2 – SKILLS (CLUSTER 0)

2-0-3D: Identify tools and materials to be used, and explain their choices.
GLO: C2, C3, C4

2-0-5B: Use, with guidance, tools to observe, measure, and construct.
Examples: Ruler, meter stick, pan balance, magnifying glass, bathroom scale, thermometer.
GLO: C2, C3, C5

GRADE 3 – MATERIALS AND STRUCTURES (CLUSTER 2)

3-2-01: Use appropriate vocabulary related to their investigations of materials and structures.
Include: Strength, balance, stability, structure, frame structure, natural structure, human-built structure, force.
GLO: C6, D3

3-2-02: Conduct experiments to compare the strength of common materials.
Examples: wooden toothpicks, plastic straws, paper, cardboard, polystyrene foam.
GLO: A1, A2, C2, D3

3-2-03: Explore to determine ways to strengthen a material used for building.
Include: changing shape, bulk, and number of layers.
GLO: B1, C2, D3

3-0-1B: Make predictions based on observed patterns, collected data, or data provided from other sources.
GLO: A1, C2

3-0-3A: Brainstorm, with the class, one or more methods of finding the answer to a given question and reach consensus on which method to implement.
GLO: C2, C7

3-0-3B: Identify, with the class, variables that have an impact on an investigation.
GLO: A1, A2, C2, C7

3-0-3C: Create, with the class, a plan to answer a given question.
GLO: C2, C7

3-0-4A: Carry out a plan, and describe the steps followed.
GLO: C2

3-0-5A: Make observations that are relevant to a specific question.
GLO: A1, A2, C2

3-0-6C: Place materials and objects in a sequence or in groups using two or more attributes, and describe the system used.
GLO: C2, C3, C5

3-0-7A: Draw a simple conclusion based on their observations.
GLO: A1, A2, C2

GRADE 4 – SKILLS (CLUSTER 0)

4-0-3D: Brainstorm possible solutions to a practical problem, and identify and justify which solution to implement.
GLO: C3

4-0-3E: Create a written plan to solve a problem or meet a need.
Include: Identify steps to follow, prepare a labeled diagram.
GLO: C3

4-0-3F: Develop criteria to evaluate an object, device, or system based on its function, aesthetics, and other considerations such as materials, and cost.
GLO: C3

4-0-5B: Estimate and measure mass/weight, length, volume, area, and temperature using standard units.
GLO: C2, C3, C5

GRADE 5 – SKILLS (CLUSTER 0)

5-0-4C: Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise.
GLO: C7

5-0-5A: Make observations that are relevant to a specific question.
GLO: A1, A2, C2

5-0-5B: Test a prototype or consumer product with respect to pre-determined criteria.
GLO: C3, C5

5-0-5C: Select and use tools and instruments to observe, measure, and construct.
Include: Balance, thermometer, spring scale, weather instruments.
GLO: C2, C3, C5

5-0-5D: Estimate and measure length using standard units.
GLO: C2, C3, C5 (Math SS-I.1.2)

5-0-5E: Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units.
GLO: C2, C5 (Math: SS-I.1.5, SS-III.1.5, SS-IV.1.5, SS-VIII.4.3)

5-0-5F: Record and organize observations in a variety of ways.
Examples: Point-form notes, sentences, labeled diagrams, charts, ordered lists of data, frequency diagrams, spreadsheets.
GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7G: Communicate methods, results, conclusions, and new knowledge in a variety of ways.
Examples: Oral, written, multi-media presentations**.**
GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-7H: Identify, with guidance, connections between the investigation results and everyday life.
GLO: C4

5-0-9B: Show interest in the activities of individuals working in scientific and technological fields.
GLO: B4

GRADE 6 – SKILLS (CLUSTER 0)

6-0-1B: Identify various methods for finding the answer to a specific question and select one to implement.
Examples: Generating experimental data, accessing information from a variety of sources.
GLO: C2 (ELA Grade 6, 3.2.2; Math: SP-I.2.6, SP-II.1.6)

6-0-1D: Identify various methods to solve a practical problem and select and justify one to implement.
Examples: Constructing and testing a prototype, evaluating consumer products, accessing information from a variety of sources.
GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-2A: Access information using a variety of sources.
Examples: Libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMS, Internet.
GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2C: Make notes on a topic, combining information from more than one source and reference sources appropriately.
GLO: C6 (ELA Grade 6, 3.3.2)

6-0-3D: Develop criteria to evaluate a prototype or consumer product.
Include: Function, aesthetics, efficient use of materials, cost, reliability.
GLO: C3

6-0-3E: Create a written plan to solve a problem.
Include: Materials, safety considerations, labeled diagrams of top and side views, steps to follow.
GLO: C1, C3, C6

6-0-7D: Propose and justify a solution to the initial problem.
GLO: C3

6-0-7H: Identify connections between the investigation results and everyday life.
GLO: C4

GRADE 7 – FORCES AND STRUCTURES (CLUSTER 3)

7-3-01: Use appropriate vocabulary related to their investigations of forces and structures.
Include: Frame, shell, solid, centre of gravity, stability, compression, tension, shear, torsion, internal and external forces, stress, structural fatigue, structural failure, load, magnitude, point and plane of application, efficiency.
GLO: C6, D4

7-3-04: Identify internal forces acting on a structure, and describe them using diagrams
Examples: Compression, tension, shear, torsion.
GLO: D4, E4

7-3-08: Describe, using diagrams, how common structural shapes and components can increase the strength and stability of a structure.
Examples: A triangle distributes the downward force of a load evenly between its two vertices.
GLO: C6, D3, D4

7-3-09: Describe and demonstrate methods to increase the strength of materials
Examples: Corrugation of surfaces, lamination of adjacent members, alteration of the shape of components.
GLO: C2, C3, D3, E3

7-3-10: Determine the efficiency of a structure by comparing its mass with the mass of the load it supports.
GLO: C1, C5

7-3-11: Evaluate a structure to determine the appropriateness of its design, using the design process.
Examples: Jacket, foot stool, local building.
GLO: C3, C4, C8, D4

7-3-12: Use the design process to construct a structure that will withstand the application of an external force.
Examples: A tower that will remain standing during a simulated earthquake.
GLO: C3, D3, D4

GRADE 8 – SKILLS (CLUSTER 0)

8-0-3E: Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow.
GLO: C3, C6

8-0-4A: Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability of results.
GLO: C2

8-0-5F: Record, compile and display observations and data using an appropriate format.
GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6A: Construct graphs to display data, and interpret and evaluate these and other graphs.
Examples: Circle graphs.
GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.7; TFS: 4.2.2-4.2.6)

8-0-6B: Interpret patterns and trends in data, and infer and explain relationships.
GLO: A1, A2, C2, C5

SENIOR 1 – SKILLS (CLUSTER 0)

S1-0-1C: Identify STSE issues which could be addressed.
GLO: C4

S1-0-1D: Identify stakeholders and initiate research related to an STSE issue.
GLO: C4 (ELA S1: 3.1.4, S1: 4.4.1)

S1-0-5C: Record, organize, and display data using an appropriate format.
Include: Labeled diagrams, graphs, multimedia.
GLO: C2, C5

S1-0-5D: Evaluate, using pre-determined criteria, different STSE options leading to a possible decision.
Include: Scientific merit; technological feasibility; social, cultural, economic, and political factors; safety; cost; sustainability.
GLO: B5, C1, C3, C4

S1-0-8F: Relate personal activities and possible career choices to specific science disciplines.
GLO: B4