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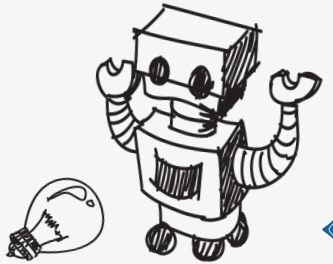
Lesson Plan:

Pipeline Challenge



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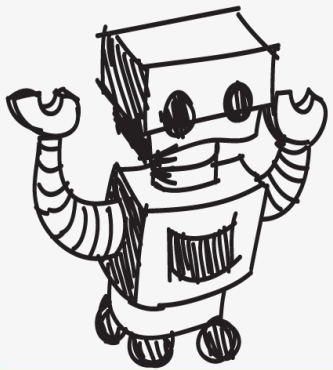
The Design Challenge



The Design Challenge

You are a team of engineers given the challenge of developing a pipeline system to transport a golf ball and a ping pong ball from one side of your classroom to the other. You will need to incorporate four angles into your design, one of which is a right angle (90 degrees). The difference in height from one end of your pipe to the other can be no more than 18 inches. Your teacher may identify environmentally protected areas, water, or other hazards in your classroom that you'll have to consider in your plan.

Defining the Challenge: Criteria & Constraints

Criteria

- Incorporate 4 right angles into design
  - One must be a right angle (90 degrees)
- Difference in height from one end to the other can be no more than 18 inches

Constraints

- Use only the materials provided.

Material

Materials – Required (Table of Possibilities)

Assuming a 15' x 15' room, allow for about 20 feet of piping per team

- Paper towel, wrapping paper and toilet paper rolls (or roll up thin sheets of cardboard) - Tubes must be large enough to accommodate a golf ball and ping pong ball.
  - To minimize the issue of balls becoming stuck in the tubes, consider cutting the tubes in half to serve as “open” piping.
- Packing or duct tape for connections
- PVC tubing, if budget allows

Material

Optional Materials

If giving students an environment challenge. Use items to represent environmentally protected areas (plastic/stuffed animals, construction paper for water, rocks, or other hazards)

Testing Materials and Process

Testing Material

- Golf ball (or similarly sized rubber ball)
- Ping pong ball

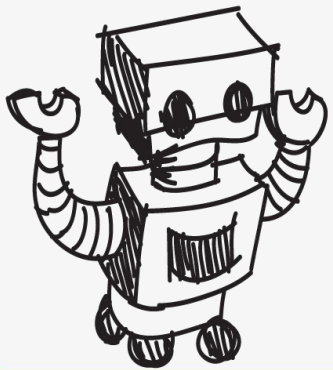
Testing Process

Test the pipeline designs by first rolling the golf ball through and then, the ping pong ball until each one stops. Students should measure and document how far each ball rolled until it stopped.

Consider...

- Before you get started building, consider the features of the classroom such as doors, desks, tables, trash cans or other obstacles.

Reflect & Debrief



Reflection

- What challenges did you face in executing your pipeline?
- Did you find you needed to rework your original plan when you began building the real pipeline in the classroom? If so, how did your pipeline change?
- Did you find your pipeline was more effective using the ping pong ball or the golf ball? Why do you think this was true?
- Which pipeline developed by another "engineering" team did you think worked best? Why?

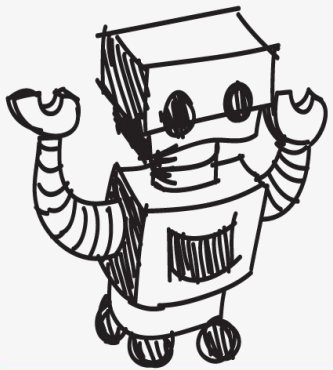
Reflection

- If your design were scaled up to a real pipeline, do you think you would need pumps to keep the materials flowing through your system? Why or why not? And, if so, how many pumps would you add, and where would you put them?
- Do you think your pipeline design would work if you used it to transport water? Feathers? Butter? Why or why not?
- Did you find that there were many ways to solve this challenge? If so, what does that tell you about the engineering designs of real pipelines?

