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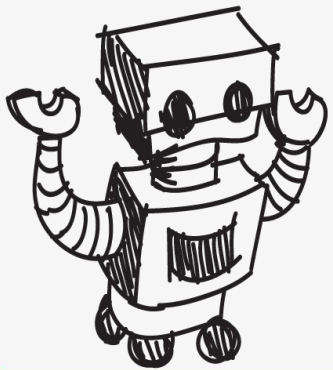
TRY Engineering

Lesson Plan:

Designing Drones

The Design Challenge



The Design Challenge

- You are a team of engineers given the challenge of creating a rotor out of simple materials that falls as slowly as possible. You may use any materials provided to you and will first work as a team to review a sample template and develop your own design for a rotor.

Defining the Challenge: Criteria & Constraints

Criteria

- Design rotor to drop the slowest from a height of 10 feet

Constraints

- Use only the materials provided.
- Teams may trade unlimited materials.

Material

Required for Build – per team

- Sample templates (included in the Student Worksheet)
- Paperclips
- Paper
- Index Card Paper
- Construction Paper
- Cardboard in a range of thicknesses
- Foam sheets

Material

Optional Kit

- If budgets allow, and as an extension idea, there are several kits to allow teams of students to build and even program a drone. The costs for these kits are continuing to drop at the basic level. At the moment you can get a basic but good drone kit for between $30-50. When using drone kits, be sure to arrange for a large open space where no people could possibly be in the way of the flying drone. A large school field is recommended and be sure to get approval from school administration.
- Sky Viper s1750 Stunt 2017 Edition Drone ($50)
- Syma X11 R/C Quadcopter ($30)
- Holy Stone HS170 Predator Mini RC Helicopter Drone ($40)

Testing Material Process

Testing Material

- Chair or step stool
- Measuring tape

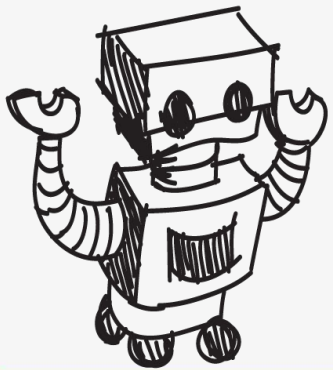
Testing Process

Test the rotors by standing on a chair or step stool and dropping each rotor from a height of ten feet. Teams should record the amount of time it takes for their rotor design to reach the floor. Each team may test their rotor three times and the slowest flight of the three should be used when comparing results to other teams.

Consider...

- Before you get started building, consider how a helicopter flies. Discuss how wing shape and length, center of gravity, and the overall weight might impact flight.
- Investigate the many different ways helicopters are used around the world. Read the NASA resource on helicopters at: www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-helicopter-58.html.

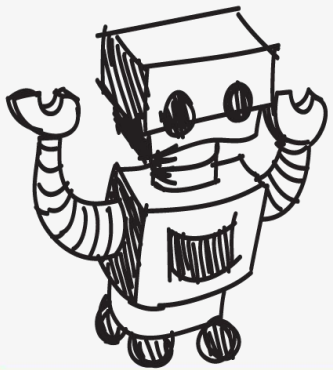
Reflect & Debrief



Reflection

- What aspect(s) of the design led to the success of the rotor that flew for the longest time?
- Describe one part of your design that you think worked the best.
- If you had a chance to do this project again, what would your team have chosen to do differently?
- If you could have selected some building materials which were not made available to you, what would you have selected? Why?
- Do you think this project worked better because you were part of a team, or do you think you could have done a better job working alone?

