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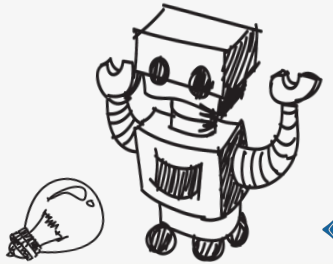
Lesson Plan:

Biomimicry in Engineering



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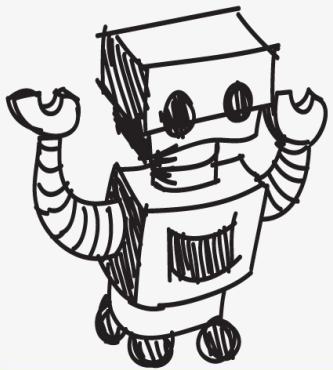
The Design Challenge



The Design Challenge

You are part of a team of engineers given the challenge of developing a system or building that will be placed on the moon. The system or building should be based on a product or system found in nature. You'll research ideas online, then work as a team to develop a sketch of your design. You'll also consider patenting your idea.

Defining the Challenge: Criteria & Constraints

Criteria

- Design to be placed on the moon.
- Design must be based on a product or system found in nature.

Constraints

- Use only the materials provided.

Material

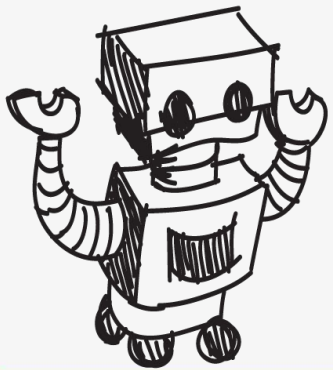
Materials – Required

- Paper
- Pen/Pencil
- Internet access (optional, though helpful).

Consider...

- Before you get started building, consider how nature engineers a product -- like a leaf. Think about the functionality of shapes such as a conch shell or palm leaf, and how they support the structure. Another point might be to look at how a lotus leaf beads up water…and consider that it is the tiny "hairs" on the surface of the leaf that suspend water beads.
- Visit Asknature.org. Take some time to explore the various challenges and solutions nature has to offer. For example, you might search for "store oxygen" or "termites" or anything related to what you are considering working on.

Reflect & Debrief



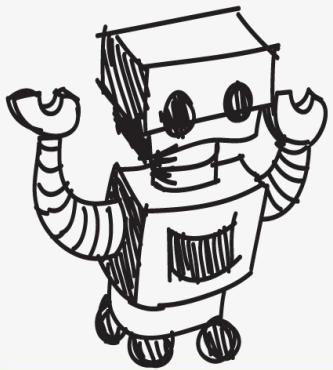
Reflection

- What was the most interesting proposed used of biomimicry that was developed in your class presentations? Why?
- Do you think that your design is patentable? Is it unique enough to be approved?
- Do you think your product, building, or system would work if manufactured?
- Do you think that you could raise funds to pay for manufacturing? How would you go about raising funds?

Reflection

- Do you think that many engineers explore solutions from nature into their inventions?
- Did you think that working as a team made this project easier or harder? Why?

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

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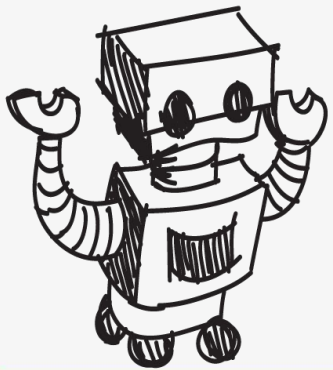
Productive Failure

- 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



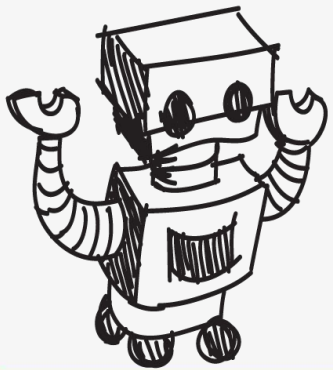
Vocabulary

- Biomimicry: When people use ideas from nature to solve problems.
- 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.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Patent: The grant of a property right to the inventor, issued by a country's Patent and Trademark Office.

Vocabulary

- Patentee: Inventor who receives a patent for their invention.
- Prototype: A working model of the solution to be tested.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Ask Nature (www.asknature.org)
- esp@cenet - European Patent Office Search (https://www.epo.org/searching-forpatents.html)
- U.S. Patent and Trademark Office (www.uspto.gov/patents)

Recommended Reading

- Biomimicry: Innovation Inspired by Nature (ISBN: 978-0060533229)
- Biomimetics: Biologically Inspired Technologies (ISBN: 978-0849331633)

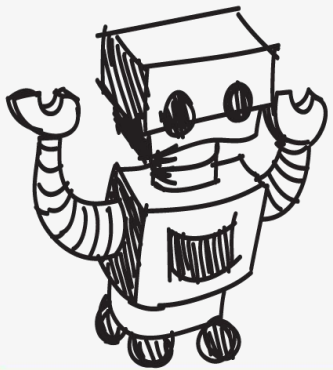
Dig Deeper into the Topic

- The Gecko's Foot: Bio- Inspiration: Engineering New Materials from Nature (ISBN: 978-0393337976)
- Biomimicry for Optimization, Control, and Automation (ISBN: 978-1852338046)
- How to Make Patent Drawings (ISBN: 978-1413306538)

Writing Activity

Write an essay or a paragraph about one example of how engineers have looked to nature to help find solutions to societal challenges.

