Powered by IEEE

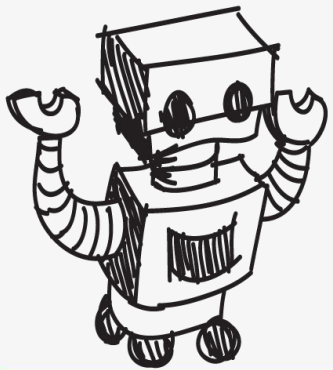
TRY Engineering

Lesson Plan:

3D Printing by Hand

IEEE

The Design Challenge



The Design Challenge

- You are part of a team of engineers working together to create a "3D-printed" model of an object using everyday materials.
  - 3D printing software maps the shape of an object, then "slices" it into layers. 3D printers then print objects by adding layer upon layer of material together to create the object. This process is called "additive manufacturing."
  - The thickness of your layers will be the same as the thickness of your building material (foam board or cardboard). In order to measure your layers, you will wrap pipe cleaners around your object at each layer/height marker (if your foamboard is ¼" thick, you will measure your object with a pipe cleaner at ¼" high, ½" high, ¾" high, and so on). The pipe cleaner will give you the size and shape of the layer. Tracing the pipe cleaner shape onto your building material, you will cut out each layer of your model. Adding one layer on top of the other and attaching them with glue, you will create your three-dimensional model.

Defining the Challenge: Criteria & Constraints

Criteria

- Object for modeling must be selected by team
- Use ruler and pipe cleaners to measure the object at each height marker

Constraints

- Use only the materials provided

Material

Required for Build

- Foam board or thick corrugated cardboard
- Rulers
- Pipe cleaners or easily bendable wire
- Pencils
- Glue
- A variety of small objects with relatively simple shapes for students to choose from.
  - Balls
  - Vases
  - Bowls
  - Bottles
  - Cups

Material

Teacher Materials

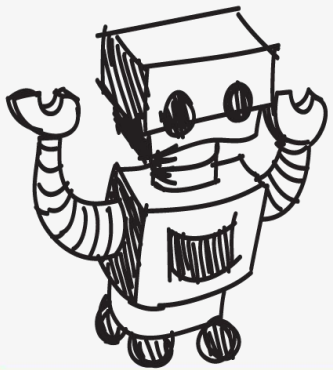
- Short video from PBS LearningMedia for a visual introduction to 3D printing https://ny.pbslearningmedia.org/resource/b9194612-d6e7-4307-b08c-9c2857956713/will-3d-printing-change-the-world/

Consider...

Before you get started brainstorming, consider discussing how 3D printers build objects using layers, which is why it is sometimes referred to as “additive manufacturing.” Review the topics in the Background Concepts Section of the lesson plan.

- You may want to view this short video from PBS LearningMedia for a visual introduction to 3D printing https://ny.pbslearningmedia.org/resource/b9194612-d6e7-4307-b08c-9c2857956713/will-3d-printing-change-the-world/

Reflect & Debrief



Reflection

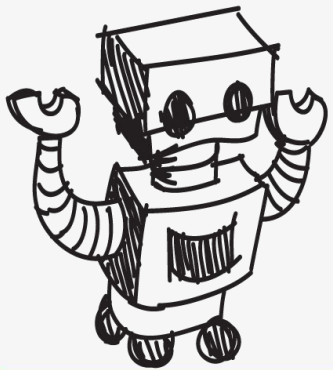
- How does the model you created compare to the object you based it on?
- What changes to the process or materials do you think would lead to a more detailed and accurate reproduction of the original object?
- In what ways are the process you used to create your 3D model similar to the actual process used by a 3D printer?
- How do you think the thickness of the layers you created here compare to the layers created for a 3D printer?

continued on next page

Reflection

- What challenges did you run into in creating your 3D model? What other tools or materials might have helped you make your measurements and construct your layers?

