



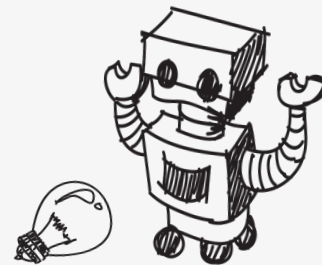
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**TRY**Engineering



**Lesson Plan:**

# Water Tower Challenge



# Real-World Application



# How Does a Water Tower Work?

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



How does a  
water tower work?



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



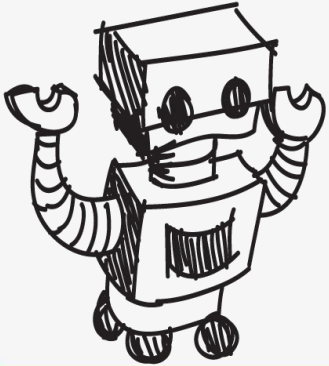
# Top 10 Coolest Water Towers

- 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.



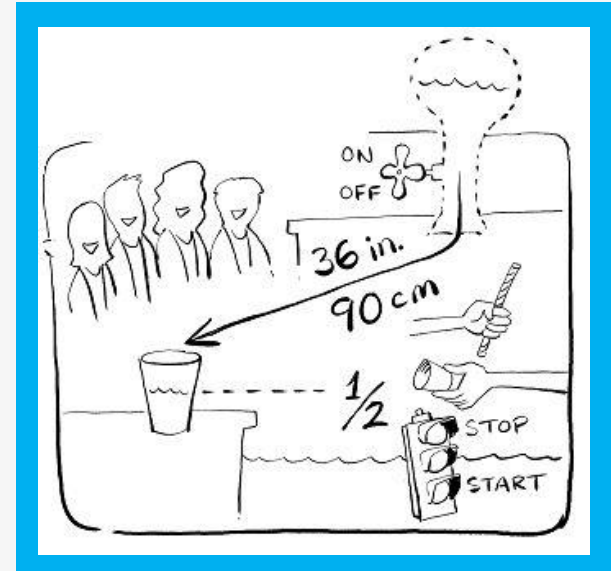
# Defining the Challenge: Criteria & Constraints

