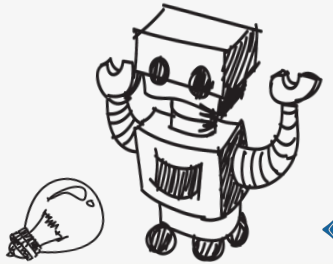
Powered by IEEE

TRY Engineering

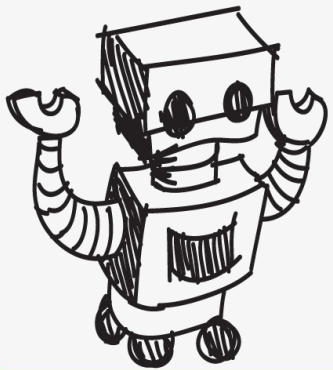
Lesson Plan:

Can You Copperplate?



IEEE

The Design Challenge



The Design Challenge

You are part of a team of engineers given the challenge of applying a copper surface to another metal. You can choose the metal item(s) you want to plate and also the chemical solution and timing you think will work best. You will develop two different methods and see which works the best.

Defining the Challenge: Criteria & Constraints

Criteria

- Must develop two different copper plating methods
- Must use a glass container

Constraints

- Use only the materials provided.

Material

Safety Note:

- Have students wear rubber gloves when removing the materials from the solution or when disposing of the solution. This activity should be done in a well-ventilated area as the solution can give off an odor after the plating process.
- Do not use valuable coins, as the finish will be altered and may impact collectible coin value.
- Students should not drink the lemon juice or vinegar solution either before or after coins have been submerged.

Material

Required Materials (per team)

- Rubber gloves
- Glass jars (jelly or canning jars work well)
- 25 pennies, euros, or any other coin with copper coating

Required Materials (Table of Possibilities)

- Iron nails, screws or bolts (not galvanized)
- Salt
- White/clear vinegar
- Lemon juice
- Orange juice
- Baking soda
- Scouring pad
- Water

Testing Materials and Process

Testing Material

- Rubber gloves
- Water source
- Bucket or sink area
- Hundreds of dirty pennies, euros or other coins or materials with a high copper surface content

Testing Process

Several methods will be successful at removing a layer of copper from the pennies or other copper surfaced items and transferring the copper to

Testing Materials and Process

- Remove the iron item and use a scouring pad to remove some of the coating and then place back in the jar.
- Add the coins and let the solution sit for 15 minutes.
- The coins should be shiny and the iron item should have a thin coating of copper.

Dispose of solutions in a sink (they will likely have a strong smell). If the pennies are not rinsed in water after the testing, they will turn bluegreen after a few days.

Testing Materials and Process

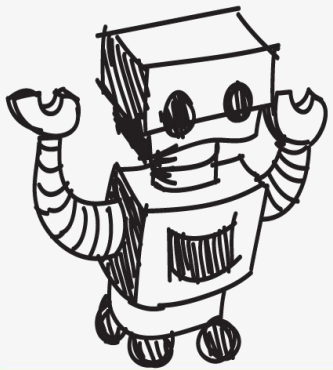
another metal item. See a suggested solution below. Consider if you want to provide these methods to the teams or whether you would like teams to come up with a solution on their own. Be sure to review and supervise ALL solutions developed for safety.

- Solution:
  - Put 25 pennies (or other coins or materials with high external copper content) into a glass jar with 1/2 cup (125 ml) of white vinegar and 1/4 teaspoon (1ml) of salt.
  - Let the solution sit for 5 minutes, then add an iron nail, screw, or other item (not galvanized) for another 5 minutes.

Consider...

- Before you get started, consider looking at several different screws or nails with different finishes and ask them why different finishes are manufactured.

