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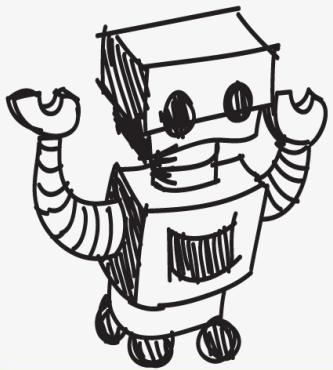
TRY Engineering

Lesson Plan:

Sticky Engineering Challenge

IEEE

The Design Challenge



The Design Challenge

You are a team of engineers who have been given the challenge of building a structure that can withstand the weight of a can of soup or soda. The can must be at least 2 inches or 5 centimeters above a tabletop surface. Your materials include popsicle sticks, paper clips, paper, and glue -- but you'll have to decide which glue works best for your design!

Defining the Challenge: Criteria & Constraints

Criteria

- Must withstand the weight of a can of soup or soda
- Can must be at least 2 inches or 5 centimeters above the tabletop surface.

Constraints

- Use only the materials provided.

Material

Materials – Required (Each team)

- 30 popsicle sticks
- 10 paper clips
- 2 sheets of paper

Materials (Table of Possibilities) - *Safety note: super glue or crazy glue is not recommended*

- A variety of glue options
- School or washable glue
- Wood glue

Material

- Craft glue
- Gel glue
- Rubber cement
- Glue sticks

Extension Idea - Making Glue

For an optional extension activity you may wish to have students develop their own glues, or recipes for glues. Some of these recipes would require the use of a stove and would require adult supervision and extra safety precautions.

Material

- Glue Recipe 1 (no heat) Mix 1/2 cup of flour with 1/4 cup of water.
- Glue Recipe 2 (no heat) Mix 2 cups flour with one 1 cup of cold water and 1 cup of hot tap water
- Glue Recipe 3 (requires heat) 1. Mix 1 cup flour, 1 cup sugar, 1 tsp. alum, 4 cups water in a saucepan. 2. Cook until clear and thick. 3. Add 30 drops oil of cloves or wintergreen (etc.) and store covered.
- Glue Recipe 4 (requires heat) 1. Mix 3/4 cup water, 3 tablespoons sugar, and 1 teaspoon white vinegar in a saucepan and bring to a rolling boil. 2. In a separate bowl, mix 1/2 cup cornstarch or corn flour and 3/4 cup water, mix over a very low heat. 3. Add cornstarch mixture slowly to water/sugar/vinegar mixture. Stir continually for two minutes. 4. Take the mixture off heat and let cool completely before using as a glue

Testing Materials and Process

Testing Material

- Identical cans of soup or soda - about 10 oz or 300 grams

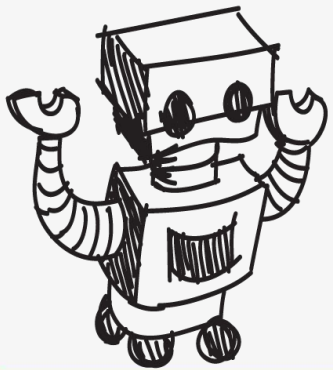
Testing Process

Test each design by placing the can on top of the structure.

Consider...

- Before you get started building, agree on how many popsicle sticks and paper clips you will need, write/draw your plan.

Reflect & Debrief



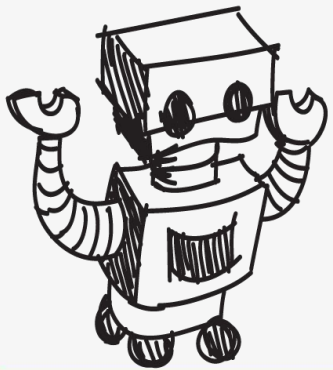
Reflection

- Did you succeed in creating a structure to hold the can? If so, why do you think your design worked? If not, why did it fail?
- How did you test your glues to make your glue selection? Did your testing process work well and provide you with the information/research you needed to make a decision?
- How important was the selection of glue to your structure's success or failure?
- If you had to do it all over again, what would you do differently? Why?

