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## Resources/Materials

- © Teacher Resource Documents (attached)
- © Student Worksheets (attached)
- © Student Resource Sheets (attached)

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## Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

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## Internet Connections

- © TryEngineering ([www.tryengineering.org](http://www.tryengineering.org))
- © IEEE Virtual Museum ([www.ieee-virtual-museum.org](http://www.ieee-virtual-museum.org))
- © ITEA Standards for Technological Literacy: Content for the Study of Technology ([www.iteawww.org/TAA/Publications/STL/STLMainPage.htm](http://www.iteawww.org/TAA/Publications/STL/STLMainPage.htm))
- © McREL Compendium of Standards and Benchmarks ([www.mcrel.org/standards-benchmarks](http://www.mcrel.org/standards-benchmarks))  
A compilation of content standards for K-12 curriculum in both searchable and browsable formats.
- © National Council of Teachers of Mathematics Principals and Standards for School Mathematics ([www.nctm.org/standards](http://www.nctm.org/standards))
- © National Science Education Standards ([www.nsta.org/standards](http://www.nsta.org/standards))
- © Project Lead the Way ([www.pltw.org](http://www.pltw.org))
- © The History of Paper Bags ([www.eurosac.org/uk/history.htm](http://www.eurosac.org/uk/history.htm))

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## Recommended Reading

- © Margaret Knight: Girl Inventor, by Marlene Targ Brill (Millbrook Press, ISBN: 0761317562)
- © Packaging Prototypes: Design Fundamentals, by Edward Denison and Richard Cawthray (Rotovision, ISBN: 2880463890)
- © 50 Trade Secrets of Great Design: Packaging, by Stafford Cliff (Rockport Publishers, ISBN: 1564968723)

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## Optional Writing Activity

- © Write an essay (or paragraph) explaining how a cardboard milk carton has been designed to be strong enough to hold its liquid contents.

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## References

Pam Newberry, Project Lead the Way ([www.pltw.org](http://www.pltw.org))  
Doug Gorham, IEEE ([www.ieee.org/organizations/eab/precollege/tispt](http://www.ieee.org/organizations/eab/precollege/tispt))

# Design and Build a Better Candy Bag



## For Teachers:

### Alignment to Curriculum Frameworks

Note: All Lesson Plans in this series are aligned to the U.S. National Science Education Standards (produced by the National Research Council and endorsed by the National Science Teachers Association), and if applicable, to the International Technology Education Association's Standards for Technological Literacy and the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics.

#### ¥ 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
- © Understanding about 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

#### ¥ 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
- © Understandings about scientific inquiry

##### **CONTENT STANDARD B: Physical Science**

As a result of their activities, all students should develop an understanding of

- © Properties and changes of properties in matter

#### ¥ Principals and Standards for School Mathematics (ages 6 - 18)

##### **Data Analysis and Probability Standards**

- Instructional programs from prekindergarten through grade 12 should enable all students to:

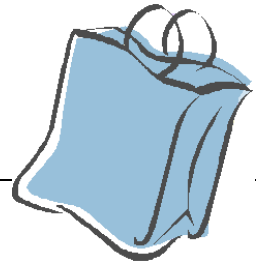
- © formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- © develop and evaluate inferences and predictions that are based on data.

#### ¥ Standards for Technological Literacy - All Ages

##### **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.

# Design and Build a Better Candy Bag



## For Teachers: Teacher Resources

### ¥ Materials

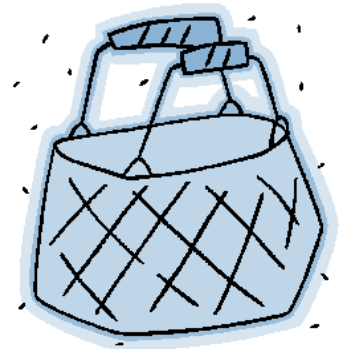
- Student Worksheet
- Sketch paper and pencil
- Standard lunch bags
- Masking tape
- Twine
- Rulers
- Scissors
- Crayons
- Scale, such as spring scale
- Measuring cups
- Books, various sizes of small bottles filled with water, bags of candy, blocks, or other objects to be used as weights
- Items to check for volume, such as rice or candy

### ¥ Time Needed

Two Class Periods

### ¥ Procedure

1. Divide students into pairs and provide the Student Reference Sheet to each. (Note: This sheet can be provided as a reading homework assignment for the prior evening.)
2. Discuss the manufacture of paper bags, and provide several examples of bag designs to share. Ask students to compare the bag designs and guess which might hold the most volume and the most weight.
3. Provide each student with the Student Worksheets and review the project with the teams. Teams will:
  - design a candy bag
  - create a model of their bag design
  - predict the bag's volume and weight capacity
  - test the bag for volume and weight capacity
  - force the bag to fail with too much weight
  - redesign their bag with a goal of holding more weight
  - build a model of the improved design
  - test the second model
  - complete the student worksheet
  - present their finding to the class and compare/contrast results



# Design and Build a Better Candy Bag



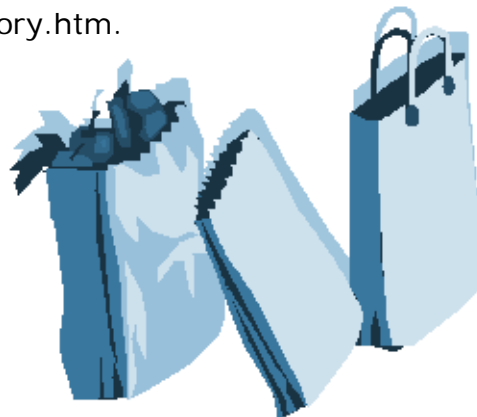
## Student Resource: Paper Bag History and Inventors

