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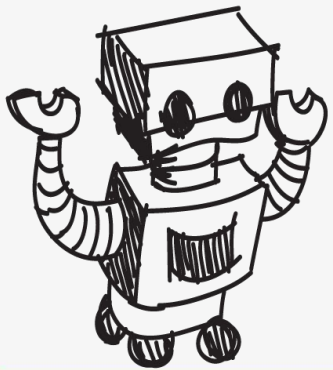
TRY Engineering

Lesson Plan:

Water Tower Challenge

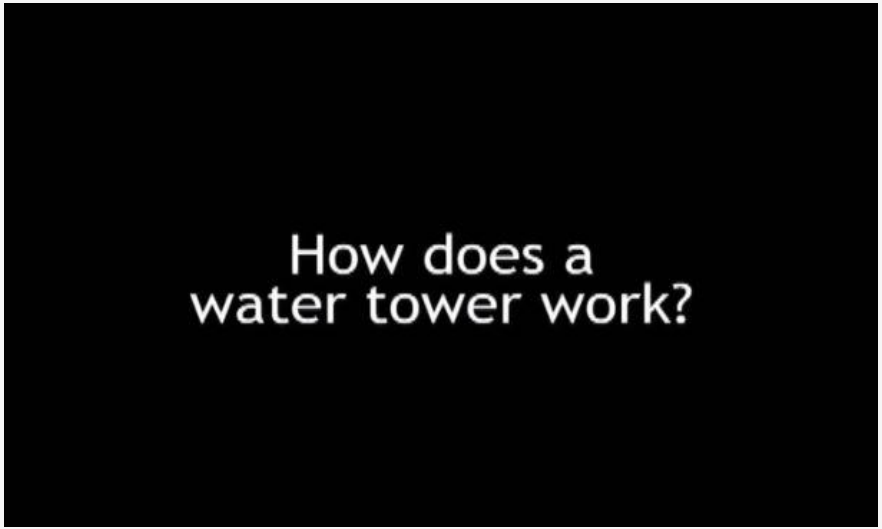
IEEE

Real-World Application



How Does a Water Tower Work?

- Learn how a water tower works with the use of pressure. *(Video 2:20)*



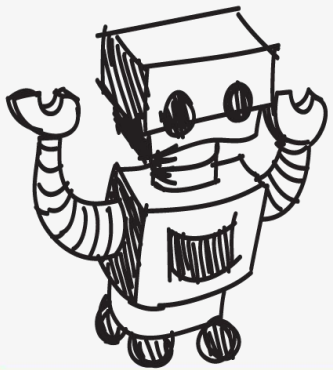
Source: City of Bloomington MN YouTube Channel: https://www.youtube.com/watch?v=ZI8WOzqHI7w

Top 10 Coolest Water Towers

- See a picture tour of the top 10 coolest water towers in the world. *(Video 2:11)*

Source: all Top Ten YouTube Channel: https://www.youtube.com/watch?v=FYxkJnDgK9s

The Design Challenge



The Design Challenge

- You’re a team of engineers given the challenge of developing a water tower out of everyday materials that can "supply" and "shut off" water as needed. The water tower must be able to deliver water or a water substitute to a paper cup that is about 36 in/90 cm away in a controlled manner.

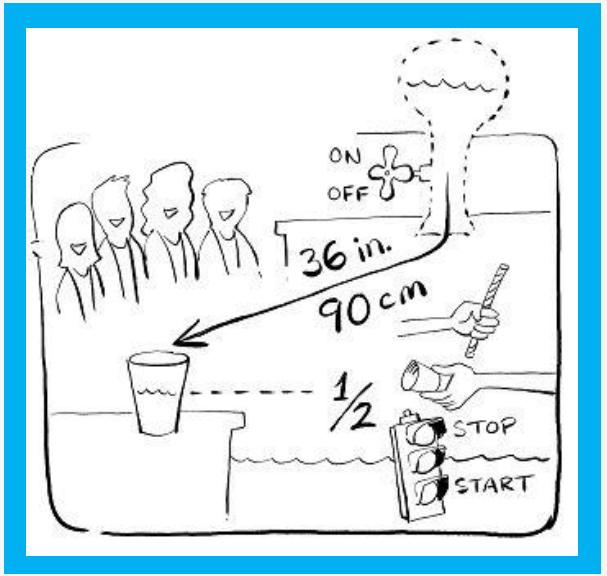
Defining the Challenge: Criteria & Constraints

Criteria

- Must be able to deliver water or a water substitute to a paper cup that is about 36 in/90 cm away in a controlled manner.
- Must be able to stop and start the flow of “water” to fill the cup half way up.

