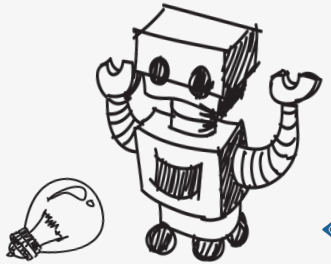
Powered by IEEE
TRY Engineering

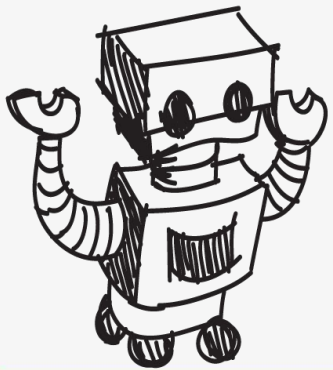
Lesson Plan:

Working with Watermills



IEEE

The Design Challenge



The Design Challenge

You are a team of engineers who have been given the challenge to design your own watermill out of everyday materials. Your wheel will need to rotate in water for three minutes without falling apart.

Defining the Challenge: Criteria & Constraints

Criteria

- Wheel must rotate in water for 3 minutes without falling apart
- All the materials will be exposed to water

Constraints

- Use only the materials provided.
- Teams may trade unlimited materials.

Material

Materials – Required (Table of Possibilities)

- Styrofoam cylinder
- Plastic or wooden spoons
- Small wooden (balsa) pieces
- Bendable wire (such as pipe cleaners, florist or craft wire)
- String or yarn
- Paperclips (large and small)
- Rubber bands
- Toothpicks

Material

Materials – Required (Table of Possibilities)

- Aluminum foil
- Wooden dowels
- Plastic or wax coated food container lids

Testing Materials and Process

Testing Material

- Water source
- Large basin or sink
- Measuring cup or container for pouring water

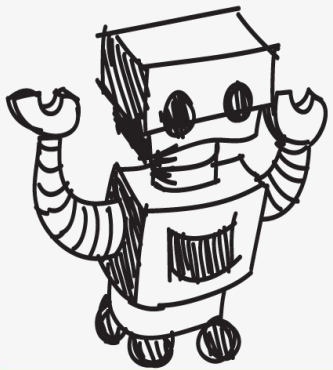
Testing Process

Test each team's watermill design by placing the design on a bin filled with water. Pour water over the watermill for 3 minutes. Students should document how many times their watermill rotated during the 3 minutes and what condition their design was in after the testing.

Consider...

- Before you get started building, consider how a watermill works. Have you seen any watermills near your home?

Reflect & Debrief



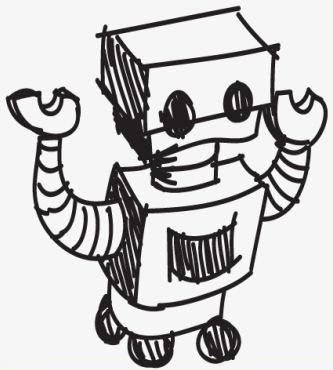
Reflection

- Did you succeed in creating a watermill that operated for three minutes? If not, why did it fail?
- Did you decide to revise your original design or request additional materials while in the construction phase? Why?
- Did you negotiate any material trades with other teams? How did that process work for you?
- If you could have had access to materials that were different than those provided, what would your team have requested? Why?
- Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

Reflection

- If you had to do it all over again, how would your planned design change? Why?
- What designs or methods did you see other teams try that you thought worked well?
- Do you think you would have been able to complete this project easier if you were working alone? Explain…
- What drawbacks does the watermill have as a reliable source of power?
- What advantages does the watermill have as a renewable source of power?

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

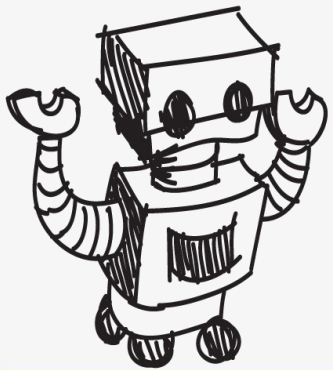
- Divide into teams
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

Powered by IEEE TRYEngineering | IEEE

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



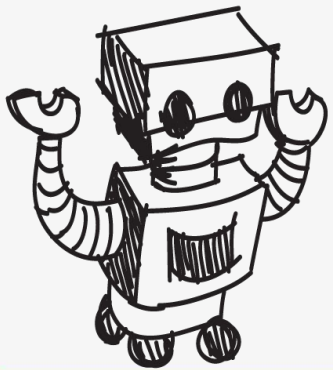
Vocabulary

- Axle: A central shaft for a rotating wheel or gear
- 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.
- Force: A push or pull.
- Hydroelectric Plant: A watermill that generates electricity.

Vocabulary

- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Prototype: A working model of the solution to be tested.
- Turbine: Blades of the wheel.
- Velocity: The rate of change in an object's position
- Watermill: A structure that uses a water wheel or turbine to drive a mechanical process such as ground flour or lumber production, or metal shaping (rolling, grinding or wire drawing).

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Waterwheel Factory (www.waterwheelfactory.com)
- U.S. Geological Survey Hydroelectric Power (https://water.usgs.gov/edu/hyhowworks.html)
- Society for the Preservation of Old Mills (www.spoom.org)

Recommended Reading

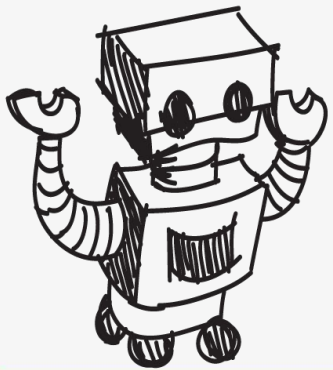
- Cathedral, Forge and Waterwheel: Technology and Invention in the Middle Ages (ISBN: 0060925817) Windmills and Waterwheels Explained (ISBN: 1846740118)

Dig Deeper into the Topic

Writing Activity

Write an essay or a paragraph about how engineering has helped reduce human work over the ages.