Reflection

- Do you think you would have been able to create a successful pipeline as easily if you had not been working in a team? What are the advantages of teamwork vs. working alone?
- How do you think engineers on the Baku-Tbilisi-Ceyhan Pipeline determined that they needed eight pumps to run the length of the project?
- How do you think engineers working on the Alaskan Pipeline attempted to avoid negative environmental impact in Alaska? Did they succeed?

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

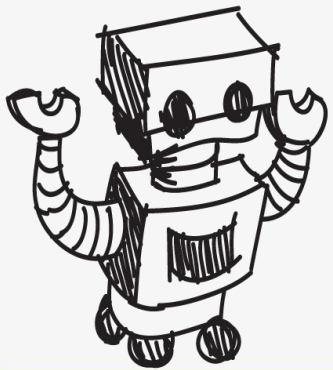
Engineering Design Process

- 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.

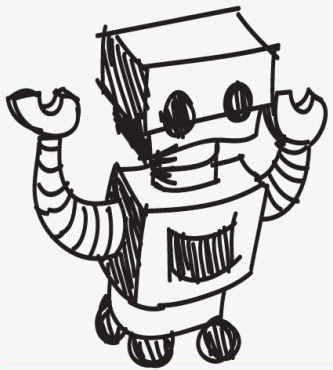
Vocabulary



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.
- Pneumatic Tubes: Transport solid capsules using compressed air.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Pipeline: Pipe that transports products.
- Prototype: A working model of the solution to be tested.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- PBS Learning: Building the Alaska Oil Pipeline (https://mpbn.pbslearningmedia.org/resource/ean08.sci.ess.earthsys.pipeline/building-the-alaska-oil-pipeline/)

Recommended Reading

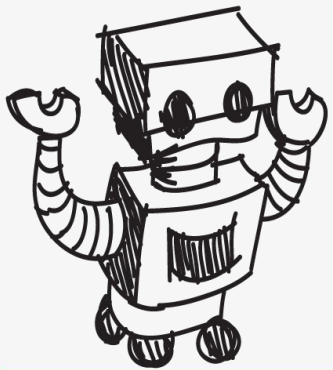
- Oil & Gas Pipelines in Nontechnical Language (ISBN: 159370058X)
- Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair (ISBN: 0824709640)

Dig Deeper into the Topic

Writing Activity

Write an essay or a paragraph describing how the impact on the environment must be considered when developing a new pipeline system. Give examples of a pipeline in your country that had environmental implications.

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)

