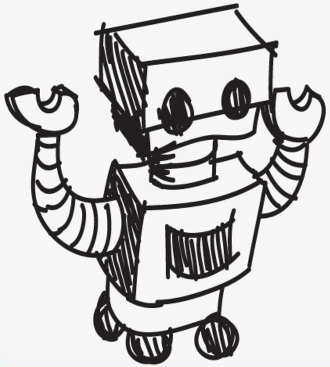
Lesson Plan:

Blast Off!

The Design Challenge



The Design Challenge

You are part of a team of engineers given the challenge of building a model rocket launcher and designing and building a rocket that can rise the highest and straightest compared with other student teams in your class.

Defining the Challenge: Criteria & Constraints

Criteria

- Designed to rise the highest and straightest

Constraints

- Use only the materials provided.

Material

Materials – Required

Model Rocket Kit

- Estes (www.estesrockets.com)
- Model Rockets (www.modelrockets.co.uk)
- Local hobby shops

Optional Materials

Internet access to explore www.grc.nasa.gov/WWW/K-12/rocket/ for research and to use online rocket simulator

Safety Considerations

- Teachers and students should be aware that most commercially available rockets generate considerable heat. Great care should be exercised to follow the manufacturer’s instructions closely.
- Students and the teacher in charge should read and follow the rocket manufacturer’s instructions CAREFULLY.
- Teachers who have never supervised a rocket launch may want to team with a teacher who has for their first launch.
- Be sure to follow your school's safety policies.
- Launching should be done outdoors.

Safety Considerations

- Students and others who are not actively involved in launching the rocket should be kept at least 250 feet from the launch area.
- All members of the launch team should wear protective eye shields.
- Rockets of the type illustrated are ignited electrically by a pair of wires about 20 ft long. Launch team should stand behind a protective barrier. They could even sit inside a car, if necessary.
- Note that an alternative to rocket launch kits would be to use a foot pump and launch an air rocket (using an empty soda bottle or other container for the rocket).

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Testing Materials and Process

Testing Material

- Rocket launcher
- Rocket
- Safety goggles
- Protective barrier, if necessary
- Outdoor space and a nice day

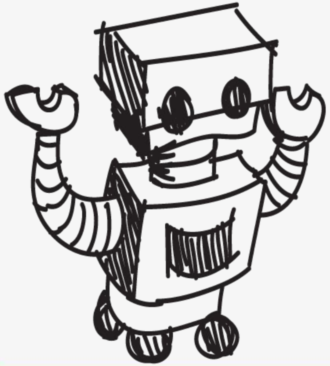
Testing Process

Test the rockets by following the launching instructions on the rocket launcher kit paying close attention to the safety considerations.

Consider...

- Before you get started building, consider how you think a rocket can fly and how engineers have to consider payload, weather, and the shape and weight of a rocket when developing a new or re-engineered rocket design.
- Discuss how you'll work together to build your rocket launcher. You should estimate how high you believe your rocket will travel. You should think about what you can do in your design to ensure your rocket will go higher and straighter.

Reflect & Debrief



Reflection

- How did the height you estimated your rocket would reach compare with the actual estimated height?
- What do you think might have caused any differences in the height you achieved?
- Did your rocket launch straight up? If not, why do you think it veered off course?
- 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?
- Did you adjust your model rocket at all? How? Do you think this helped or hindered your results?

Reflection

- How do you think the rocket would have behaved differently if it were launched in a weightless atmosphere?
- What safety measures do you think engineers consider when launching a real rocket? Consider the location of most launch sites as part of your answer.
- When engineers are designing a rocket which will carry people in addition to cargo, how do you think the rocket will change in terms of structural design, functionality, and features?

Reflection

- Do you think rocket designs will change a great deal over the next ten years? How?
- What tradeoffs do engineers have to make when considering the space/weight of fuel vs. the weight of cargo?

