STEM Symposium: Breaking Chocolate

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Electronic resources at
sites.ieee.org/albuquerque

Objectives

- Intro to Engineering processes
  - Breaking chocolate as a vehicle
- Measurements of physical properties (quantities)
  - Different physical quantities, such as length and force
- Uncertainty in measurements
- Calibration of a measurement instrument (applying the methods of the engineering design process)
- Lots of “hands-on”

Don’t worry about taking notes—we have handouts that we will pass out, and all materials are available on the Albuquerque IEEE website.

Standards connection

Next Generation Science Standards

(https://www.nextgenscience.org/overview-topics)

Disciplinary Core Ideas:

(MS-PS1-1) Develop models to describe the atomic composition of simple molecules and extended structures.

(MS-PS2-2) Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

(MS-PS2-5) Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.

Cross-Cutting Concepts:

(MS-PS1-1) Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

(MS-PS1-3) Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

(MS-PS1-3) Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

(MS-PS2-3),(MS-PS2-5) Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Science and Engineering Practices:

(MS-PS1-1),(MS-PS1-4)Develop a model to predict and/or describe phenomena.

(MS-PS2-2),(MS-PS2-4)Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Common Core State Standards for Science and Technical Subjects: (http://www.corestandards.org/ELA-Literacy/RST/6-8/)

RST.6-8.7*:* Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1),(MS-PS1-4)

RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1),(MS-PS2-2),(MS-PS2-5)

MP.2: Reason abstractly and quantitatively. (MS-PS1-1)

MP.4: Model with mathematics. (MS-PS1-1)

Intro to Engineering

- Engineers solve real world problems using a structured process:
  - Identify and understand needs or requirements
  - Generate potential solutions
  - Evaluate and analyze
  - Produce and document the solution

Use math & science in these steps

- Handout engineering decision matrix (example slide next)

Typical decision aid (handout-2 sheets/individual)

Simplified Quality Function Deployment (QFD) Template **Name:** _____	**IDEA 1:**	**IDEA 2:**	**IDEA 3:**	**IDEA 4:**	**IDEA 5:**
REQUIREMENT 1:					
REQUIREMENT 2:					
REQUIREMENT 3:					
REQUIREMENT 4:					
REQUIREMENT 5:					

Typical decision aid example

Simplified Quality Function Deployment (QFD) Template Take out coffee container Name: _____	IDEA 1: Paper cup	IDEA 2: Paper cup and sleeve	IDEA 3: Plastic foam cup	IDEA 4: Refillable travel mugs	IDEA 5:
REQUIREMENT 1: Keep temperature					
REQUIREMENT 2: Does not leak					
REQUIREMENT 3: Inexpensive					
REQUIREMENT 4: No germs					
REQUIREMENT 5: Minimal landfill					