Constraints

- Can use only the materials provided.
  - Unused building materials can be shared or traded with other teams.



Build Materials

Optional for Build – Trading/Table of Possibilities

- Soda or water bottle
- Cardboard/Cardstock/Paper
- Plastic/Paper cups
- Hoses/Tubes
- Rubber bands/Binder clips/String
- Straws/Balloons
- Aluminum foil/Plastic wrap

Testing Materials

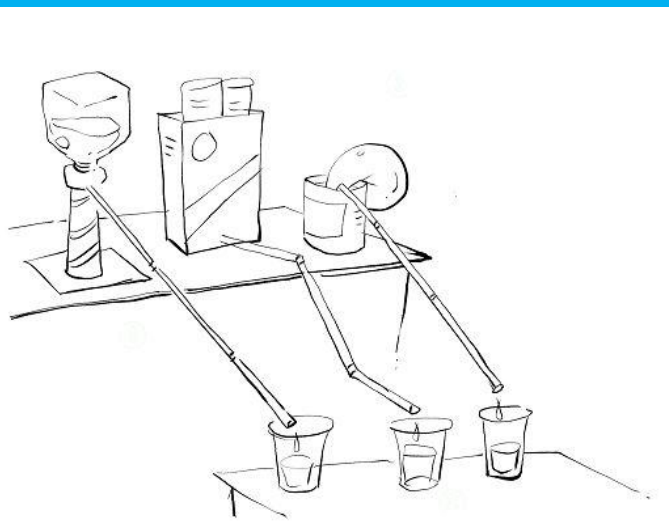
Testing Materials

Using water

- Water source
- Bucket
- Paper/Plastic cups

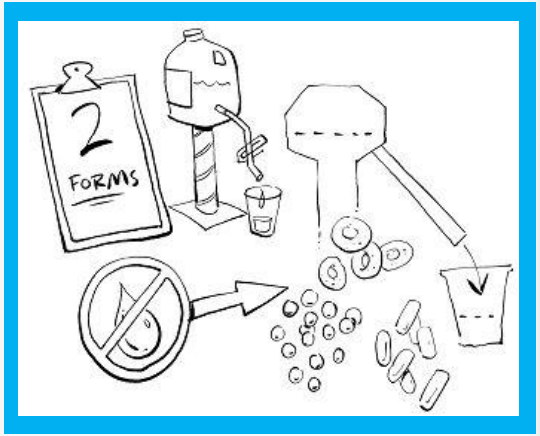
Using water substitute

- Paper/Plastic cups
- Small beads/Cheerios/Small candy
- Any other material that can substitute for water



Testing Process

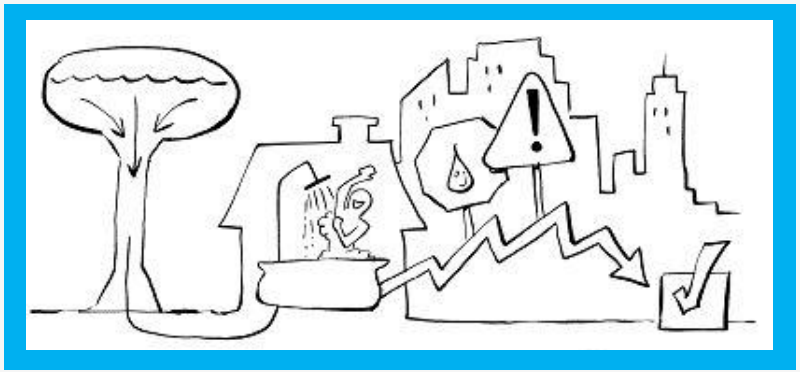
- Each team will test their design by demonstrating how their water tower delivers water or a water substitute to a paper cup within the defined criteria.
- Testing with water:
  - This testing approach should be used when the materials used to design the water tower can withstand water.
- Testing with water substitute:
  - In the event that the design materials can't withstand water, alternative materials may be used. Consider using small beads, cheerios, small candy, or any other material that can substitute for demonstrating how the water tower delivers those items from the water tower to a cup.