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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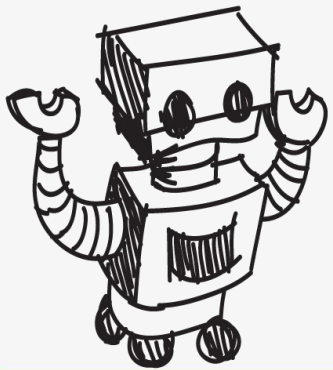
Productive Failure

- 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



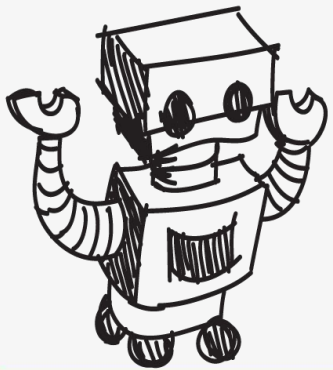
Vocabulary

- Aerodynamic: The qualities of an object that affect how easily it is able to move through the air.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Drag: A force that acts opposite to the relative motion of any object moving with respect to surrounding air (or water).
- 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

- Lift: An aerodynamic force that helps to counteract weight. The heavier an object is, the harder it is for lift to work against it and achieve flight.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Prototype: A working model of the solution to be tested.
- Thrust: The forward motion (velocity) or thrust of an aircraft through the air along with the shape of the aircraft and its parts.
- Weight: Everything has weight, which is a result of gravitational forces. The materials selected for a glider design will have a weight that will need to be offset by “lift” in order to fly.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- NASA What is a Helicopter (www.nasa.gov/audience/forstudents/5-8/features/nasaknows/what-is-a-helicopter-58.html)
- NASA Updrafts and Downdrafts (www.grc.nasa.gov/www/k12/airplane/move4.html) FAA Unmanned Aircraft Systems (www.faa.gov/uas)

Recommended Reading

- "How Do Helicopters Work?" by Jennifer Boothroyd (ISBN: 978-1467707848)
- "How Does a Helicopter Work?" by Sarah Eason (ISBN: 978-1433934650)

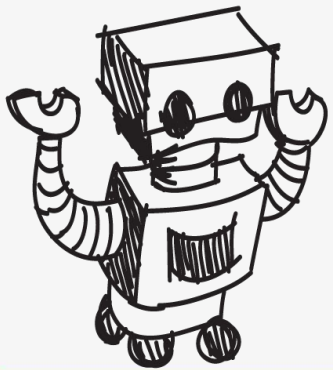
Dig Deeper into the Topic

- “Flight” by Philip Wilkinson (ISBN: 978-0195219968)
- “Drones: An Illustrated Guide to the Unmanned Aircraft that are Filling Our Skies” by Martin J. Dougherty (ISBN: 978-1782742555)

Writing Activity

Write an essay or a paragraph describing a situation where a helicopter or drone would be a more efficient flight vehicle than a plane. Or, write an essay about how drones are used in agriculture or by real estate salespeople.

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 the engineering and design of flying vehicles like drones. 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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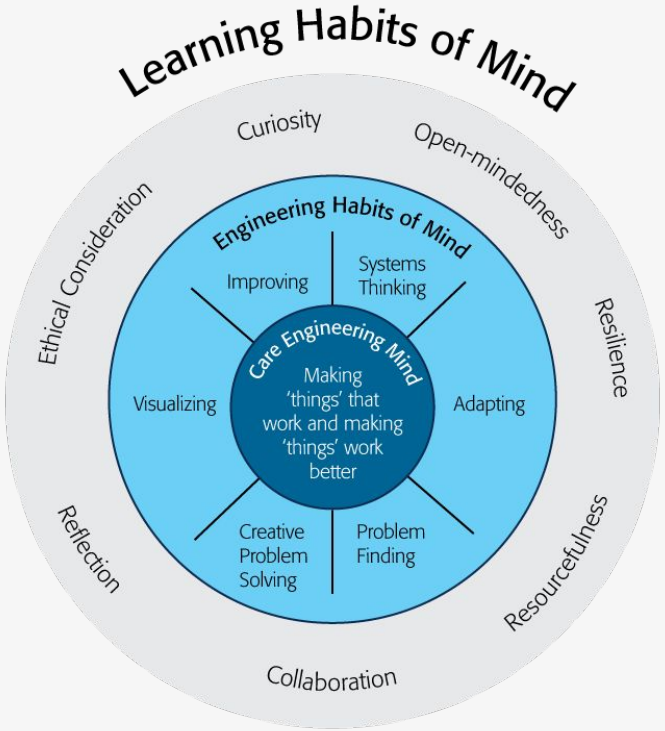
Engineering Habits of Mind