## 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

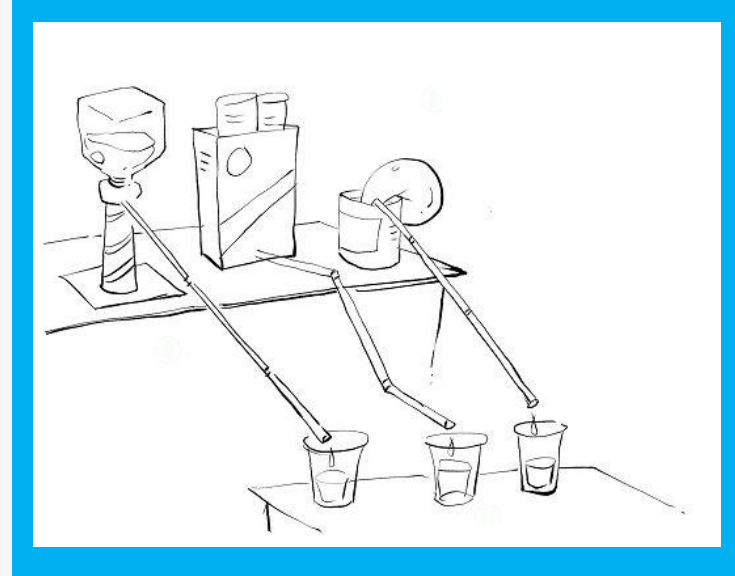
## Testing Materials

### Using water

- Water source
- Bucket
- Paper/Plastic cups

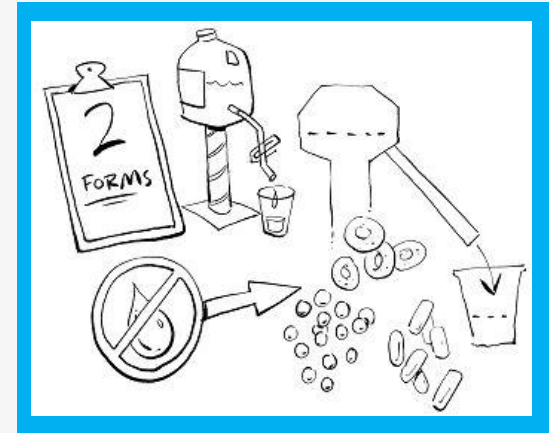
### Using water substitute

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



# Testing Process

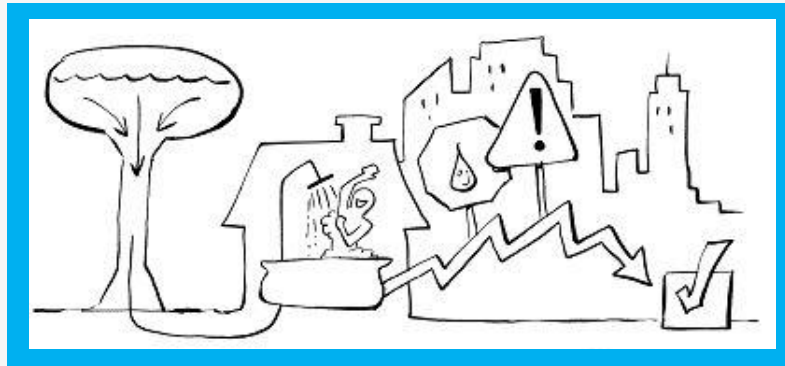
- Each team will test their design by demonstrating how their water tower delivers water or a water substitute to a paper cup within the defined criteria.
- Testing with water:
  - This testing approach should be used when the materials used to design the water tower can withstand water.
- Testing with 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...

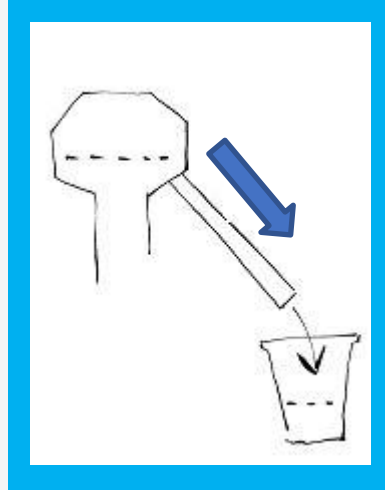
Before you get started brainstorming and sketching your design...consider the following...