Consider...

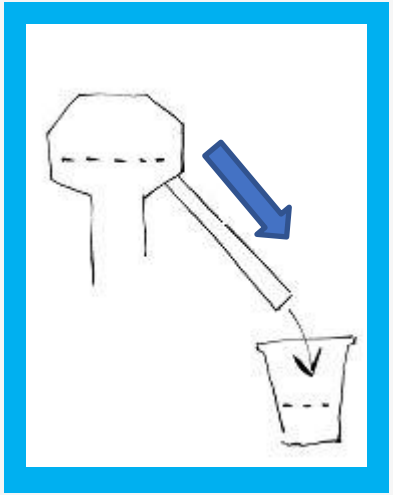
Before you get started brainstorming and sketching your design...consider the following...

- How your design will stop and start the flow of water
- The shape of your tower's reservoir
- How a water tower works using hydrostatic pressure

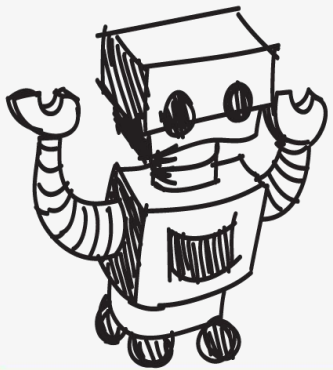


Variations

- Have students test their designs to see if they are scalable by doubling and tripling the distance from the water source to the cup.

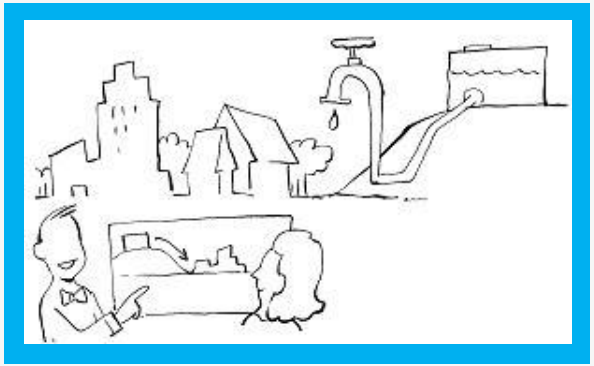


Reflect & Debrief

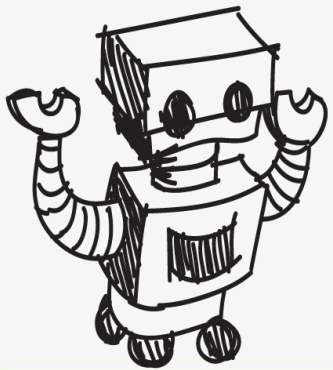


Reflection

- How similar was your original design to the actual water tower your team built?
- Which water tower that another team made was the most interesting to you? Why?
- Do you think your design is scalable? Would it work efficiently if the cup were 360 in/900 cm away from the water source? Why? Why not?



Engineering Design Process



The Engineering Design Process

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

(Video 1:47)

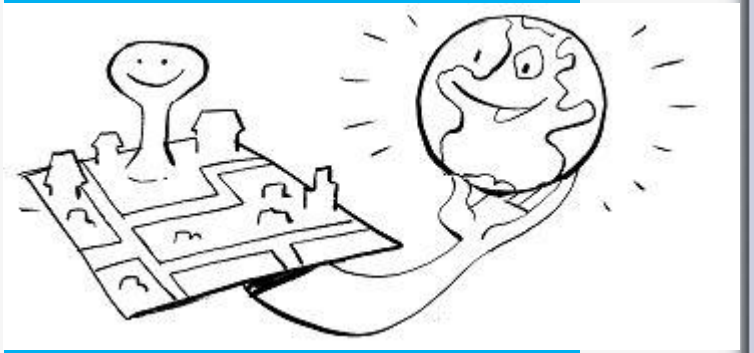
Source: TeachEngineering YouTube Channel http://www.youtube.com/watch?v=b0ISWaNoz-c