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)

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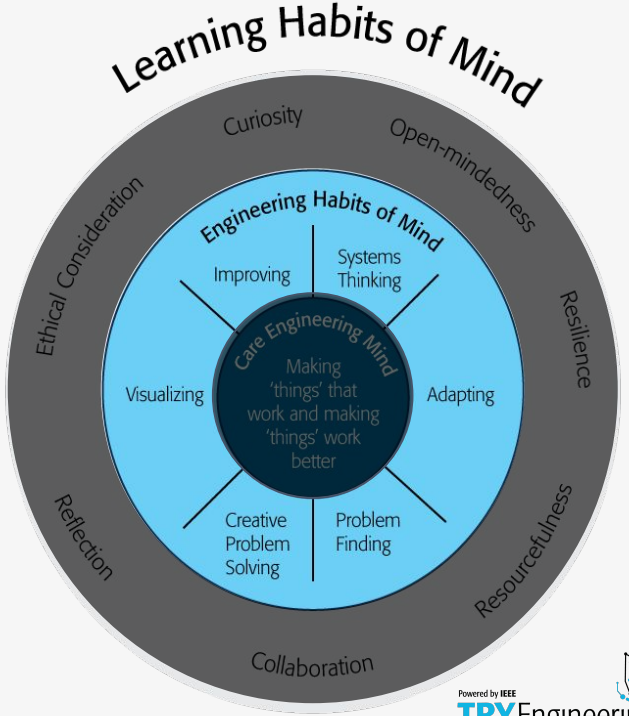
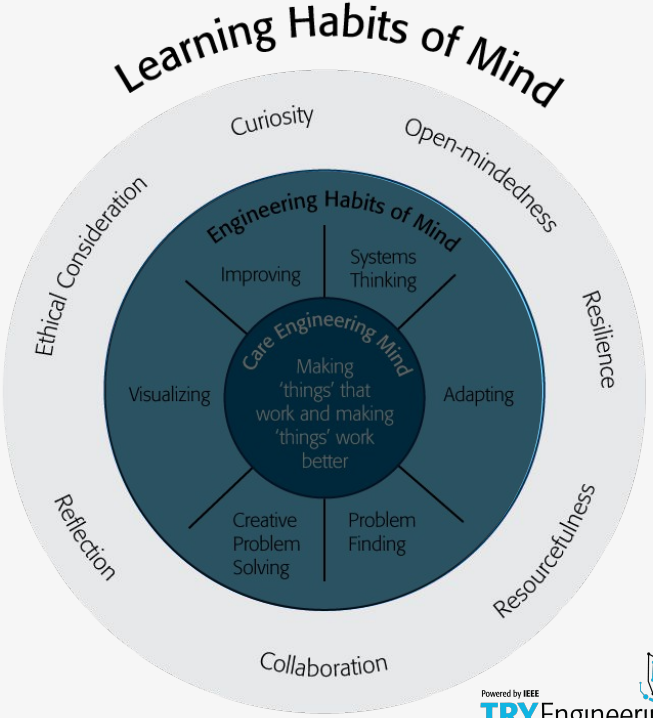
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

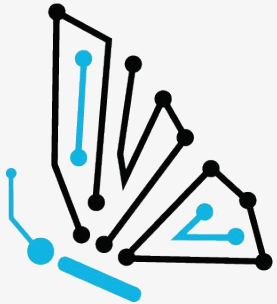


Greatest Engineering Achievements of the 20th Century

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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