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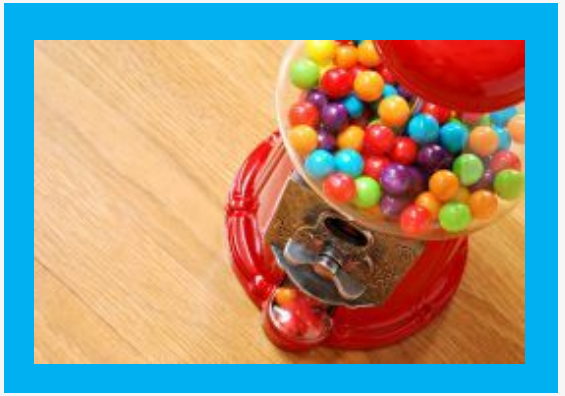
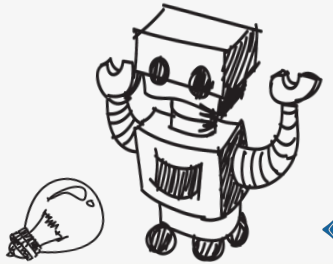


Lesson Plan:

Interactive Gumball Machine



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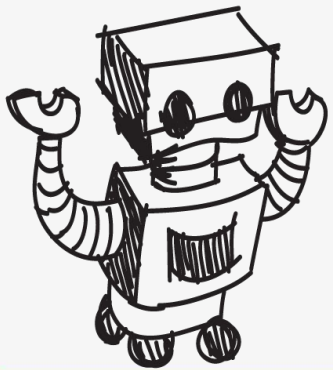
The Design Challenge



The Design Challenge

You are a team of engineers who have been given the challenge of designing and building a slide for a gumball to travel down as fast as possible and land in a cup. The gumball must stay on a track and land in a cup. The slide must be able to stand on its own (self-supporting).

Defining the Challenge: Criteria & Constraints

Criteria

- Gumball must stay on the “track.”
- Gumball must land in a cup. (Where you place the cup is up to your team)
- Slide must be self-supporting (stand on its own).

Constraints

- You cannot push the gumball to start.
- Use only the materials provided.
- Teams may trade unlimited materials.

Material

Materials – Required for Activities 2 & 3 (Table of Possibilities)

- Cardboard boxes
- 2 Liter plastic bottles
- Paper cups
- Popsicle sticks
- Dowels
- Skewers
- Clay
- Pipe cleaners
- Scissors

Material

- Rubber bands
- String
- Paper clips
- Binder clips
- Card stock and/or file folders
- Cardboard pieces (cut up a few boxes into different size pieces)
- Masking tape
- 6’ Tubing (pipe insulator cut in half lengthwise) – 1 per team
- Xacto Knife (For Teacher)

Testing Materials and Process

Testing Material

- Gumballs (or marbles to represent gumballs, if your school does not allow gum)
- Paper cups
- Wastepaper basket (for younger children)

Testing Process

Activity 2 - Each team tests their slide design by placing the marble at the top of their slide and letting it roll into a cup. The students can decide where they would like to place the cup. Students should document if the marble stayed on the track and if it landed in the cup.

Testing Materials and Process

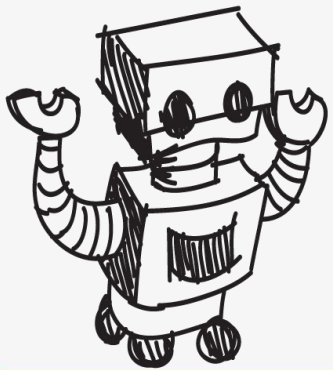
Activity 3 - Each team tests their gumball machine design by placing the gumball at a starting point within their machine and allowing it to follow the track until it lands into a cup. Students should demonstrate how the interactive element and loop(s) work. Students should document how long it takes the gumball to go from the starting point to the cup.

For younger students, use a wastepaper basket instead of cups to catch the gumballs.

Consider...

- Before you get started building, discuss what interactive or interaction means.
  - Interaction- is a kind of action that occurs as two or more objects have an effect upon one another.
  - Interactive- acting with each other.
    - Example: Video Games- interaction between user and game. It is interactive because it requires the user to participate for the game to move forward.

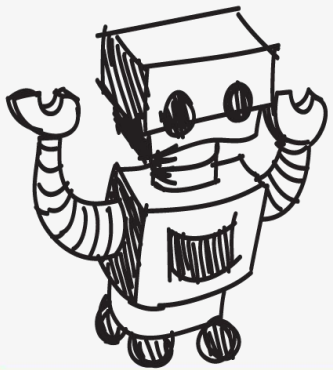
Reflect & Debrief



Reflection

- What went well?
- What didn’t go well?
- What is your favorite element of your interactive gumball machine?
- If you had time to redesign again, what changes would you make?

Engineering Design Process



The Engineering Design Process

Learn about the engineering design process (EDP). The process engineers use to solve problems.