Engineering Design Process

- Divide into teams of two or three
- 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

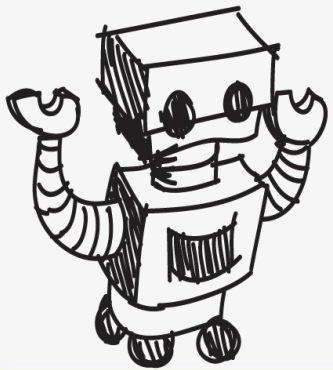
Productive Failure

- 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.
- Hydrostatic Pressure: Pressure exerted by a fluid at equilibrium due to the force of gravity. It is the pressure of the water that forces water to flow through pipes into homes.

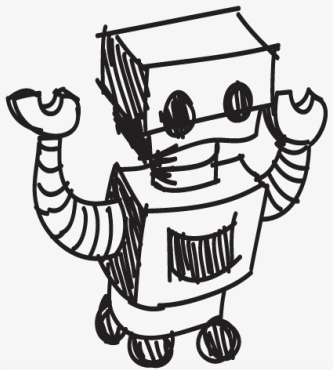
Vocabulary

- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Potable Water: Fit or suitable for drinking.
- Pressurize: Exerting a steady force upon a surface.
- Prototype: A working model of the solution to be tested.
- Pumping Station: A house where pumps are installed and operated.
- Reservoir: A place where large amounts of water get stored.
- Scalable: Capable of being easily expanded or upgraded on demand.

Vocabulary

- Water Distribution System: Part of water supply network with components that carry potable water from a centralized treatment plant or wells to water consumers.
- Water Tower: A large elevated drinking water storage container that is engineered to safely hold a water supply at a height sufficient to pressurize a water distribution system.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Water Towers

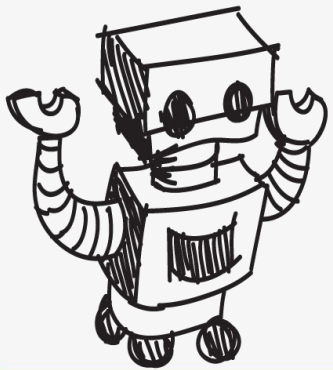
Recommended Reading

- Water Towers (ISBN: 978-0262022774)
- Design for Water: Rainwater Harvesting, Stormwater Catchment, and Alternate Water Reuse (ISBN: 978-0865715806)

Writing Activity

Write an essay or a paragraph about environmental challenges to a water tower design. Consider how the weather, topography, the population of an area, or other factors might impact the design of a new water tower.

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 water towers. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Electrical Engineering
  - Computer Engineering
  - Software Engineering

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

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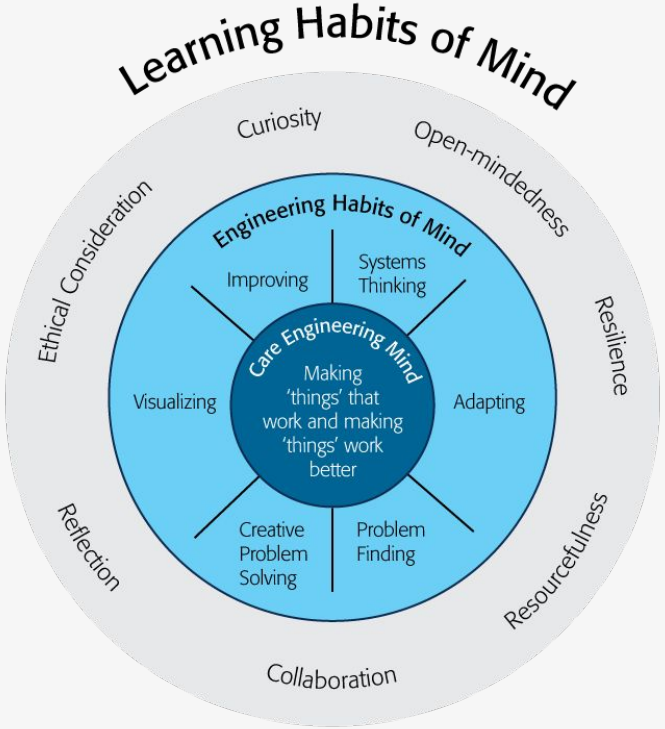
Engineering Habits of Mind



