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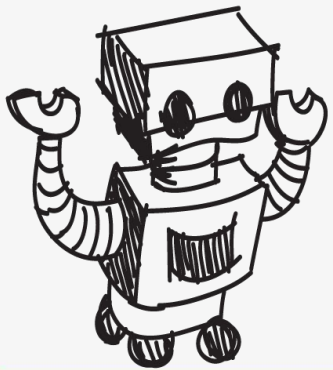
Lesson Plan:

Water Rocket Launch

IEEE

The Design Challenge



The Design Challenge

You are part of a team of engineers given the challenge of building a model rocket using a soda or water bottle that will be launched using a bicycle air pump. Your goal is to have your rocket shoot up the highest and the straightest.

Defining the Challenge: Criteria & Constraints

Criteria

- Must design a base to hold the rocket

Constraints

- If you've been given a payload challenge, the payload must not be placed inside the bottle
- Use only the materials provided
- Teams may trade unlimited materials

Material

Materials – Required (Each team)

- Empty 2-liter plastic soda bottle

Materials – Required (Table of possibilities)

- Cork with a hole drilled in the middle (these may be plastic)
  - The hole should be slightly smaller than the air valve to ensure a tight fit
  - An alternative would be a soft rubber plug used as temporary stoppers in partially emptied wine bottles.
  - The objective here is to use a plug which can be tightly squeezed into the neck of the plastic bottle so that it is air-tight.

Material

- Cardboard
- Rubber bands
- Aluminum foil
- Optional Payload Items - i.e., hard boiled egg, tennis ball, rubber ball

Testing Materials and Process

Testing Material

- Water source
- Drill for corks - hole should be slightly smaller than an air valve (if not using a kit)
- Small plastic tubing (3 meters or more) and 1 air valve to be used for all rocket launches
- Air valves - 1 for each rocket (used for inflating bicycle tires, footballs or basketballs)
- Bicycle tire pump
- Altimeter or altitude finder (optional)

Testing Materials and Process

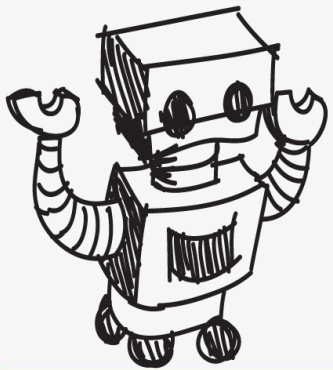
Testing Process

See lesson plan for specific instructions. The launch procedure can be reviewed at www.grc.nasa.gov/www/K-12/rocket/rktbot.html

Consider...

- Before you get started building, consider how a rocket can fly and how engineers have to consider payload, weather, and the shape and weight of a rocket when developing a new or re-engineered rocket design.
- If time allows, explore www.grc.nasa.gov/www/K-12/rocket for research and use the online rocket simulator.

Reflect & Debrief



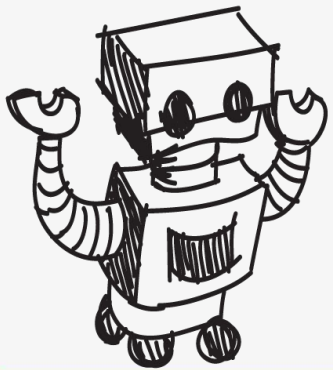
Reflection

- How did your height estimate compare with the actual height your rocket reached?
- What do you think might have caused any differences in the height you achieved?
- Did your rocket launch straight up? If not, why do you think it veered off course?
- Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?
- Did you adjust your model rocket at all? How? Do you think this helped or hindered your results?

Reflection

- How do you think the rocket would have behaved differently if it were launched in a weightless atmosphere?
- What safety measures do you think engineers consider when launching a real rocket? Consider the location of most launch sites as part of your answer.
- When engineers are designing a rocket which will carry people in addition to cargo, how do you think the rocket will change in terms of structural design, functionality, and features?
- Do you think rocket designs will change a great deal over the next ten years? How?
- What tradeoffs do engineers have to make when considering the space/weight of fuel vs. the weight of cargo?

