Welcome to

Playing With Your Food
workshop at E4 Conference
January 28, 2010, College of St. Catherine

Jane Snell Copes

Why experiment with food? Food is ideal because

it's familiar and appealing to students
it's safe to handle and easy to obtain
it is a good model for other materials
you can (often) eat the results

Where's the engineering? Engineers need to

identify and measure properties of materials
solve problems creatively
work in teams
evaluate solutions
work within a budget
scale up and scale down processes
process large quantities of materials
protect intellectual property (patents and trade secrets)

What's up today? We'll have fun investigating

Want to contact me?

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How Strong is a Pretzel?
Playing With Your Food

What you need:
- large paper cup
- scissors
- pill bottle that will hold penny rolls
- thin wire
- thin stick pretzels
- loose pennies
- rolls of pennies

What else?

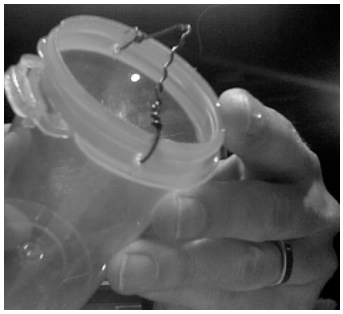
Draw and label the parts of the Pretzel Breaking Machine.

How would you change the machine to break Giant Log Pretzels? breadsticks? carrots?

Do you think spaghetti noodles are weaker or stronger than pretzels?

What's the big idea: We use uniform weights (pennies) to test the bending strength of a stick pretzel. I'll surprise you!

What to do:
- Cut most of the bottom out of a paper cup, leaving a rim of paper near the edge. Cut a large viewing hole in the side of the cup. Cut two slots for the pretzel in the bottom rim of the cup.
- Fasten a wire handle on the pill bottle. [See picturess.]



- Put the bottle mouth up under the cup (mouth down). Lift the bottle by the handle. and slip a pretzel under the handle. Let the pretzel rest in the notches on the cup bottom. Be sure the bottle swings freely and doesn't rest on the table top.
- Add pennies to the bottle until the pretzel breaks. Count as you go or at the end. If you run out of loose pennies, start over with a roll of 50 pennies in the bottle.
- Please eat your results.
- Please don't eat the pennies.

What's this about?

You just measured the **flexural** strength of a rod using a **3-point bend test**. I invented the Pretzel Breaking Machine to show my daughter something about what I did at work (testing brittle materials). My first guess was 10 or 15 pennies to break a pretzel! Was I ever surprised! I had to scale up my machine a couple of times to break pretzels.

Stick pretzels used to come in a bag inside a cardboard box. I could break them with about 100 pennies. Now pretzels come in cello bags, and they must be a lot thicker so they don't break in transit. That means that I'll have to scale up my machine again to break them.