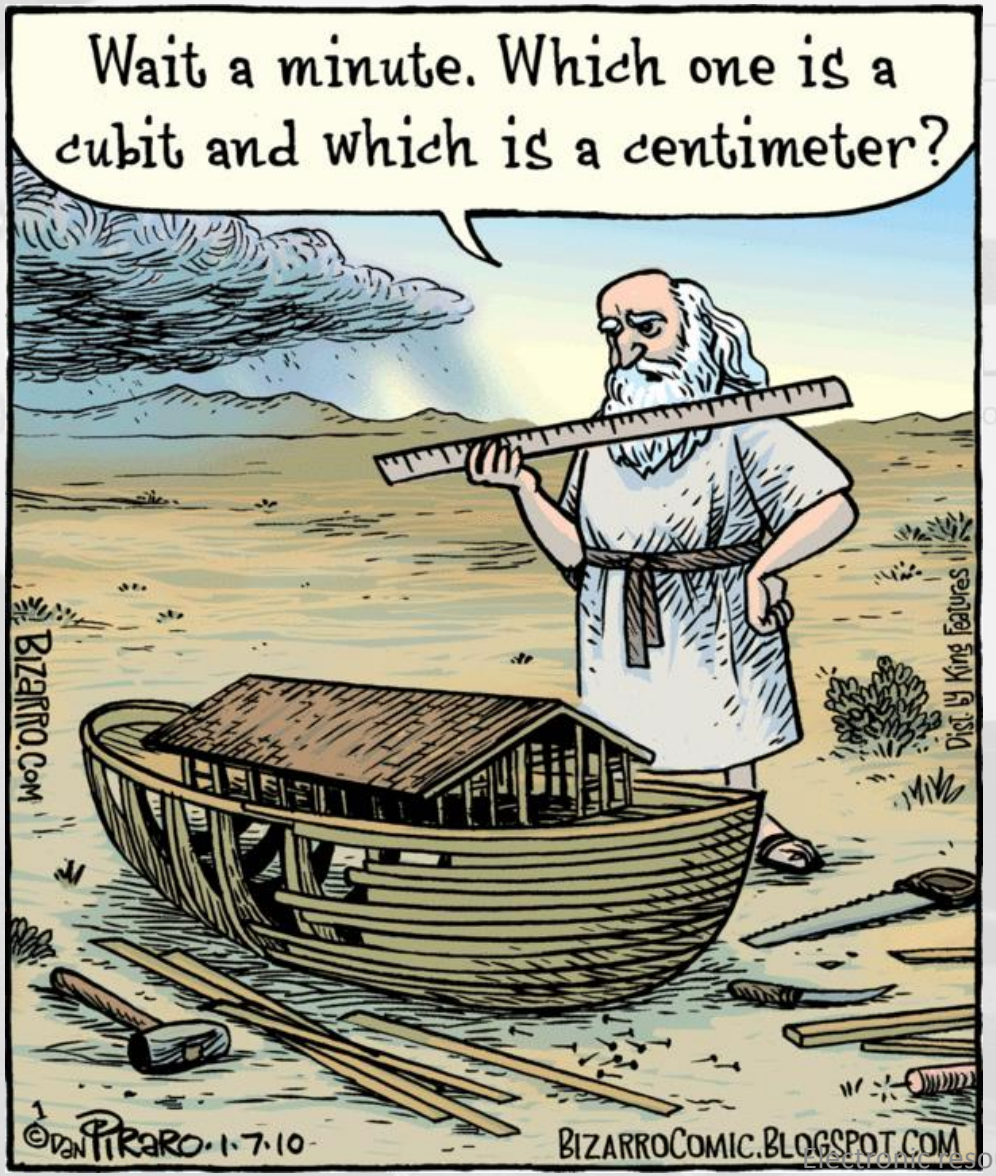
The “breaking chocolate” experiment

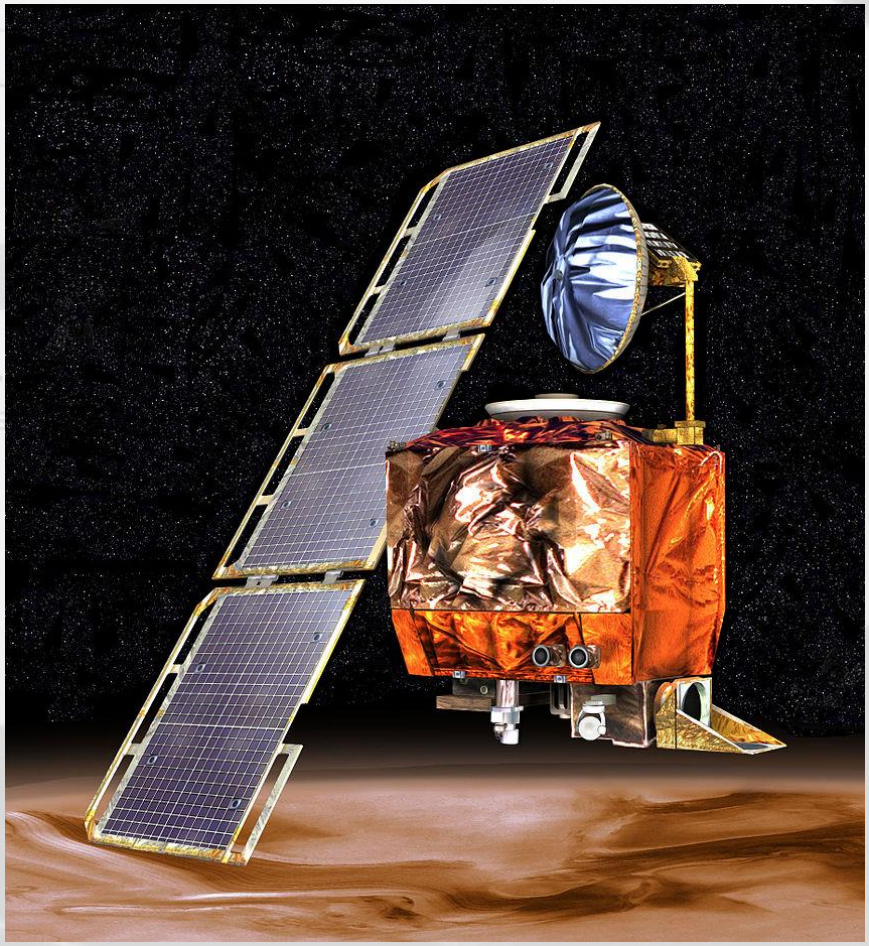
- Initially designed for high school physical sciences
  - We adapt to use cross-cutting concepts in engineering and measurement for 6-8, adaptable to lower grades
- Three-point breaking strength test
  - Measurements are crucial in calculating the breaking strength:
    - Thickness and width of the chocolate
    - Distance between the end supports
    - Applied force that breaks the chocolate

What do we measure

- Physical properties and their quantities (we will often use “physical quantities” when referring to physical properties)
  - The SI system (commonly called metric)
  - Treaty signed in 1875; the US was one of the founding nations
  - US has used metric standards at the highest level since 1893