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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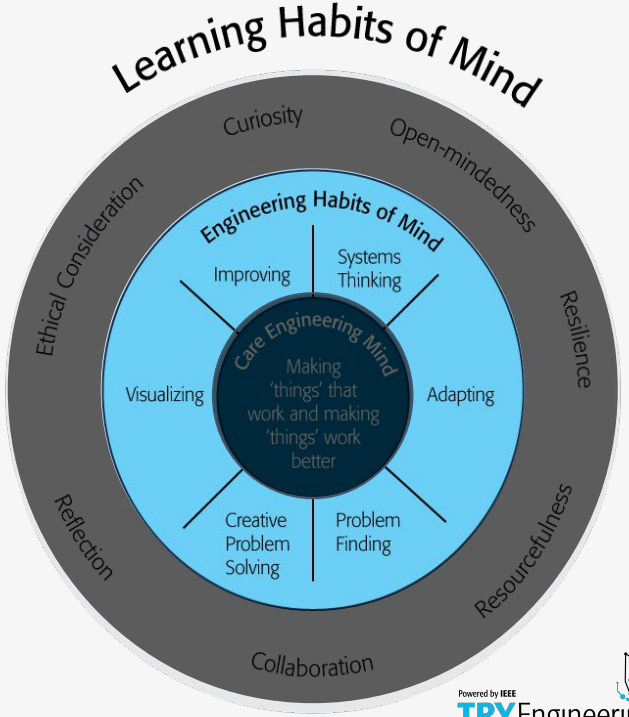
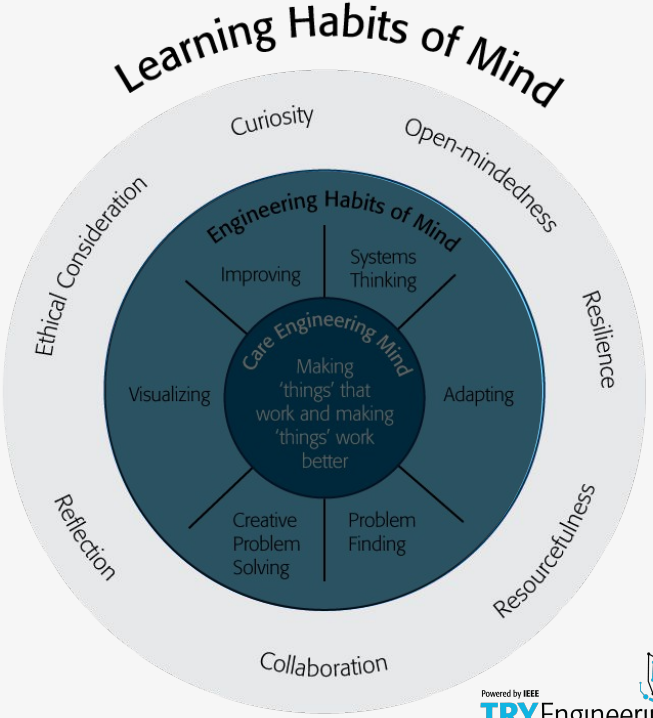
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

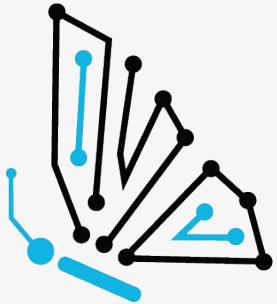


Greatest Engineering Achievements of the 20th Century

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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