- 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

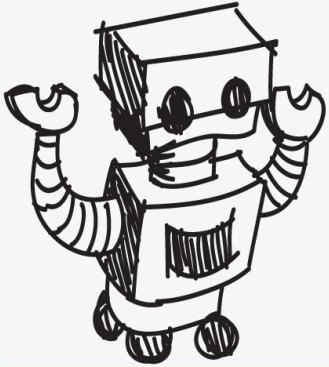


# Variations

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

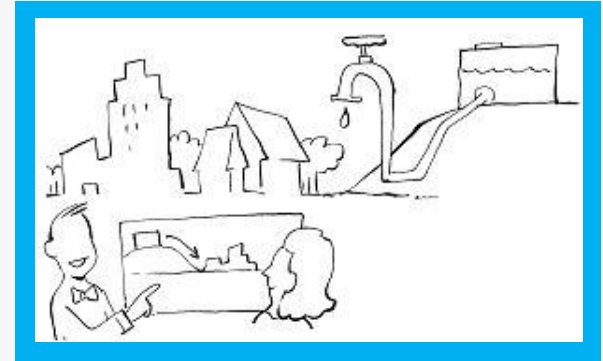


# Reflect & Debrief

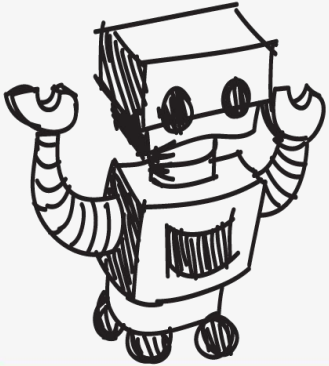


# Reflection

- 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>



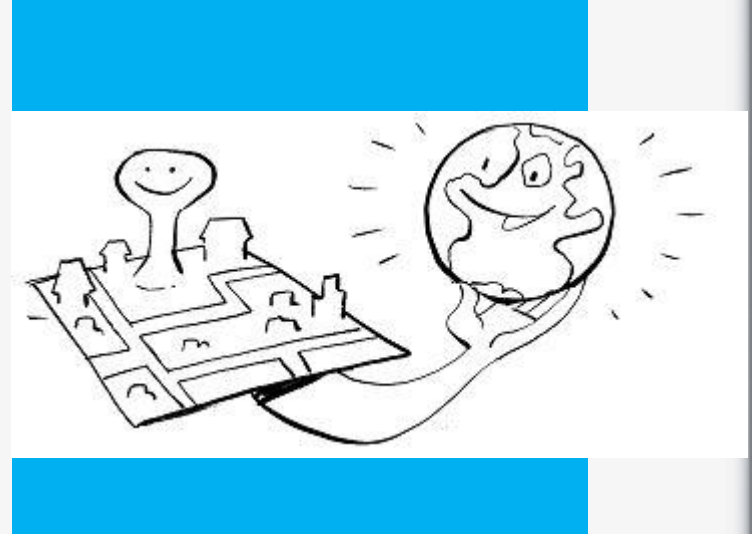
# Engineering Design Process

- 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

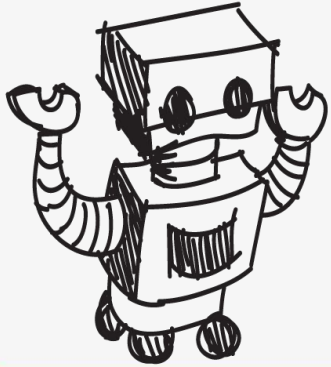


# Productive Failure

- 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.

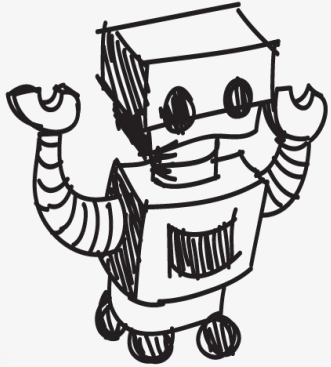


# Vocabulary

- 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)

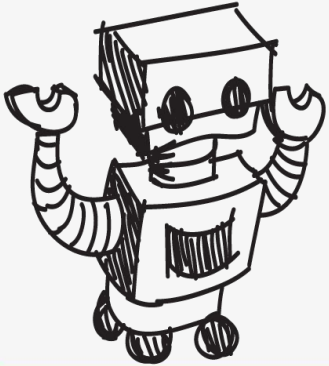
## Writing Activity

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)*



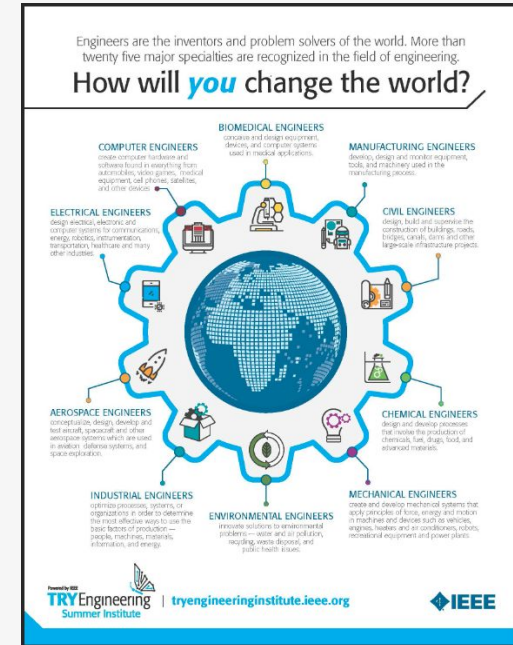
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvGmVo>

# Related Engineering Fields

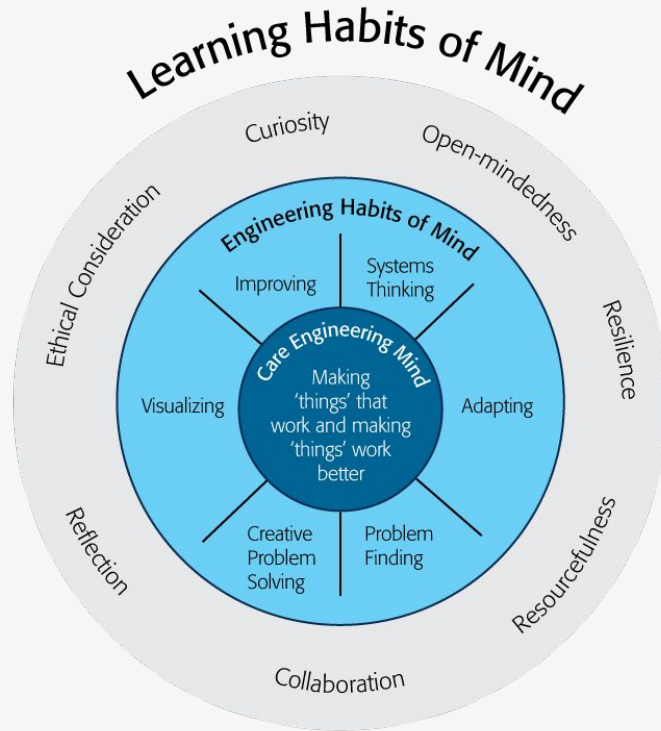
- There are several types of engineering fields that are involved with designing water towers. Here are just some of the related engineering fields.