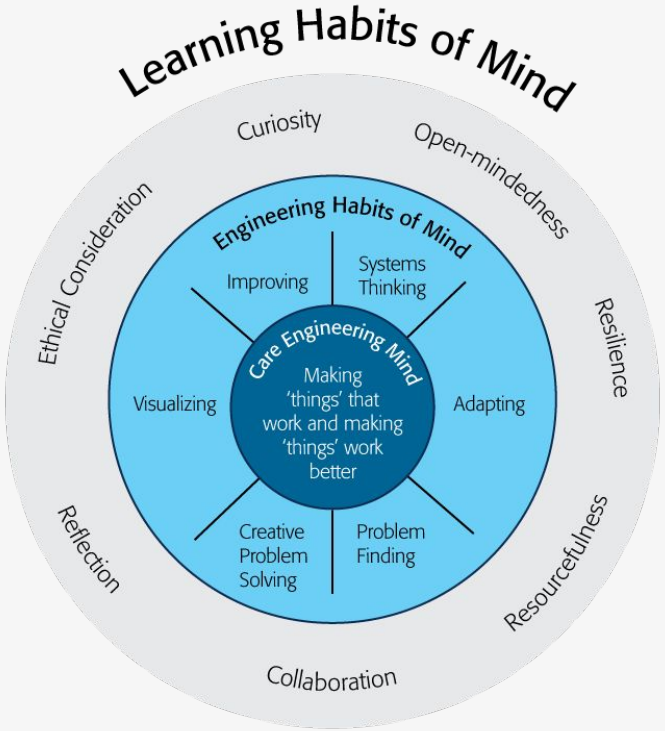
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with building pipelines. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Environmental Engineering
  - Materials 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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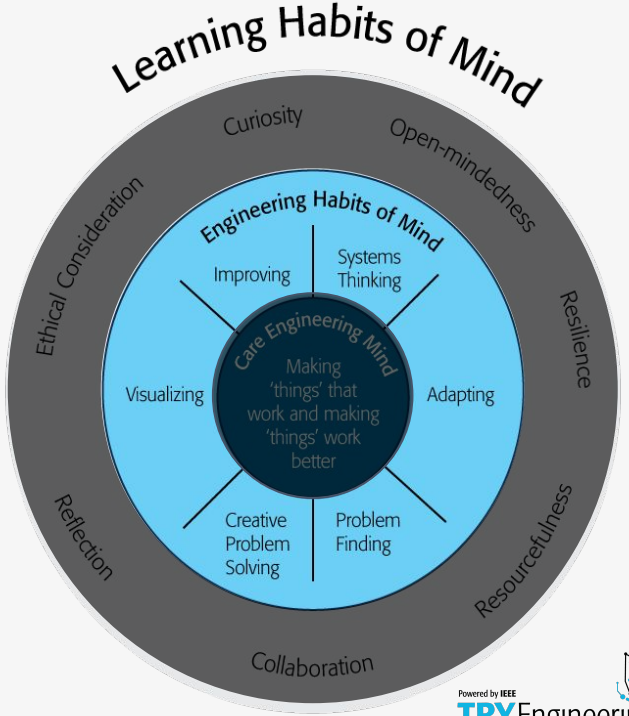
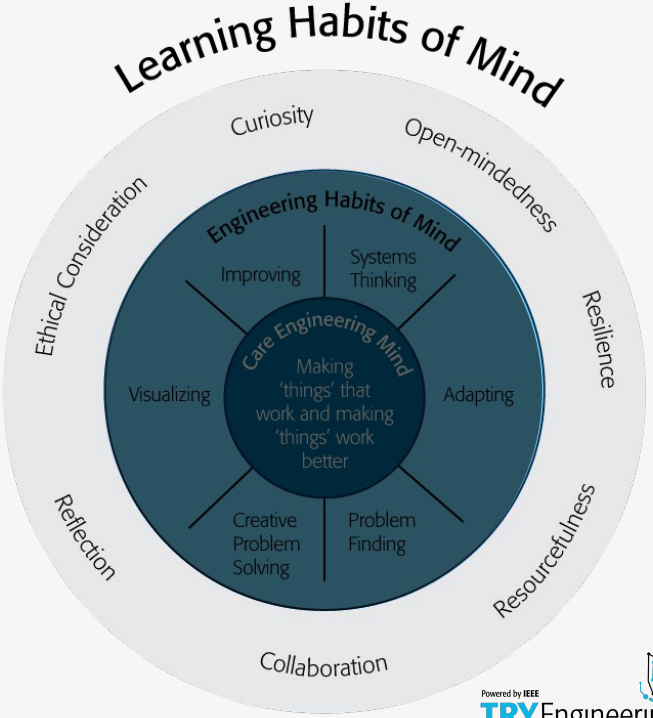
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

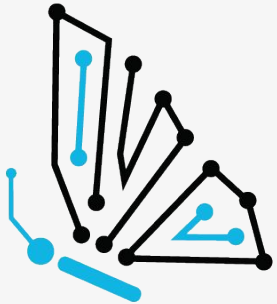


Greatest Engineering Achievements of the 20th Century

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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