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

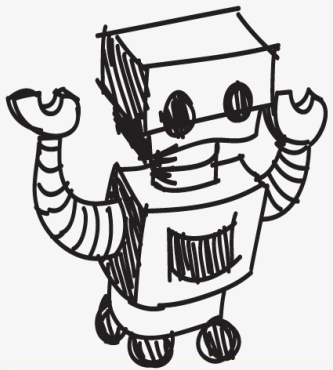
Engineering Design Process

- 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

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



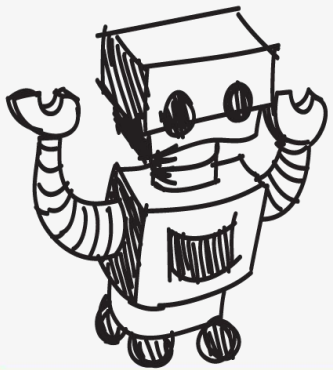
Vocabulary

- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering (see infographic).
- Engineering Design Process: Process engineers use to solve problems.
- Engineering Habits of Mind (EHM): Six unique ways that engineers think.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Liftoff: Occurs when the amount of thrust is greater than the weight of the rocket

Vocabulary

- Payload: The amount of goods or material that is carried by a vehicle
- Prototype: A working model of the solution to be tested.
- Propulsion: The force that moves something forward.
- Rocket: A self-propelled device that carries its own fuel.
- Thrust: A force or a push.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Timeline of Rocket History (http://history.msfc.nasa.gov/rocketry/)
- NASA Beginners Guide to Rockets (www.grc.nasa.gov/WWW/K12/rocket/bgmr.html)
- Water Rocket Launcher (www.nasa.gov/pdf/153405main_Rockets_Water_Rocket_Launcher.pdf)

Recommended Reading

- Rockets and Missiles: The Life Story of a Technology (ISBN: 978-0801887925)

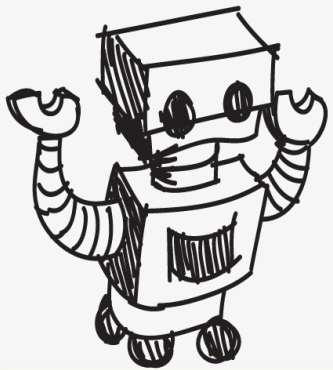
Dig Deeper into the Topic

- Rocket Propulsion Elements (ISBN: 978-1118753651)
- Firing a Rocket (ISBN: 978-1549688683) "A Pictorial History of Rockets" (www.nasa.gov/pdf/153410main_Rockets_History.pdf)
- Soda-Pop Rockets: 20 Sensational Rockets to Make from Plastic Bottles (ISBN: 978- 1556529603)

Writing Activity

Write an essay or a paragraph describing an example of rockets might be used to help society in peaceful times.

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)

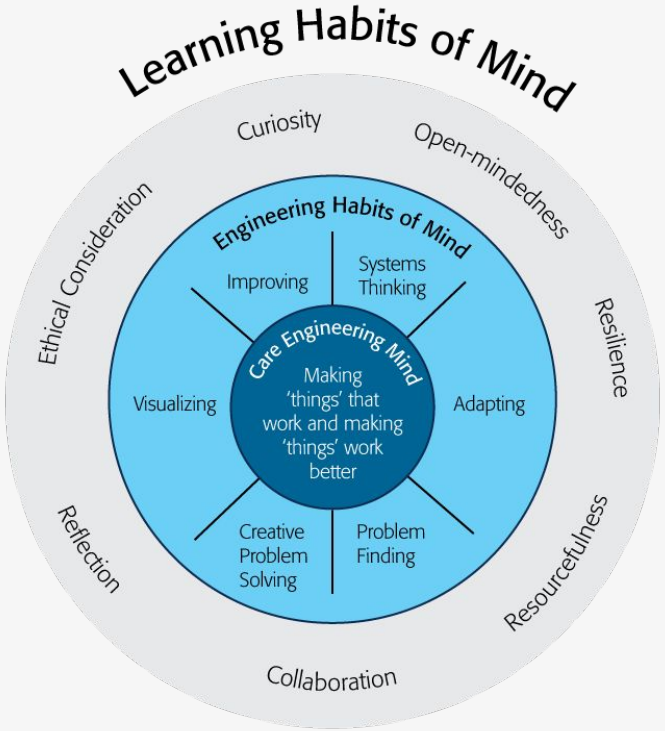
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with designing rockets and working in aerospace. Here are just some of the related engineering fields.
  - Aerospace Engineering
  - Mechanical Engineering
  - Electrical Engineering