metric and egyptian measures collide





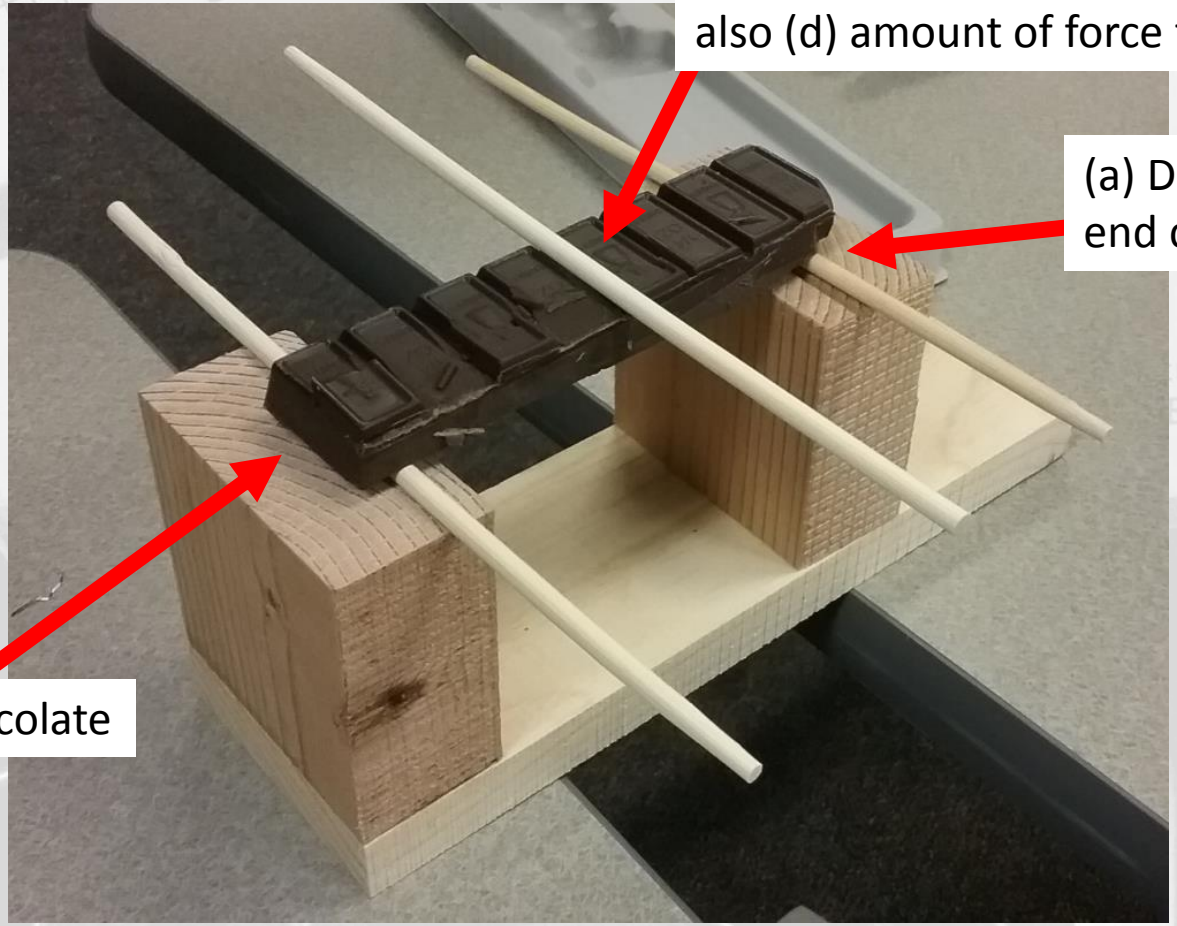
The MCO MIB has determined that the root cause for the loss of the MCO spacecraft was the failure to use metric units in the coding of a ground software file, “Small Forces,”…

What is length?

- Hands on #1, hand out rulers to tables, copies of the reference tables properties, and a handful of coins per table (2 teams of 5 per table)
- Come up with multiple ways of testing the rulers. You're not limited to the materials we provide. Evaluate which method your team wants to use.
- Test your process, and report out (per table group) (quick 2 sentence verbal explanation of best solution)

Set up the chocolate breaking experiment

- 3 contact points breaking strength:



What about force?

- Objective: How do you apply force until the chocolate breaks, and measure the applied force?
  - How well do you need to measure the breaking force?
- Consider, study, and explore the supplies set up in front (amount of time for study will be announced)
- Groups take 5 minutes to develop different ideas, and be ready to report (2 sentences per group, or write as a “tweet”)

Next

- Pass out remaining handouts for reference

Let's get to breaking!

- Each group gets a bunch of wood blocks, chopsticks, string, and 1 spring scale; at least three bars of chocolate
  - Do you want the same type of chocolate, or different types of chocolate?
- Remember to handle the chocolate as little as possible (melting!)
- Report (make your own table with poster paper & markers)
  - Your team name, and the type of chocolate
  - Distance between endpoints
  - Distance center to endpoints (should be as close to the same as possible)
  - Width of chocolate
  - Thickness of chocolate where the center chopstick is
  - Breaking force
- Make a summary tweet!

tryengineering.org

- Get on internet & show tryengineering.org; also show resource list of names (one of the handouts)

Acknowledgments

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- The Albuquerque IEEE section, the UNM IEEE student section, Sandia Nat'l Labs, the Albuquerque inter-technical-society council, NMPMSE, and other societies

- You can always reach me at hdtran@sandia.gov; I will do my best to respond in a timely fashion