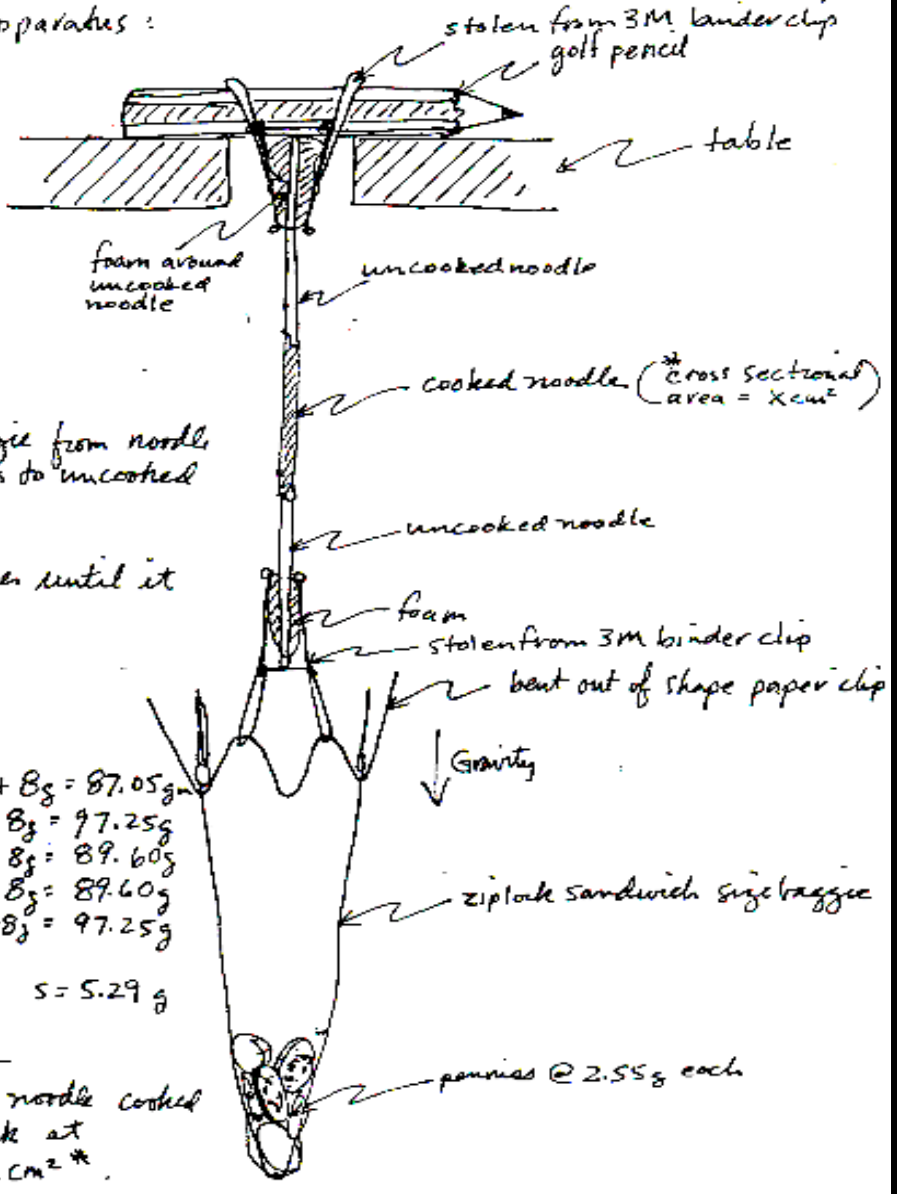
How Strong is a Wet Noodle?

Gary Featherstone.
Inorganic Chem —
Dr. Jane Copes 1st
12/92

1. Fettucine cooked 10 min — ends left raw

2. 100 post 1983 pennies = 255g or 2.55g each
(100 pre 1980 pennies = 307g or 3.07g each)

3. testing apparatus:



4. wt of:
Inner binder clip
baggie
paperclip
foam
= 8g

5. Suspend baggie from noodle by attaching clips to uncooked ends of noodle

6. add pennies until it breaks

7. 5 trials:

A. 31 pennies + 8g = 87.05g
B. 35 " + 8g = 97.25g
C. 32 " + 8g = 89.60g
D. 32 " + 8g = 89.60g
E. 35 " + 8g = 97.25g

$\bar{x}$ = 92.15g s = 5.29 g

8. Conclusion —
A wet fettucini noodle cooked 10 min will break at approx. 92g / X cm² *.

Gummy Worm Stretch
Playing With Your Food

What you need:
- gummy worms
- centimeter ruler

What else?

You can introduce fractions and percentages with this activity.

Students who keep Kosher and Halal dietary rules may not wish to work with gelatin-containing products.

Does worm color matter?

How could you test a wet noodle? See next page for an idea.

See this website for a way to test the strength of a human hair: http://marshallbrain.com/science/hair-strength.htm

What's the big idea: How far can you stretch a gummy worm before it breaks? Will it come back to the same length when you let it go?

What to do:

- Measure your relaxed Gummy Worm against the centimeter side of a ruler. Be sure her head or tail is at the zero centimeter mark. Record her length to the nearest 0.1 centimeter: 9.8 cm or whatever.

unstretched length _____ cm

- Stretch your worm as far as you can without breaking it. How long is it now?

stretched length _____ cm

- Let your worm relax back and measure it again.

relaxed length _____ cm

- You may consume the evidence.

What's this about?

Elastic limit (how far will a substance stretch before it breaks) and **tensile strength** (what pulling force does it take to break a material) are commonly measured engineering properties. What's often the hardest part of a tensile test is gripping the ends of the test piece so it doesn't slip but also without crushing the material.

Eggs on Your Brain
Playing With Your Food

What you need:
- several raw and hard-boiled eggs in shells
- glass bottle with mouth ~ 1¼ to 1½ " across
- large paper and markers

What's the big idea:
Here are several thought-provoking, team-building, and potentially messy activities. Your job is **brainstorming**, not evaluating, not doing. How is this job engineering?