Reflection

- What designs or methods did you see other teams try that you thought worked well?
- Did you find that there were many designs in your classroom that met the project goal? Can you think of examples of everyday products that do the same job but look or perform very differently?
- Do you think you would have been able to complete this project easier if you were working alone? 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

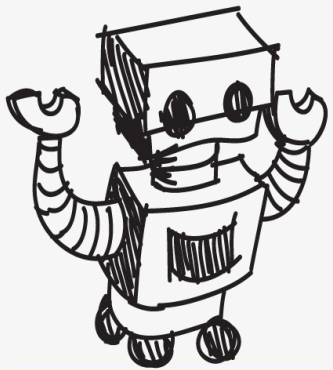
Engineering Design Process

- Divide into teams
- 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.

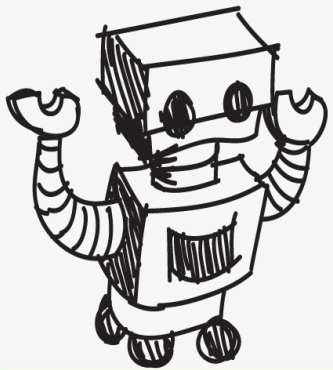
Vocabulary



Vocabulary

- Adhesive: A substance that is used to make things stick together.
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Critical load: The weight at which a building or structure fails.
- 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.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Wikipedia: Adhesive (https://en.wikipedia.org/wiki/Adhesive)
- 3M Post-it Note History: (https://www.post-it.com/3M/en_US/post-it/contactus/about-us/)

Recommended Reading

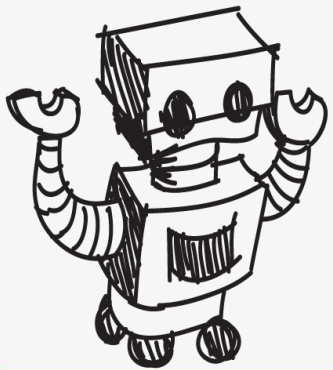
- The Complete Guide to Glues and Adhesives (ISBN: 0873418204)
- Adhesion and Adhesives Technology (ISBN: 1569903190)

Dig Deeper into the Topic

Writing Activity

Write an essay or a paragraph offering real world examples of how engineers have created products that are either more cost effective or more efficient because glues or adhesives are incorporated in the product.

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)

