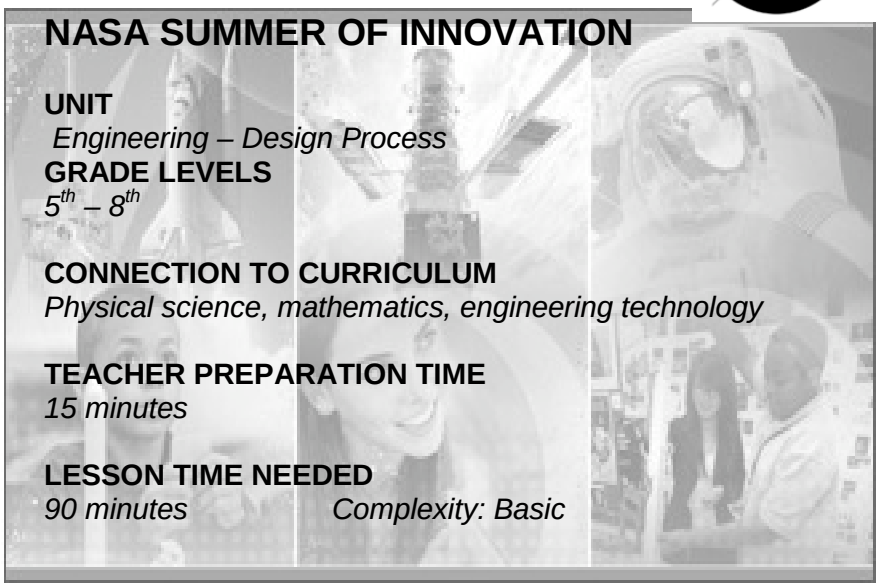
National Aeronautics and Space Administration

Spaghetti Anyone? Building with Pasta



DESCRIPTION
Use the engineering design process to build a structure to handle the greatest load. Gain firsthand experience with compression and tension forces.

OBJECTIVES
Students will:

- Test factors affecting the strength and stability of a structure
- Use the design process to identify the problem, brainstorm, design, build, test, redesign and share their solutions
- Measure and record strength and amount of weight the structure will hold

NATIONAL STANDARDS

National Science Education Standards (NSTA)
Science as Inquiry

- Understanding of scientific concepts
- An appreciation of "How we know" in science
- Skills necessary to become independent inquirers about the natural world
- Dispositions to use the skills, abilities and attitudes associated with science

Common Core State Standards for Mathematics (NCTM)
Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems

Geometry

- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume

ISTE NETS and Performance Indicators for Students (ISTE)
Creativity and Innovation

- Create original works as a means of personal or group expression
- Use models and simulations to explore complex systems and issues

Communication and Collaboration

- Contribute to project teams to produce original works or solve problems

MANAGEMENT
Prepare materials ahead of time. Organize students into small groups. Introduce the materials and the challenge. Introduce the Design Process to the students and answer questions about the process.

MATERIALS
- uncooked thick spaghetti
- marshmallows
- 100 cm (1 m) of masking tape
- scissors (to cut spaghetti)
- science journal
- pencil
- metric ruler or meter stick

CONTENT RESEARCH

Many **forces** are at work on towers. **Gravity** and the dead **load** of the tower push down; the ground pushes back up and small air movements push from the side. A foundation distributes the load into the surrounding ground material and can help balance the sideways wind force. The size of the foundation depends on the strength of the supporting ground. A foundation placed in rock can be smaller than a foundation placed in sand or mud.

Encourage the kids to brainstorm all of the ways they can alter the structure. Encourage them to think about shapes and stability. Squares are weak, triangles are strong. Let the kids discover triangular trusses. Reinforce that looking at what other groups are doing is okay; this is a competition, but also a chance to learn from others students' discoveries.

Watch this first! This is an explanation of the activity on Video. It shows Kindergarteners and business men performing this activity.
http://www.ted.com/talks/tom_wujec_build_a_tower.html

Grades 4-6- Read this first: Technology for Children: Building Big
Contains the Building Big video series and resources (hands-on activities and website).
http://www.iteaconnect.org/Publications/TandC/Sep07.pdf

Key Concepts

Bending: Combination of forces that causes one part of a material to be in compression and another part to be in tension
Compression: Force that squeezes material together
Design Process: Identify the problem, brainstorm, design, build, test, evaluate, share, redesign, and rebuild
Load-bearing members: To support or strengthen a roof, bridge, or other elevated structure with a network of beams and bars
Neutral axis: An imaginary plane that runs through the middle of a material under bending, at which zero stress is experienced
Tension: A force that pulls material apart
Truss: Support something with a structure

LESSON ACTIVITIES
http://www.knowitall.org/nasa/pdf/scifiles/wright_full.pdf

1. Create a design for your spaghetti structure.
2. Build the tower
3. Redesign to correct for any structural flaws.
4. Draw the final design at the bottom of this page.
6. Measure and record the height of your structure.
7. Share your model with the class and compare heights to other models.

ADDITIONAL RESOURCES

http://www.ustream.tv/recorded/13400346 explains how building strength is important in earthquakes. Earthquake video, Includes additional resources, including wall sheets, videos, lithographs, podcasts, websites, etc., that can be used to enhance the lesson.

DISCUSSION QUESTIONS

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DISCUSSION QUESTIONS

1. What did you contribute to your team? *Answers will vary*
2. What do you think engineers have to consider when they suggest which materials would be best for a certain structure? *The strength of the materials, the types of forces acting on the structure, etc.*
3. What forces cause the tower to tip over? *Buildings fail when engineers do not use designs and materials that are strong enough to resist compressive and tensile forces*
4. What features of the design helped your tower to reach new heights? *Answers will vary*
5. After testing what changes did you make to your tower? *Answers will vary*
6. Engineers early ideas rarely work out perfectly, How does testing help improve your design? *Testing helps you see what works and what doesn't. Knowing this lets you improve a design by fixing the things that aren't working well or could work better*
7. What did you learn from watching others? *Answers will vary*

ASSESSMENT ACTIVITIES

Have the students demonstrate their towers structural strength and talk about how they solved their problems that came up during the design process.

Ask about compression and tension forces as they relate to the strength of their structures.

Videos and pictures of the students working on their towers would be helpful tools for their presentations. Journals and data sheets should present measurements and mathematical calculations.

ENRICHMENT

The Physics of Sandcastles:
http://science.nasa.gov/science-news/science-at-nasa/2002/11jul_mgm/