What to do:
- Before you choose one Egg-speriment, you'll want to know how to tell a hard-boiled egg from a raw one without cracking it. It's about spinning. This activity is described at www.exploratorium.edu/cooking/eggs/activity-spin.html (see next page).

- Now with a partner, choose **one** of our three Egg-speriments and brainstorm some solutions on big paper. Try to come up with as many ideas as you can without evaluating or censoring them. Think like a student!

A. How did the egg get into the bottle? And how could you get it out?

B. An egg is not spherical. It is not exactly elliptical either. How could you measure the volume of an egg? How could you most accurately separate the white, yolk, and shell of an egg and determine their masses separately?

C. Watch the egg-dropping video on the laptop computer. Site is www.marshallbrain.com/science/egg-drop.htm It shows one approach to protecting an egg from a fall. Your job is to plan the logistics of an egg drop event for your own class. Even if you think you would never do this, imagine that you could.

What else?
Ramona Quimby, age 8, by Beverly Cleary, chapter 3

Steve Spangler egg in bottle www.stevespanglerscience.com/experiment/00000022

Egg shell halves are remarkably strong structures. Here's a great resource: www.csun.edu/~mk411573/discrepant/discrepant_event.html

Edible Building Materials
Playing With Your Food

What you need:
Make your shopping list after you read the main paragraphs.

What else?
- Be especially careful of food allergies: wheat gluten and peanut allergies are all too common in children.
- DOTS are better than gumdrops—no sugar on the surface, and they are not made with gelatin.
- Ask students to wash their hands often when using edible building materials.

What's the big idea:
Edible materials are safe, versatile, inexpensive, and – well, edible. Here's a list of items you can easily find at a grocery store, compiled from Steven Caney's Ultimate Building Book, Running Press 2006.

Type of Building Project	Food Resources
rods & connectors	pretzels, spaghetti, bread sticks, toothpicks connected with raisins, marshmallows, jelly candies, soaked dried peas or beans
small blocks	sugar cubes, peanut shell halves, bread cubes, cereals, kitchen clays
flat panels	graham crackers, savory crackers, matzohs, flat bread, chips, stale bread, granola bars

Glue "recipe"	best for
1 packet unflavored gelatin + 1 cup cold water. Dissolve, then cook until nearly boiling, let cool	pasta, pretzels
2 parts white flour, 1 part salt, 1 part water. Just mix, don't cook.	peanut shells, crackers
peanut butter OR marshmallow fluff	graham crackers, savory crackers, matzohs, flat bread
equal parts white flour, cornstarch, and water	sugar cubes
1 pound confectioners' sugar, 3 egg whites, ½ teaspoon cream of tartar. Using electric mixer, beat to make stiff peaks.	graham crackers, savory crackers, matzohs, flat bread

Resources and References
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Jane Snell Copes

Food Science (chemistry, physics, microbiology)

Harold McGee, On Food and Cooking, and The Curious Cook. North Point Press.
Robert L. Wolke, What Einstein Told His Cook, W.W. Norton.
Hervé This, Molecular Gastronomy, Columbia University Press.

You NEED this book

Steven Caney's Ultimate Building Book, Running Press

Food-themed Picture Books

Jon Buller, Fanny and May, Crown Publishers, Inc.
Judi Barrett, Cloudy with a Chance of Meatballs, Macmillan.
Dr. Seuss, Green Eggs and Ham, Scrambled Eggs Super, Random House.
Dayal Kaur Khalsa, How Pizza Came to Queens, Clarkson N. Potter.
Robert McCloskey, Blueberries for Sal, Homer Price (doughnut machine story), Scholastic.
Helen Ketteman, Luck with Potatoes, Orchard Books.

Webography checked January 2010

• Geology and Paleontology cookbook
http://www.uky.edu/KGS/education/cookbook.html
• Exploratorium Science of Cooking
www.exploratorium.edu/cooking
• Physics of Whipped Cream
http://science.nasa.gov/headlines/y2008/25apr_cvx2.htm?list198358
• International Edible Book Festival
http://www.books2eat.beatricecoron.com/photos.html
• Vienna Vegetable Orchestra
http://www.gemueseorchester.org/
• How to make gummy candies
http://blog.khymos.org/2007/03/30/first-experiments-with-sodium-alginate/