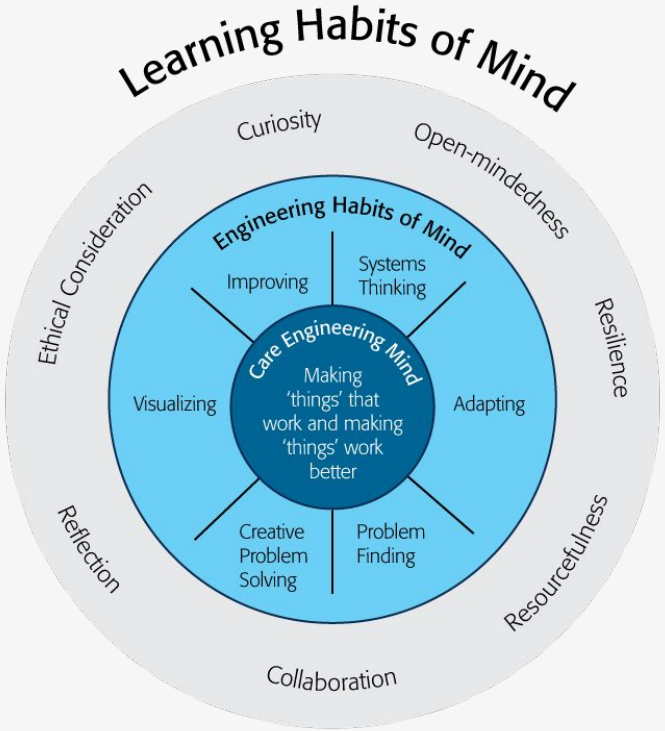
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that work with materials and building structures. Here are just some of the related engineering fields.
  - Civil Engineering
  - Materials Engineering
  - Structural 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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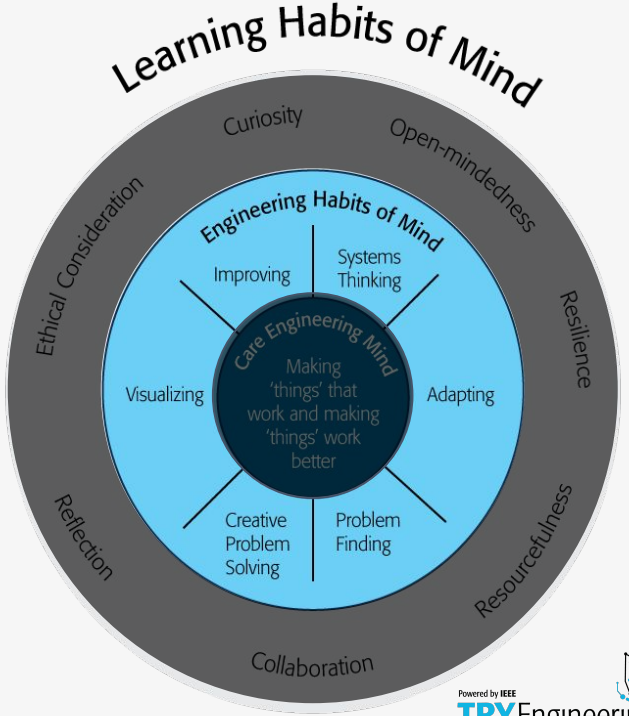
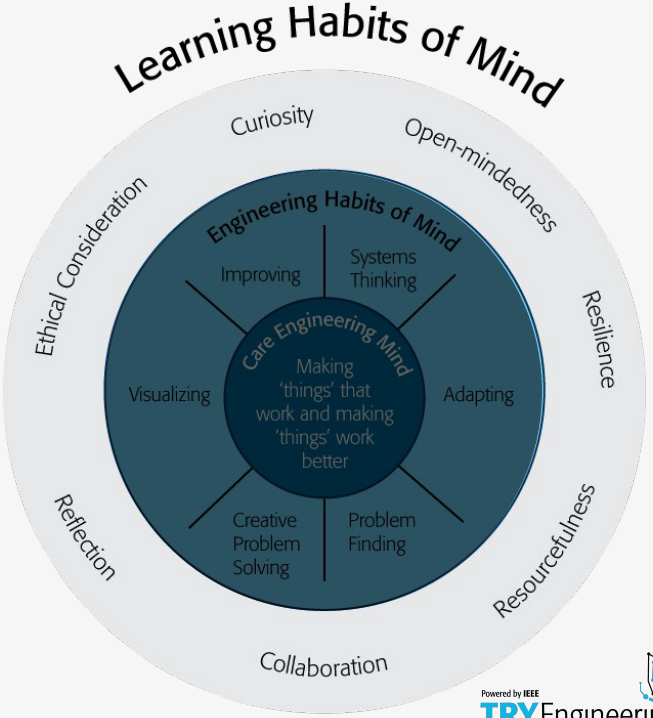
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

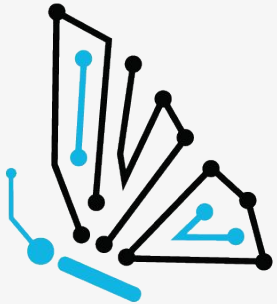


Greatest Engineering Achievements of the 20th Century

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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