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

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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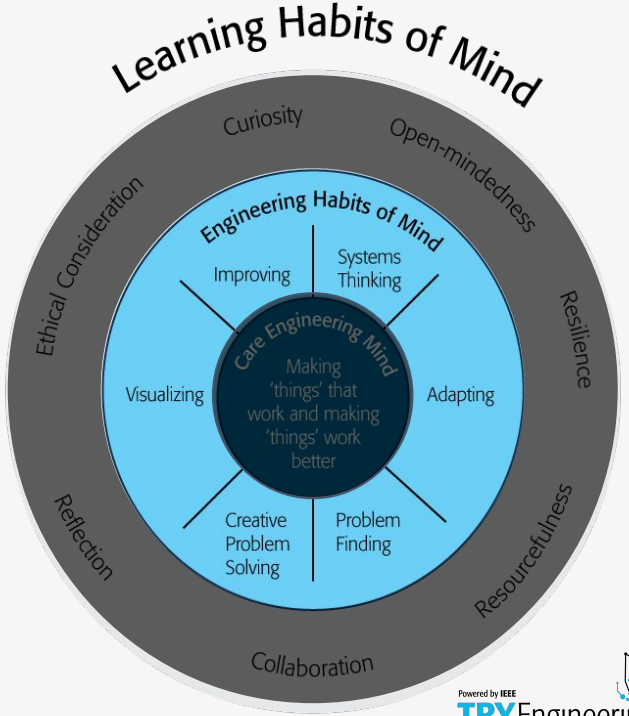
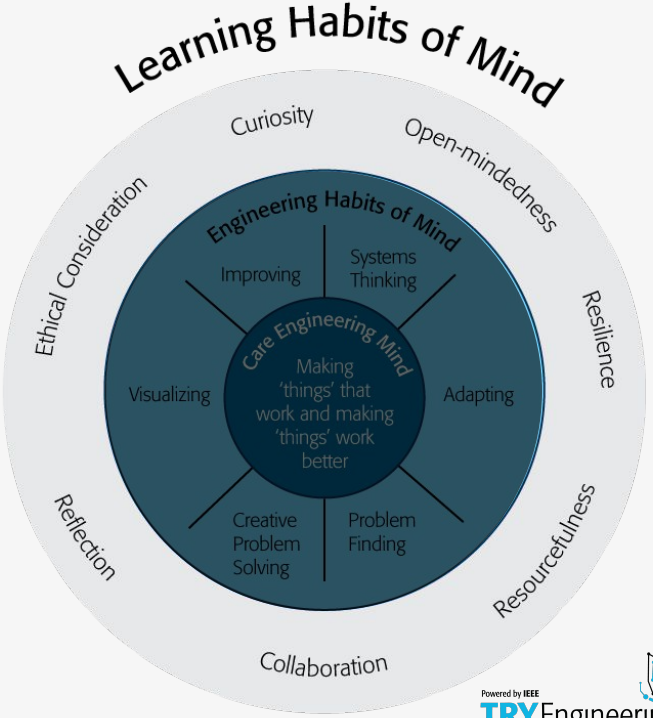
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

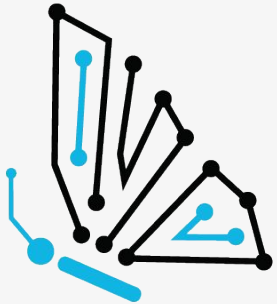


Greatest Engineering Achievements of the 20th Century

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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