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

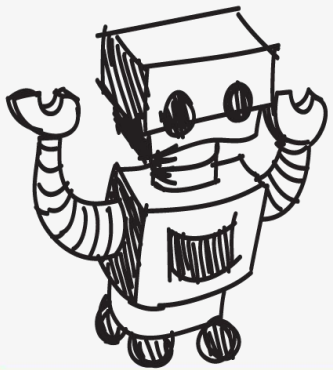
Engineering Design Process

- Divide into teams of two (or up to 4 max)
- 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



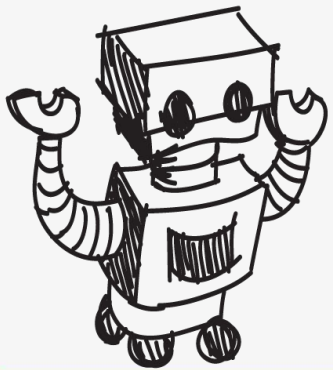
Vocabulary

- 3D: The quality of being three dimensional.
- Additive manufacturing: Creation of lighter, more complex designs.
- 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.

Vocabulary

- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Layers: A sheet, quantity, or thickness of material.
- Model: A three-dimensional representation of a person or thing or of a proposed structure, typically on a smaller scale than the original.
- Prototype: A working model of the solution to be tested.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- PBS LearningMedia: Will 3D Printing Change the World? https://thinktv.pbslearningmedia.org/resource/b9194612-d6e7-4307-b08c9c2857956713/will-3d-printing-change-the-world/

Recommended Reading

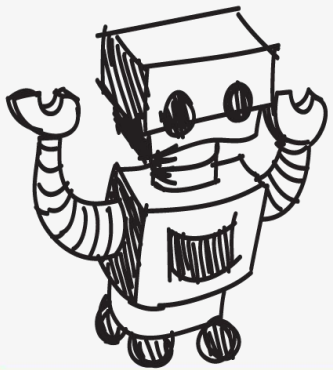
- 3D Printers: A Beginner's Guide by Oliver Bothmann (ISBN: 978-1565238718)
- Make: Getting Started with 3D Printing: A Hands-On Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution by Liza Wallach Kloski and Nick Kloski (ISBN: 978-1680450200)

Dig Deeper into the Topic

Writing Activity

Write an essay or paragraph about the ways 3D printing can be helpful to society and the potential dangers, pitfalls, or moral issues that it may raise.

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

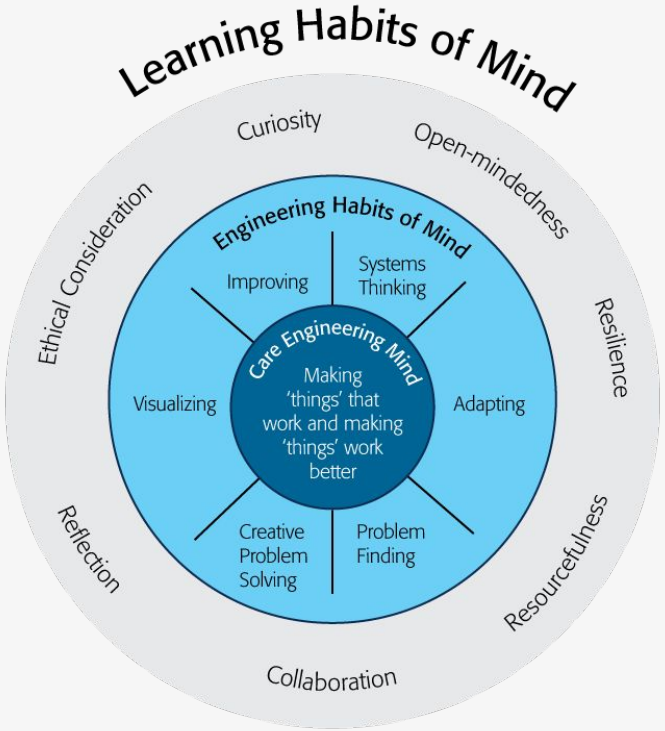
Related Engineering Fields

- There are several types of engineering fields that are involved with 3D printing. Here are just some of the related engineering fields.
  - Computer Engineering
  - Software Engineering