(Video 1:47)

Source: TeachEngineering YouTube Channel http://www.youtube.com/watch?v=b0ISWaNoz-c

Engineering Design Process

- Divide into teams
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

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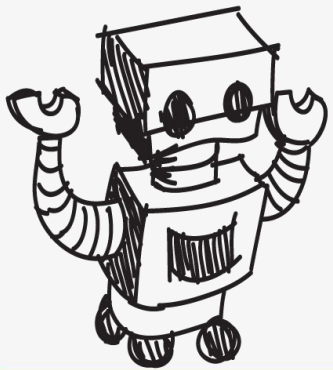
Productive Failure

- The engineering design process involves productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.
- It’s also important to showcase the fact that there can be multiple solutions to the same problem. There’s no one “right” solution.

Vocabulary



Vocabulary

- Acceleration: The rate at which an object changes its velocity. An object is accelerating if it is changing its speed or direction. An object is accelerating if it is changing its velocity (both speeding up of slowing down).
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Energy: The capacity to do work. You do work when you use a force (push or a pull) to cause motion.
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering (see infographic).

Vocabulary

- Engineering Design Process: Process engineers use to solve problems.
- Engineering Habits of Mind (EHM): Six unique ways that engineers think.
- Force: A push or pull on an object resulting from an object's interaction with another object.
- Friction: A force that resists motion of an object.
- Gravity: The force of attraction by which objects tend to fall toward the center of the earth.
- Interaction: A kind of action that occurs as two or more objects have an effect upon one another.
- Interactive: Acting with each other.

Vocabulary

- Kinetic Energy: Energy of motion. All moving objects have kinetic energy. The amount of kinetic energy depends on the mass and speed of an object. The formula for kinetic energy is KE=1/2mv2 . [m = mass of object, v = velocity of object]
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Mass: The quantity of matter in a body.
- Motion: A change in position of a body with respect to time as measured by a particular observer in a frame of reference.

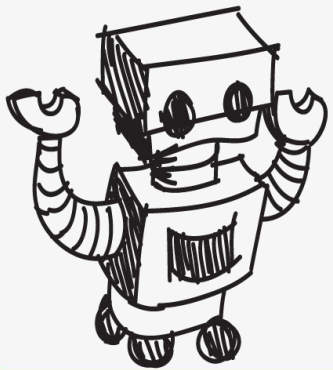
Vocabulary

- Potential Energy: Energy of position. The amount of potential energy depends on the mass and the height of an object. The formula for potential energy is PE=mgh. [m = mass of object, g = acceleration due to gravity (9.8 m/s2), h = height of object]
- Prototype: A working model of the solution to be tested.
- Speed: How fast an object is moving.
- Velocity: The rate at which an object changes its position. Momentum: Mass in motion. The amount of momentum depends on how much stuff is moving and how fast the stuff is moving.

Vocabulary

- Weight: The force of the gravitational attraction of the earth on the body.
- Work: Force acting on an object to move it across a distance. The formula for work is W = fd. [f= force applied to object, d = displacement of object]

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- History of Gumball Machines (www.gumballs.com/history.html)

Recommended Reading

- Vending Machines: An American Social History (ISBN: 978-0786413690) Vending Machines (ISBN: 978-0981960012)

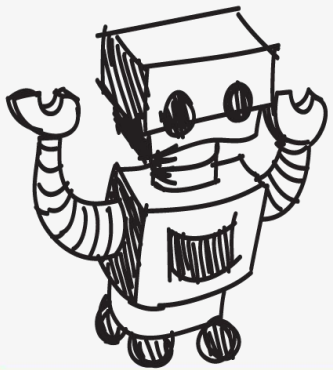
Writing Activity

- Have students write short stories about a “day in the life” of their gumball machine. Who does the gumball machine meet and what happens? How does the gumball machine change the lives of the kids who get a gumball from it?

Dig Deeper into the Topic

- Students could also create an ad to draw more customers into the toy store. They should feature the interactive gumball machine in the ad. Why should kids come to this toy store? Why is the interactive gumball machine a must visit?

Engineering Fields



What is Engineering?

Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.
(Video 3:43)

Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with building gumball machines. Here are just some of the related engineering fields.
  - Mechanical Engineering

- Download the Engineering Fields Infographic How will **YOU** change the world?

