



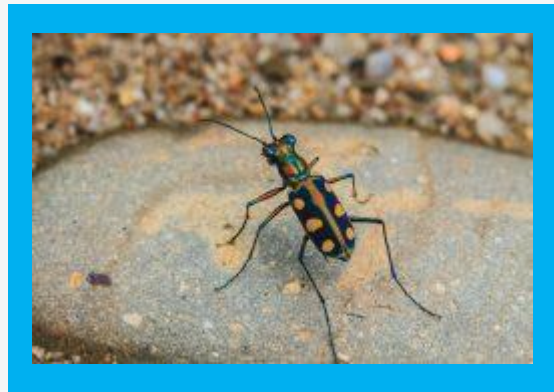
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TRYEngineering



Lesson Plan:

The Boat and the Beetle



The Design Challenge



The Design Challenge

- You are an engineer given the task of building a boat out of modeling clay. Draw a picture of your planned design, sculpt your boat, test it by floating it on the water. If it sinks, change (redesign) your boat and test it again until your boat floats.



Defining the Challenge: Criteria & Constraints

Criteria

- Draw a picture of the design
- Sculpt the boat from modeling clay

Constraints

- You can only use the modeling clay to build your boat



Material

Required for Build

- Modeling clay/plasticine
- Scale to break modeling clay into pieces
- Toy boats/ships
- Crayons and coloring sheets with boat theme



Testing Material Process

Testing Material

- Inflatable play pool/tank or large bowl of water
- Plastic table covering

Testing Process

As students are sculpting their boats, allow them to test how well their design floats. They can then change (redesign) their boat and test again until they have a design that floats.



Consider...

Before you get started building, discuss surface tension. See the topics in the Background Concepts section.

Consider reading the following story to get excited about the hands-on activity.

Once upon a time there was a beetle who loved to tell everyone how fast he could run. “I am the fastest insect in the park,” he would say. His slow and steady friend the snail, tired of hearing him brag, challenged him to a race. “Ha,” the beetle thought to himself, “there is no way a snail could ever win against me.”



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Consider...

On the day of the race, all of the insects in the park gathered to watch. The centipede waved a checkered flag to start the race. The beetle zoomed past the starting line as fast as he could, while the snail carefully inched herself forward bit by bit. The beetle cried out “You will never win this race at that slow, slow pace.”

Out of breath from running, the beetle eventually reached a small pond of water. He thought, “I have plenty of time. I just will go around the pond.” The beetle sped off on his way.

Inch by inch the snail crawled along the path. As she reached the pond, she thought, “It would be much shorter if I could somehow float across the water.” Perhaps I could build a boat.



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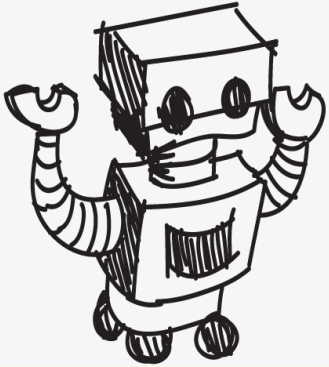
Consider...

The snail gathered up some leaves, twigs and vine. She fashioned a small boat that helped her glide smoothly across the water of the pond. When she got to the other side, she hopped off the boat and could see all of her friends waiting for her at the finish line.

Little by little the snail crept along the path until she crossed the finish line at long last. All of her friends cheered. "Hooray for snail!" they cried. A moment later the beetle came running across the finish line. "I can't believe you beat me!" he said. "You know," the snail replied with a smile, "being the fastest isn't always everything". "Sometimes if you just slow down for a moment and think about your challenge, you can come up with great solutions."



Reflect & Debrief

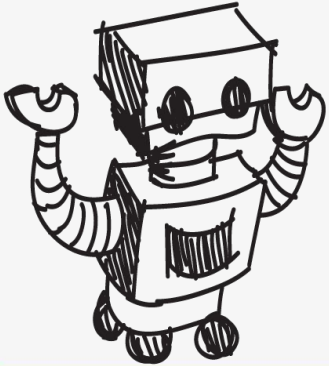


Reflection

- Did your boat sink or float? If it did not float, how did you change it so it displaced more water?
- How many times did you have to test and sculpt your boat again before it would float?
- Did you have to change the shape of your boat's hull?
- What did you like about other students' boats?
- Have you learned with buoyancy means?