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

Powered by IEEE TRYEngineering | IEEE

Engineering Habits of Mind



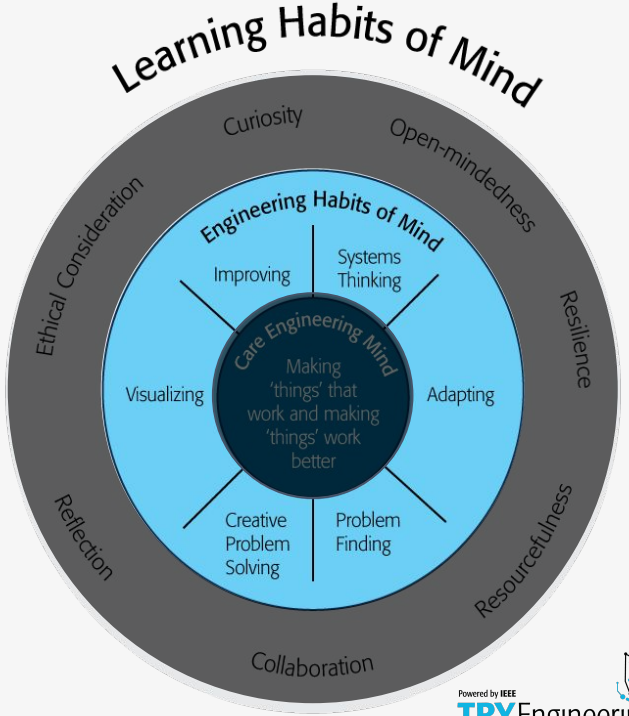
Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

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

Powered by IEEE TRYEngineering | IEEE

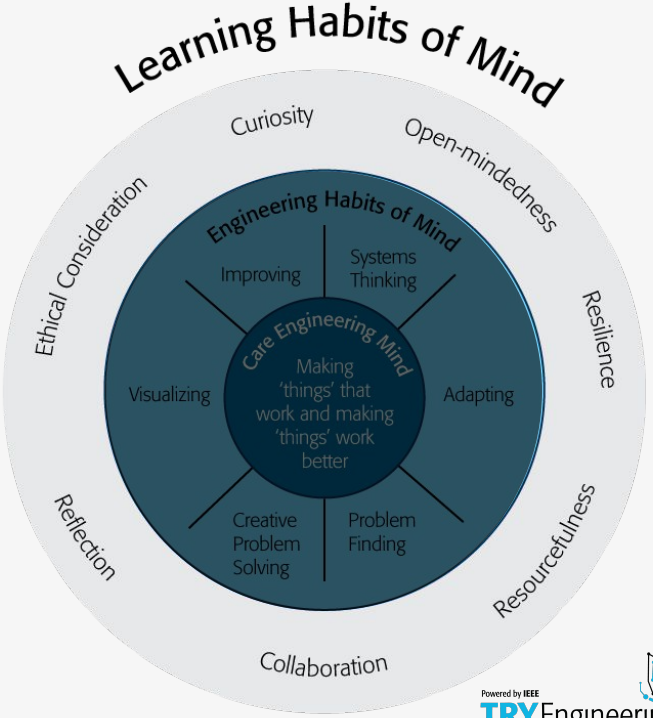
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

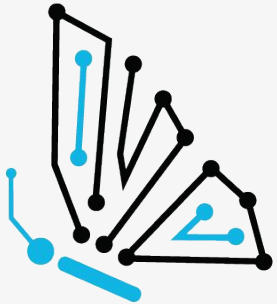


Greatest Engineering Achievements of the 20th Century

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