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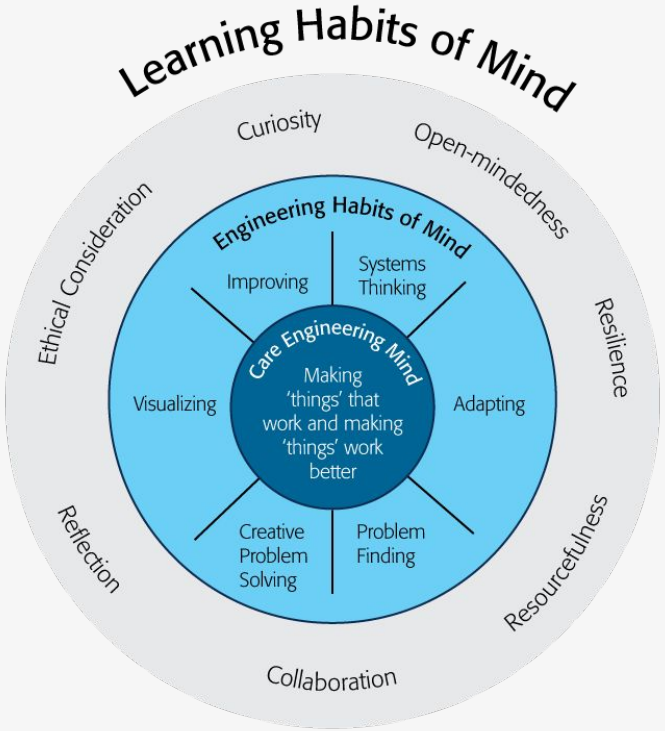
Engineering Habits of Mind



Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

Source: https://online-journals.org/index.php/i-jep/article/view/5366)

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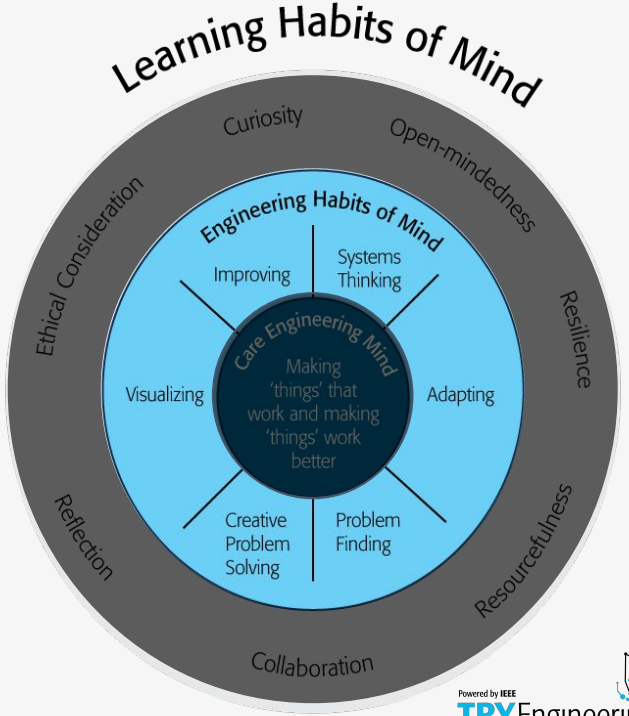
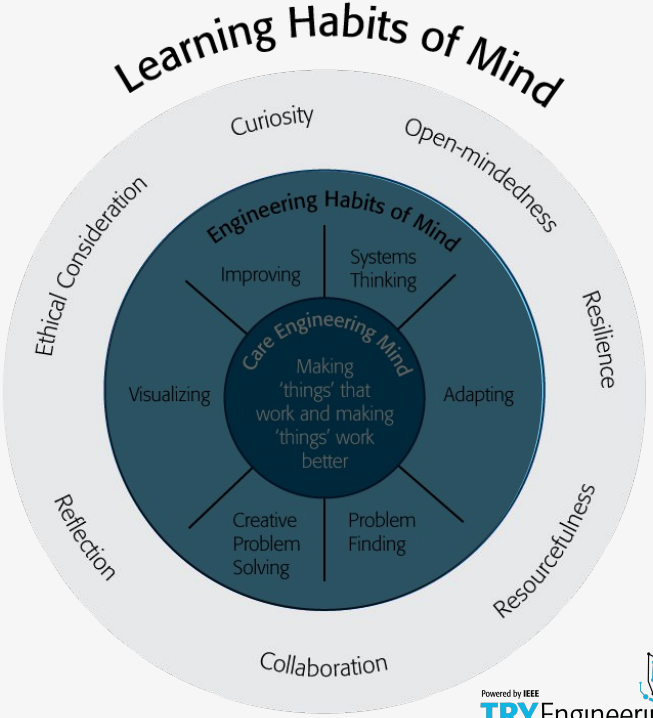
Engineering Habits of Mind Checklist

- ❑ **Systems thinking**
- ❑ **Problem-finding**
- ❑ **Visualising**
- ❑ **Improving**
- ❑ **Creative problem-solving**
- ❑ **Adapting**



Learning Habits of Mind Checklist

- Open-mindedness
- Resilience
- Resourcefulness
- Collaboration
- Reflection
- Ethical Consideration
- Curiosity

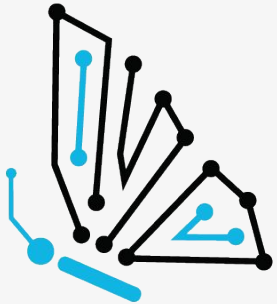


Greatest Engineering Achievements of the 20th Century

Source: http://www.greatachievements.org/

Learn more about how engineers make the world a better place

For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE's TryEngineering.org



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