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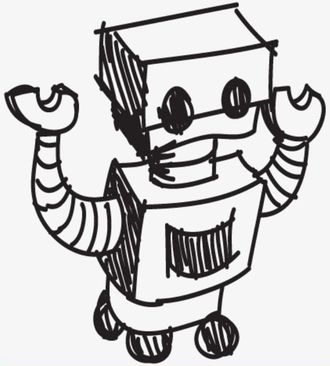
Engineering Design Process



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

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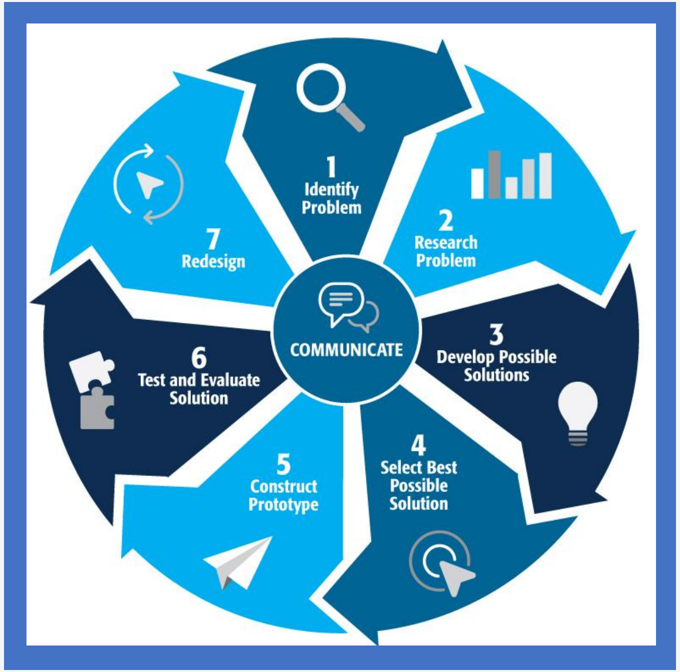
Engineering Design Process

- 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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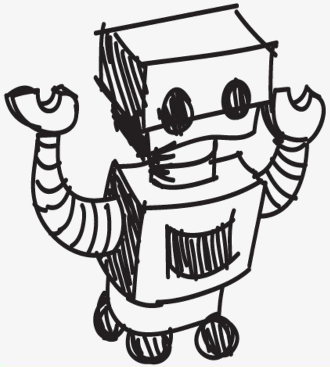
Productive Failure

- 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

- 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.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Payload: Amount of goods carried by a vehicle, aircraft or spacecraft

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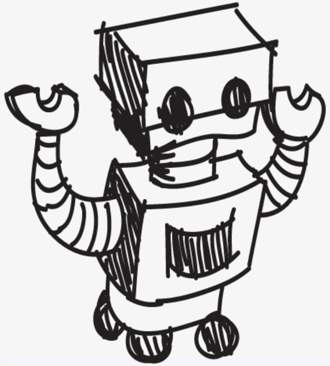
Vocabulary

- Prototype: A working model of the solution to be tested.
- Rocket: A flying device, shaped like a tube, that is driven by hot gases released from engines in its rear.



Dig Deeper

Dig Deeper into the Topic

Internet Connections

- Timeline of Rocket History (http://history.msfc.nasa.gov/rocketry/)
- NASA Beginners Guide to Rockets (www.grc.nasa.gov/WWW/K-12/rocket/bgmr.html)
- Virgin Galactic Human Space Flight (www.virgingalactic.com/human-spaceflight)
- NASA Parker Solar Probe (www.nasa.gov/content/goddard/parker-solar-probehumanity-s-first-visit-to-a-star)

Dig Deeper into the Topic

Recommended Reading

- Make: Rockets: Down-to-Earth Rocket Science (ISBN: 978-1457182921)
- Handbook of Model Rocketry (ISBN: 978-0471472421)
- "A Pictorial History of Rockets" (www.nasa.gov/pdf/153410main_Rockets_History.pdf)

Writing Activity

Write an essay or a paragraph describing an example of rockets might be used to help society in peaceful times.

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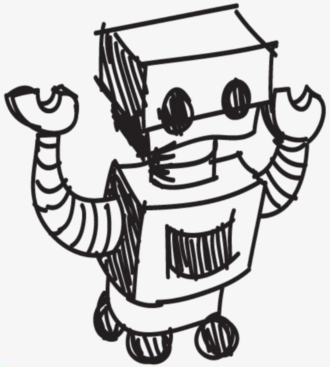
Engineering Fields



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 rockets and aerospace. Here are just some of the related engineering fields.
    - Aerospace engineering
    - Mechanical Engineering
    - Electrical Engineering