Reflect & Debrief



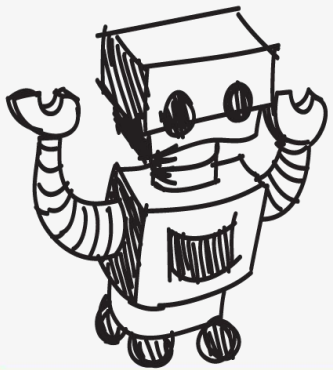
Reflection

- Was your team able to copperplate a metal item? What factors do you think contributed to the success or failure of your method?
- If you found you needed to make changes to your method after listening to the methods planned by other teams, describe why your team decided to make revisions.
- Which method that another team adopted was the most successful? Why do you think this method worked so well?
- Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

Reflection

- Do you think that chemical engineers have to make many attempts to achieve a goal? What do you think it would be like to fail over and over before having success?
- What industry or business do you think might want to use the method you developed?

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

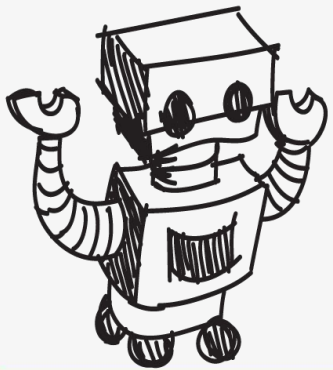
- Divide into teams
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

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



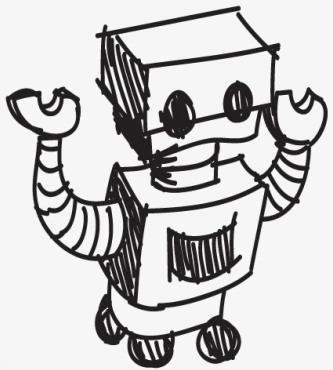
Vocabulary

- Chemical: Any substance (as an acid) that is formed when two or more other substances act upon one another or that is used to produce a change in another substance.
- Constraints: Limitations with material, time, size of team, etc.
- Copper: A reddish brown metal that is one of the chemical elements
- Copperplate: Applying a copper surface to another metal.
- 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).

Vocabulary

- 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.
- Solution: A mixture of two or more substances that stays evenly mixed.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- NASA Corrosion Technology Laboratory (http://corrosion.ksc.nasa.gov)

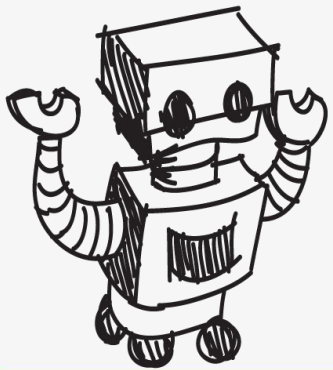
Recommended Reading

- Electroplating Engineering Handbook (ISBN: 978- 1475708561)
- The Polishing and Plating of Metals (ISBN: 978- 1246867176)
- Electro-deposition of Metals (ISBN: 978- 1176590250)

Writing Activity

Write an essay or a paragraph about why nails used in construction are galvanized.

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)

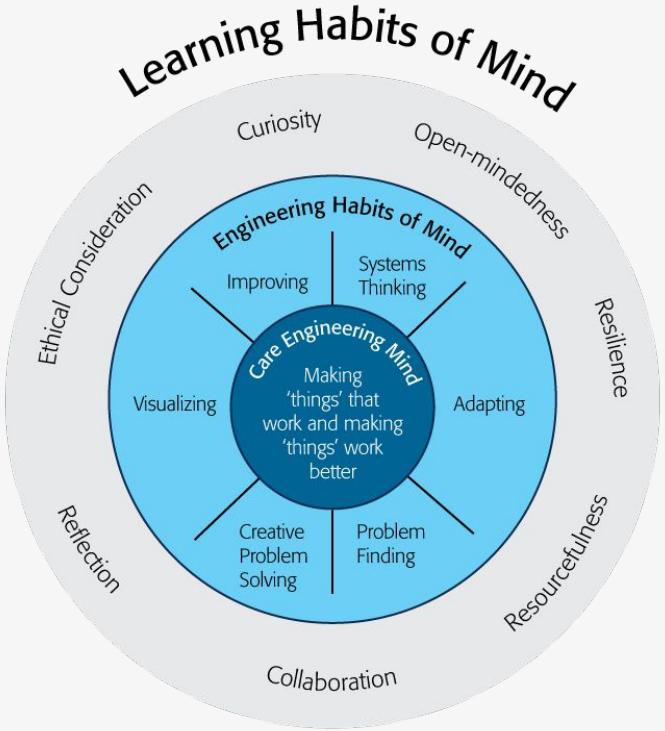
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with chemical materials or even bio materials. Here are just some of the related engineering fields.
  - Chemical Engineering
  - Bioengineering