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)

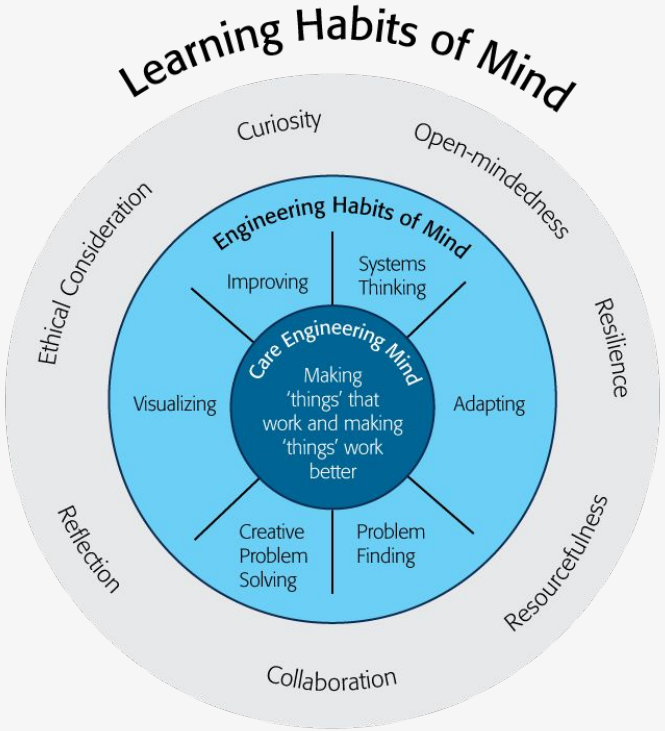
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with designing watermills. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Electrical Engineering

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

Engineering Habits of Mind



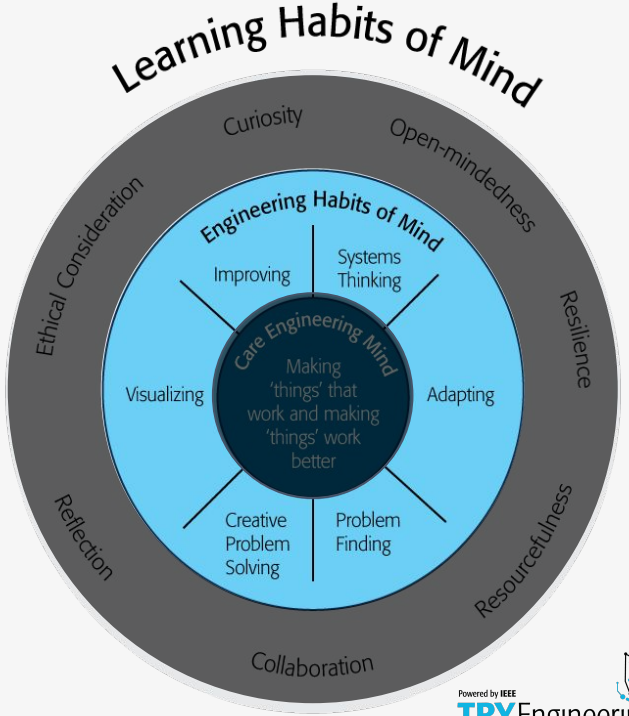
Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

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

Powered by IEEE TRYEngineering | IEEE

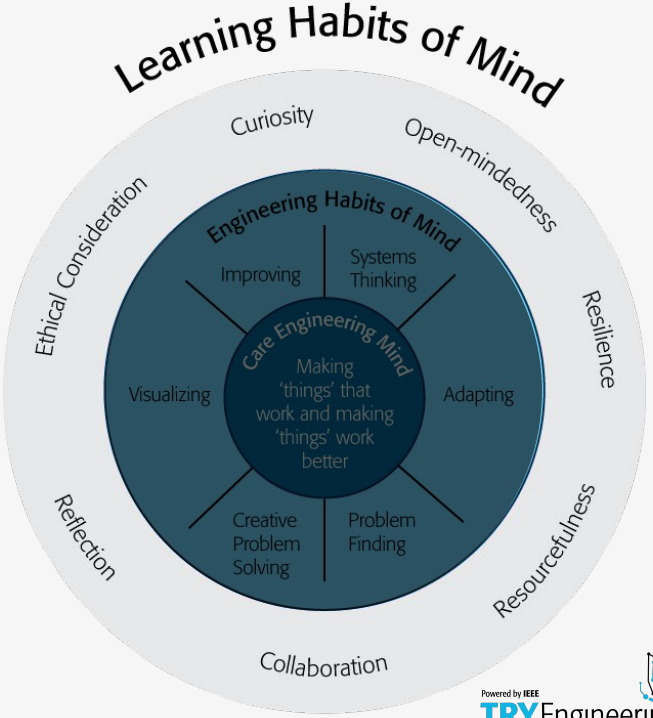
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

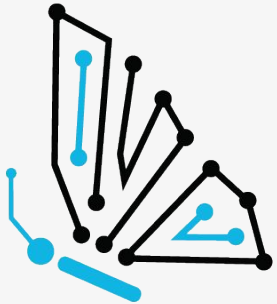


Greatest Engineering Achievements of the 20th Century

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



Powered by IEEE

TRY Engineering