- Mechanical Engineering
- Electrical Engineering
- Computer Engineering
- Software Engineering

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



# 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.

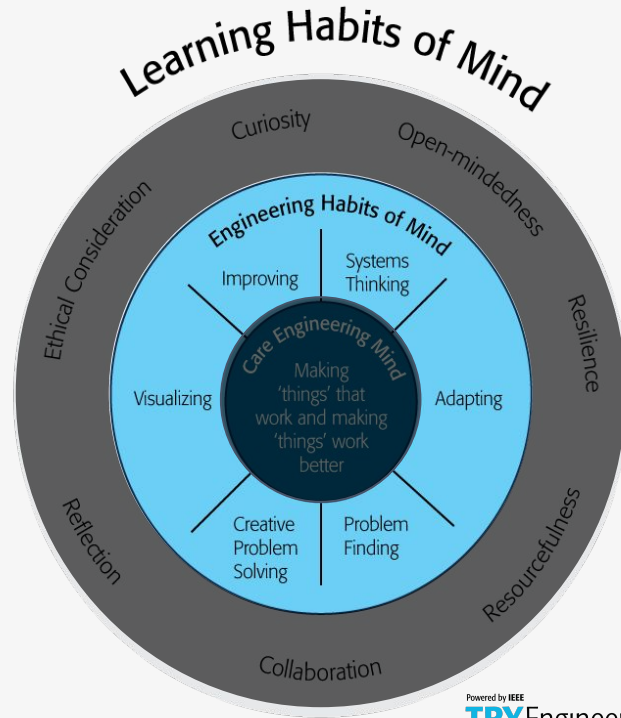
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<https://online-journals.org/index.php/i-jep/article/view/5366>



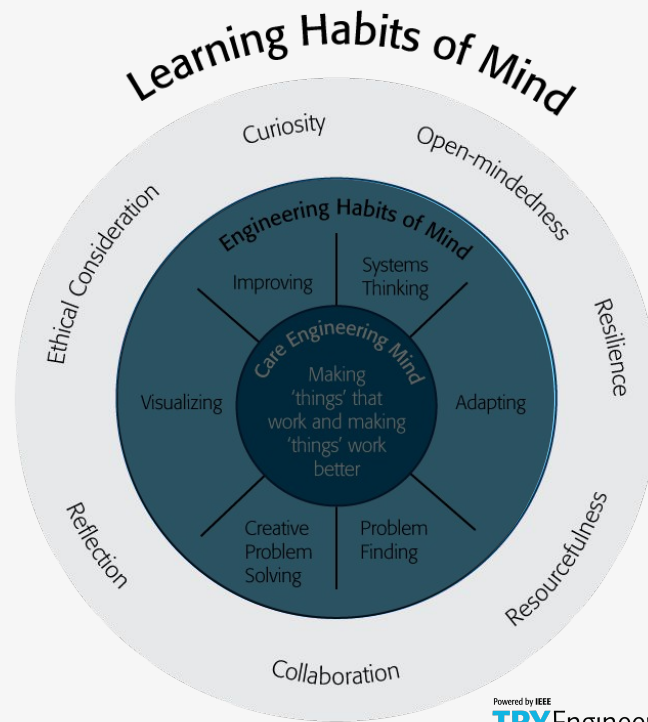
# Engineering Habits of Mind Checklist

- ❑ 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



## Greatest Engineering Achievements OF THE 20<sup>TH</sup> CENTURY

### Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration

11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

LinkEngineering



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

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# Learn more about how engineers make the world a better place



The banner features the NAE logo (three interlocking puzzle pieces in blue, green, and yellow) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" with "NATIONAL ACADEMY OF ENGINEERING" in smaller text below. Navigation buttons for "Challenges", "News", and "Community" are in green rounded rectangles. The main visual is a large green puzzle piece on the left containing a white atomic symbol, set against a dark background with a complex network of glowing green lines and dots radiating from a central point. Below this, the text "Provide energy from fusion" is displayed in a large, dark font. Underneath, a paragraph reads: "Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way." At the bottom of the banner is a row of twelve diamond-shaped icons representing various engineering fields: a smartphone, VR, a gear, a bridge, a water drop, a nuclear symbol, a CO2 molecule, a microscope, a brain, a laptop, a padlock, a gear, a circular arrow, and a DNA helix.

NAE GRAND CHALLENGES  
FOR ENGINEERING  
NATIONAL ACADEMY OF ENGINEERING

Challenges News Community

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.





For more engineering lesson plans and  
resources like games, engineering careers,  
and STEM opportunities visit IEEE's  
[TryEngineering.org](https://www.tryengineering.org)

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