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

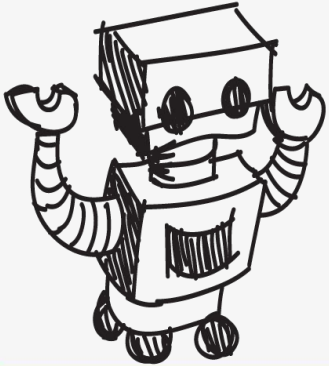


Productive Failure

- 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

- Hull: the main part of a ship or boat: the deck, sides, and bottom of a ship or boat
- Buoyancy: the ability of an object to float on water
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Displace - when a floating object physically pushes water out of the way
- Displacement - the volume or weight of water displaced by a floating body (as a ship) of equal weight
- Float: to rest on top of a water (or a liquid)

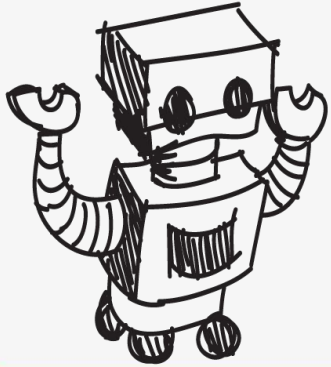


Vocabulary

- 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).
- Prototype: A working model of the solution to be tested.
- Sink: to go down below the surface of water
- Surface tension: An effect where the surface of a liquid is strong.



Dig Deeper



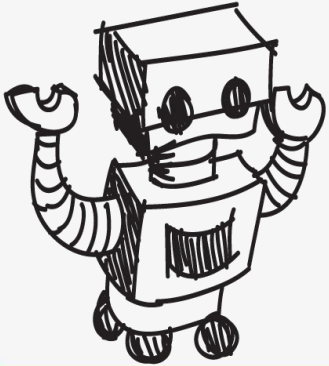
Dig Deeper into the Topic

Writing Activity

- Draw a picture of what happened to your boat in the pool. (This can be used as an assessment of the student's understanding of the activity).
- Write a sentence or word (dependent on age/ability) describing the activity alongside your picture: e.g. 'sink' or 'float.' You may need a dotted model to trace over the words: My boat floats.



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.

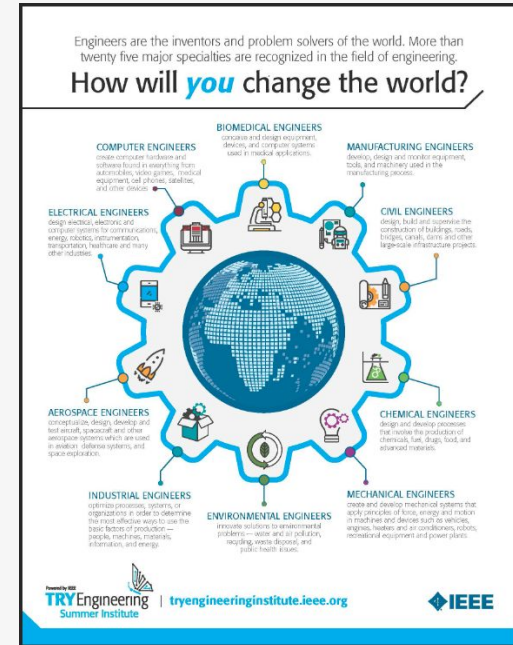
(Video 3:43)



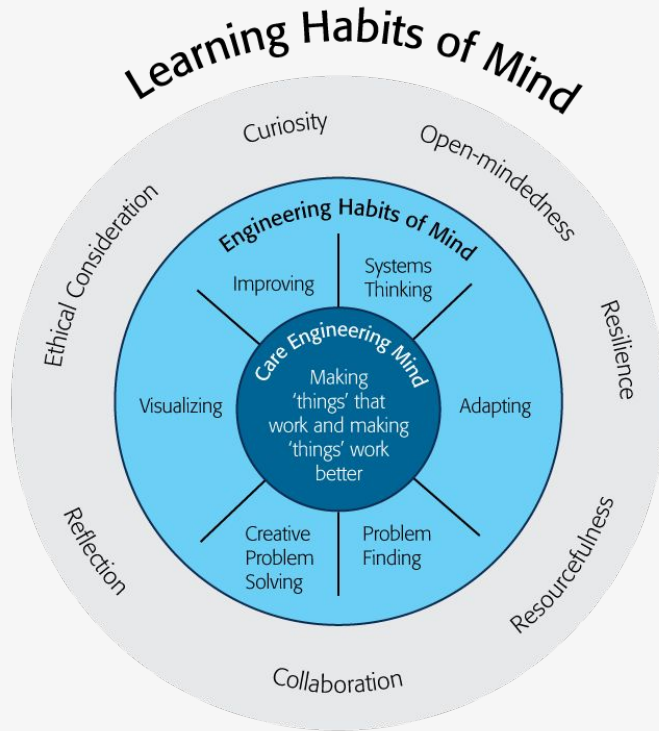
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvqGmVo>