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

Engineering Habits of Mind



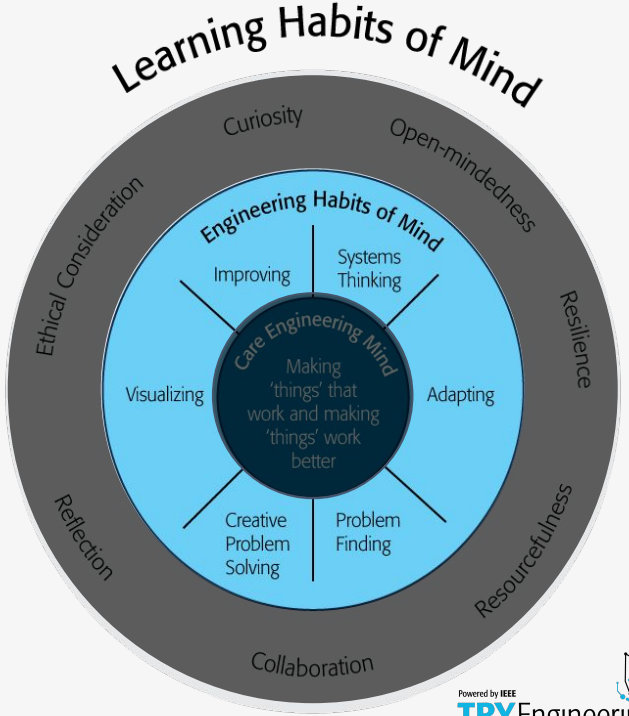
Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

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

Powered by IEEE TRYEngineering | IEEE

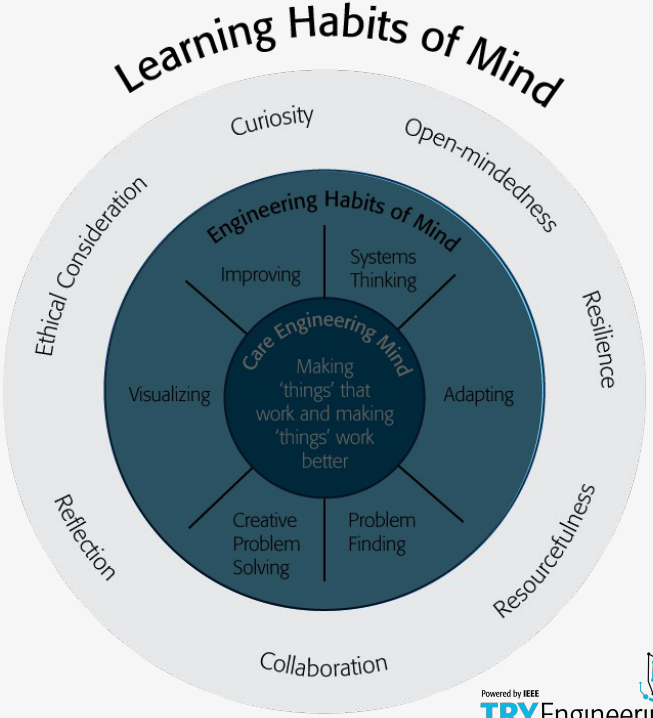
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

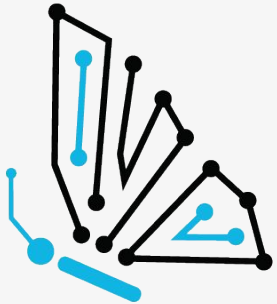


Greatest Engineering Achievements of the 20th Century

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