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

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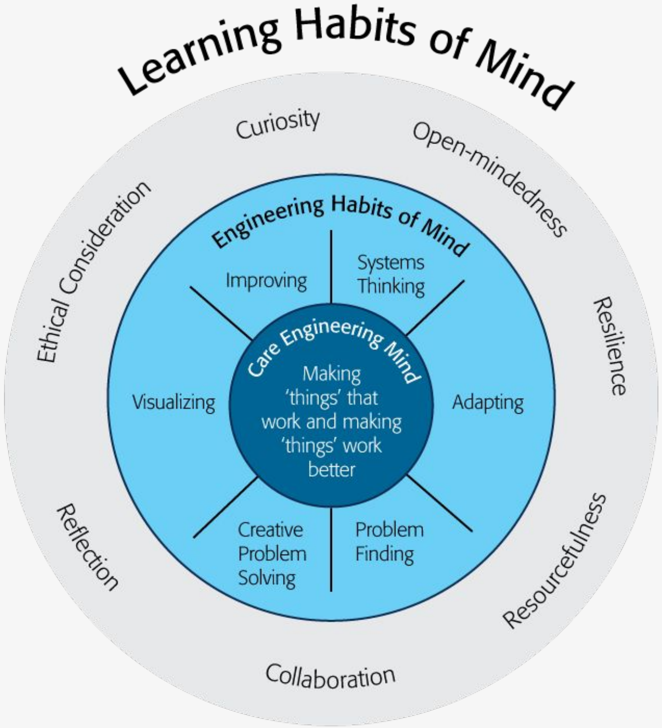
Engineering Habits of Mind

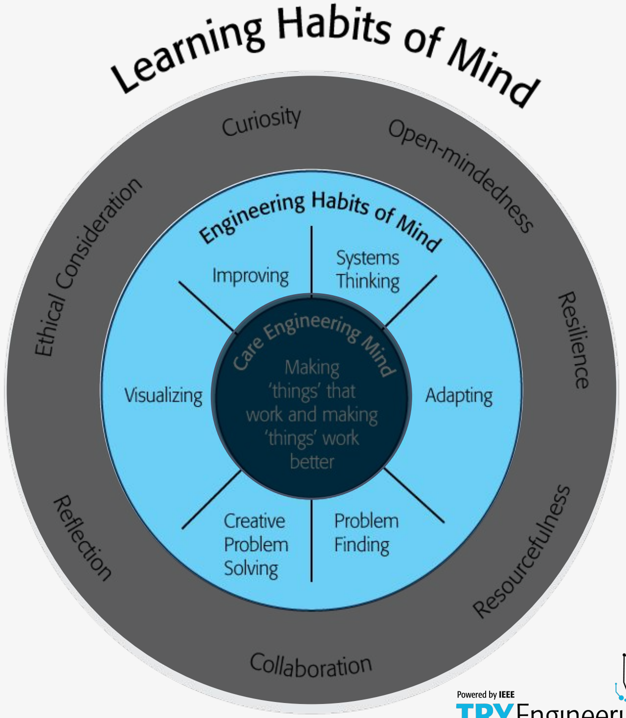


Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

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**



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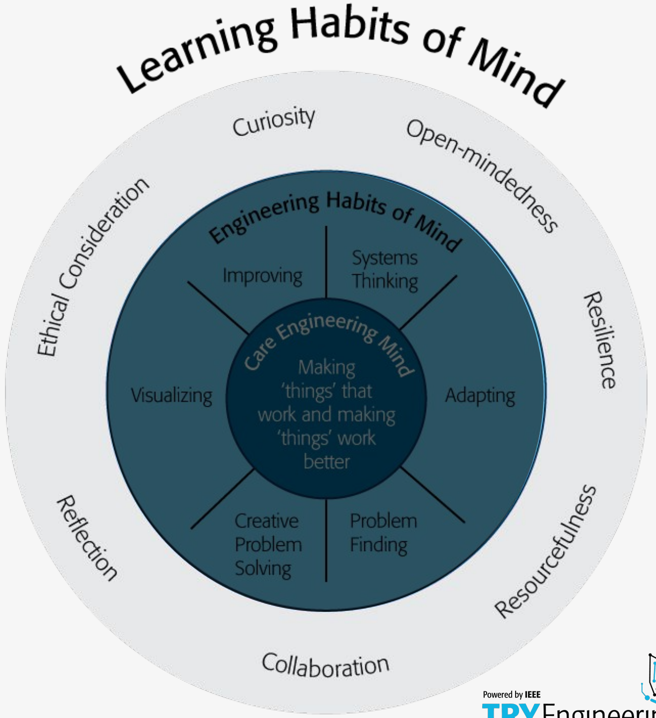
Learning Habits of Mind Checklist

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



Greatest Engineering Achievements of the 20th Century


Greatest Engineering Achievements
OF THE 20^{TH} 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

Greatest Achievements

Source: http://www.greatachievements.org/

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For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE’s TryEngineering.org

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