Related Engineering Fields

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

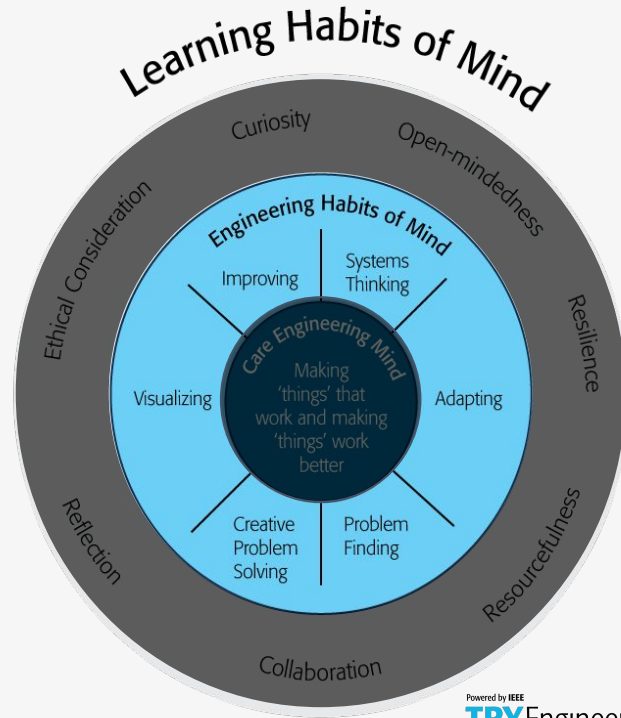
Source:

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



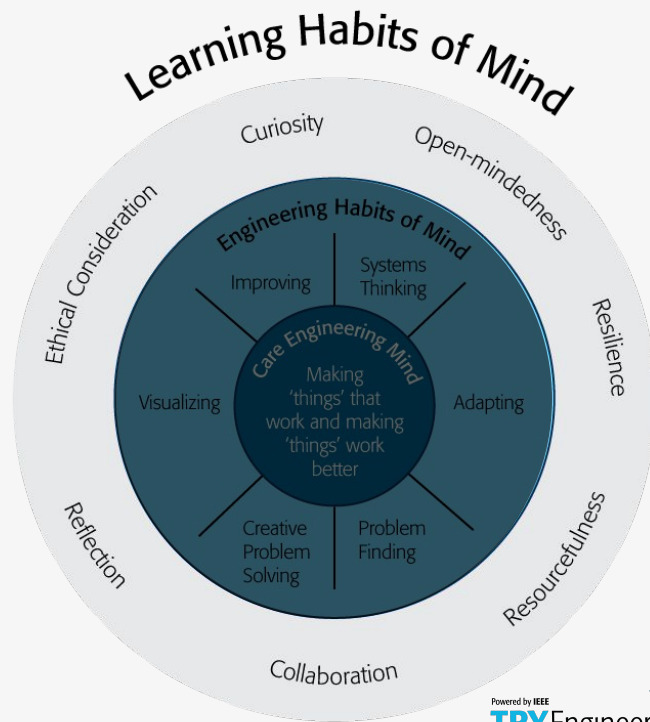
Engineering Habits of Mind Checklist

- ❑ 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 20TH 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" and "NATIONAL ACADEMY OF ENGINEERING". Navigation buttons for "Challenges", "News", and "Community" are in green. The main visual is a large green puzzle piece on the left with a fusion symbol, and a network of glowing green lines radiating from a central point on the right. Below the puzzle piece, the text "Provide energy from fusion" is displayed, followed by a paragraph about scaling up fusion. A row of 15 diamond-shaped icons represents various engineering challenges, including a smartphone, VR, a lightbulb, a bridge, a water drop, a nuclear symbol, a CO2 canister, 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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