### ¥ Paper Bag History and Inventors

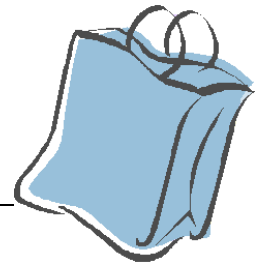
Over the years a variety of designs for candy bags have been created. They are built of a variety of materials (paper, plastic, cardboard) and are designed in a variety of shapes. A woman inventor from York, ME, named Margaret Knight (1838-1914) is credited with inventing a process for automatically folding and gluing paper to form the square or rectangular bottom of a paper bag. As a child, Margaret was often designing, or redesigning mechanical parts for everything from kites to sleds. When she grew up, she initially worked at the Columbia Paper Bag Company in Springfield, MA. At the time, paper bags were folded and glued much like envelopes. After her work hours, Margaret began to design a machine part that would automatically fold and glue the square or rectangular bottoms needed for paper bags.



Finally, she came up with a design that she thought would work. She had a Boston machinist create an iron model of the part so that she could apply for a design patent. Initially, her design was ignored as the workmen in the factory questioned what a "woman would know about machine design." Margaret Knight did receive a patent for her machine in 1870, but she had to go through a lawsuit first with a man named Charles Annan who had attempted to steal her design and patent the machine himself! Now, Margaret Knight is often considered the mother of the grocery bag. She eventually partnered with a Newton, MA man and started a company in Hartford, CT in 1870 with her invention: the Eastern Paper Bag Company. Now, Margaret's machine is on display at the Smithsonian Institution in Washington, DC. Visit [www.smithsonianlegacies.si.edu/objectdescription.cfm?ID=92](http://www.smithsonianlegacies.si.edu/objectdescription.cfm?ID=92) to view a photo of her machine. For more information on the history of paper bags, visit [www.eurosac.org/uk/history.htm](http://www.eurosac.org/uk/history.htm).



# Design and Build a Better Candy Bag



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## Student Resource: Student Challenge

### ¥ Student Challenge

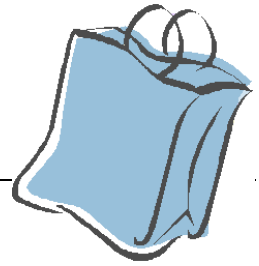
You and your partner are employees of the Sweet-Tooth Candy store. Recently your boss has learned that customers would like to have a candy bag that is attractive and more functional than the one they currently use when they shop in the store. Your boss has asked you to design and build a new and improved candy bag that is sturdy, functional, and attractive. She is interested in a candy bag that is able to hold maximum weight and that is attractive, but she has not specified minimum dimensions or the amount of weight the bag must hold.

You have learned that the design and construction method as well as materials used will determine the strength of a bag. You will want to test the strength of your candy bag and will redesign and retest as needed. Measurements may be taken to determine how to improve the strength of your candy bag and to estimate the volume or weight the bag will hold.

### The Task

1. As a team, discuss and agree upon a design for your candy bag (Note: If you decide to cut the bag, remove no more than 2" from the height of the bag)
2. Draw a sketch of your design in the attached Student Worksheet
3. Build a prototype candy bag based on your design
4. Calculate the approximate volume of the bag
5. Predict how much weight the bag might hold (Note: One 8 oz. bottle of water weighs 9.7 ounces)
6. Test the strength of your candy bag by holding the bag by the handles and placing weight in the bag until it breaks
7. Discuss and agree upon a redesigned candy bag
8. Draw a sketch of your new design in the attached Student Worksheet
9. Rebuild your prototype bag based on your agreed upon redesign
10. Test the strength of your improved candy bag design
11. Present your groups' findings to the class

# Design and Build a Better Candy Bag



## Student Worksheet: Design a Better Candy Bag

### ¥ Candy Bag Designs

In the box below, draw the candy bag your team agreed upon for your first design. Include how large it will be, a list of materials needed to construct it, and your estimate of how much weight it will hold.

Materials Needed:

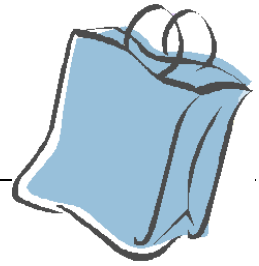
Estimated Volume:

Estimated Weight The Bag Can Hold:

Actual Volume:

Actual Weight The Bag Can Hold:

# Design and Build a Better Candy Bag



## Student Worksheet: Design a Better Candy Bag

### ¥ Candy Bag Designs

After you have tested your original design and added enough weight to break the bag, redesign your bag, and draw the new design in the box below.

How did this design differ from the prior design?

New Estimated Volume:

New Estimated The Bag Can Hold:

Actual Volume:

Actual Weight The Bag Can Hold:

# Design and Build a Better Candy Bag



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## Student Worksheet: Design a Better Candy Bag

### ¥ Results

Once you have built your candy bag and tested it, complete the questions below.

1. When you tested your prototype, what was the approximate volume of the bag?
2. How much weight did your bag hold?
3. Did you have to redesign your initial prototype?  
If so, why? What did you discover because of your redesign?  
If not, why do you believe your prototype worked so well the first time?
4. The one thing I liked about our design was...
5. The one thing I didn't like about our design was...
6. The one thing I would change about our design based on my experience is ...
7. What technology, science, and mathematics concepts did you use when you designed the prototype?