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)

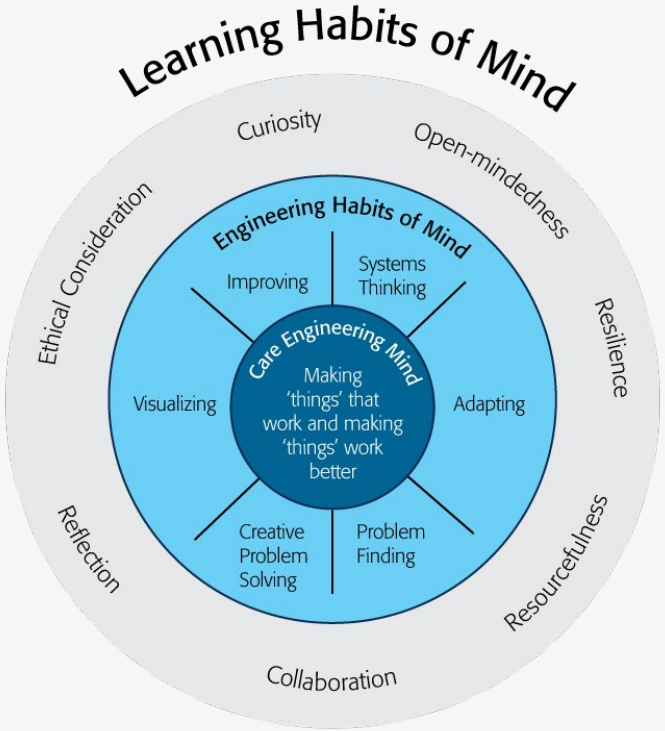
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that work with products or systems found in nature. Here are just some of the related engineering fields.
  - 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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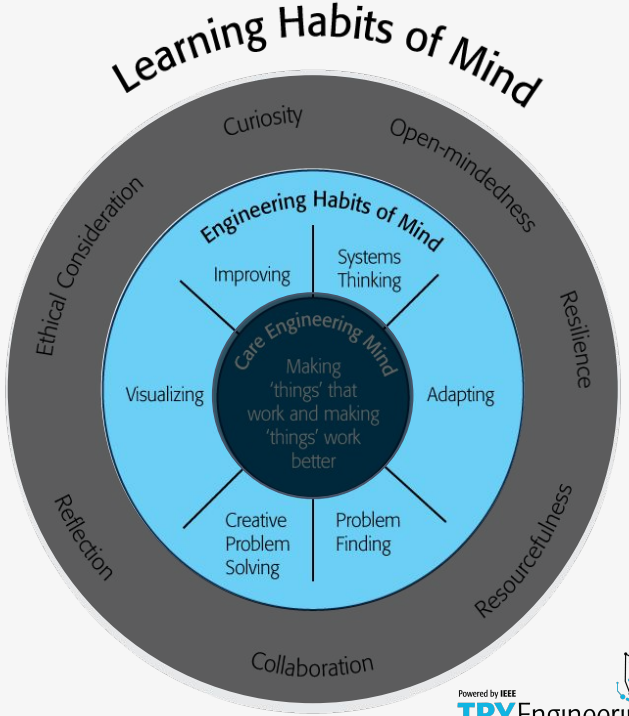
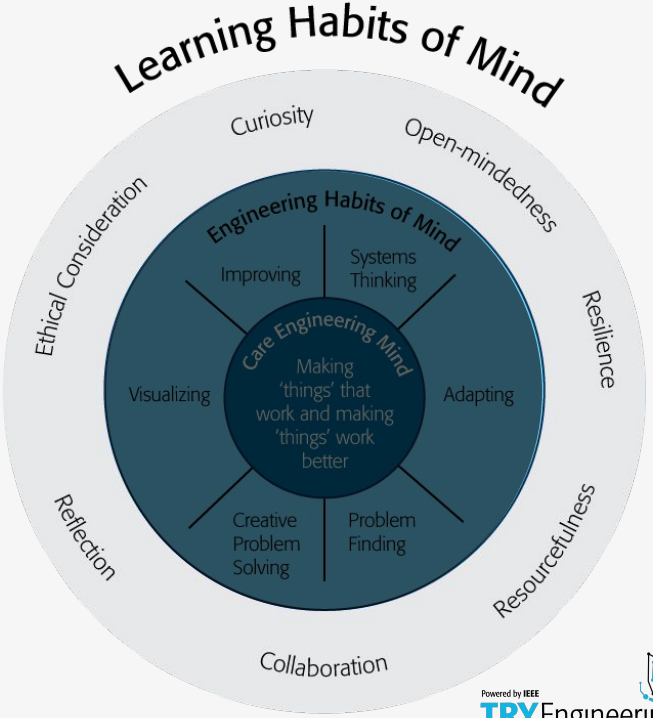
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

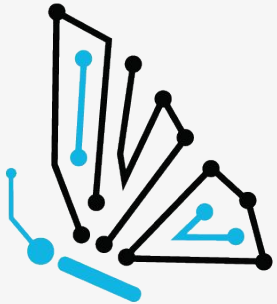


Greatest Engineering Achievements of the 20th Century

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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