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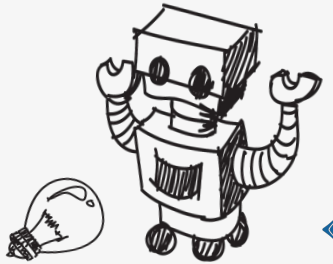
TRY Engineering

Lesson Plan:

Solar Structures



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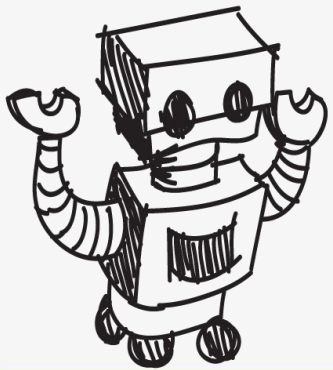
The Design Challenge



The Design Challenge

You are a team of engineers who have been given the challenge to design a passive solar house. The house must have 4 walls, at least four windows, 2 functional doors, and a roof. It must be at least 10cm high, 10cm wide and 25cm long. Your design must also include a way to hold a thermometer inside the structure so it can be easily read. Your house will be tested for how well it keeps warm or keeps cool depending on the time of year.

- For cooler months, the goal is to increase and maintain the internal temperature of the house by as much as possible.
- For warmer months, the object will be to limit temperature increase as much as possible.

Defining the Challenge: Criteria & Constraints

Criteria

- Must have 4 walls, at least four windows, 2 functional doors and a roof.
- Must be at least 10cm high, 10cm wide and 25cm long.
- Design should include a way to hold a thermometer inside the structure.

Constraints

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

Material

Materials – Required (Table of Possibilities)

- Cardboard or cereal boxes
- Construction paper
- Plastic/Paper cups
- Sand
- Stones
- Plastic wrap
- Felt
- Light and dark color tempera paint
- Foliage

Testing Materials and Process

Testing Material

- Compass
- Thermometer or temperature strips
- A sunny day

Testing Process

Test the solar house designs by placing each house in the sun (preferably midday) at the desired orientation (typically along the east west axis to take maximum advantage of the sun's orientation) using a compass.

Testing Materials and Process

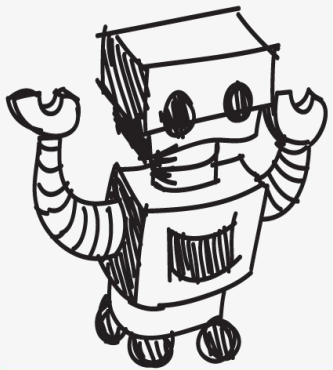
Students should record the initial inside temperature of their house, and then again every 2 minutes for a total of 12 minutes. If time permits, they can then bring their house into the shade and record the temperature every 2 minutes for another 12 minutes.

- If the activity is being conducted during the cooler months, the goal is to increase and maintain the internal temperature of the house by as much as possible.
- If this activity is being conducted during the warmer months the object will be to limit temperature increase as much as possible.

Consider...

- Before you get started building, consider sharing what you already know about green buildings. Discuss how engineering homes to make better use of renewable energy sources such as the sun can make homes more energy efficient and environmentally friendly.

Reflect & Debrief



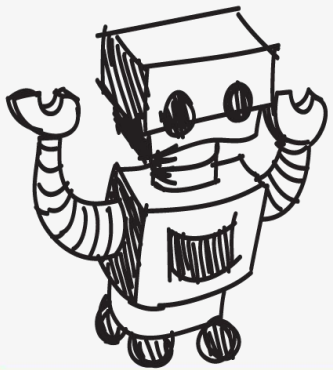
Reflection

- Did you succeed in creating a solar house that could increase and maintain its temperature or keep cool (depending on the time of year)? If not, why did it fail?
- Did you decide to revise your original design or request additional materials while in the construction phase? Why?
- Did you negotiate any material trades with other teams? How did that process work for you?
- If you could have had access to materials that were different than those provided, what would your team have requested? Why?
- Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

Reflection

- If you had to do it all over again, how would your planned design change? Why?
- What designs or methods did you see other teams try that you thought worked well?
- Do you think you would have been able to complete this project easier if you were working alone? Explain…
- What advantages does passive solar building design have?
- What drawbacks does passive solar building design have?

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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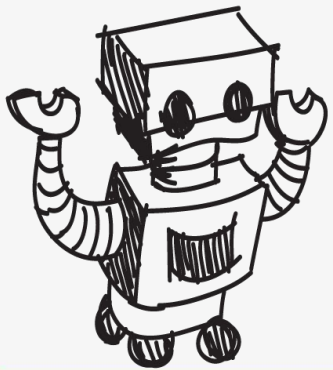
Productive Failure

- 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

- Active Solar Design: Relies on the use of mechanical or electrical devices to convert sunlight into electricity, which can then be used to supply heat or power to a building.
- 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).

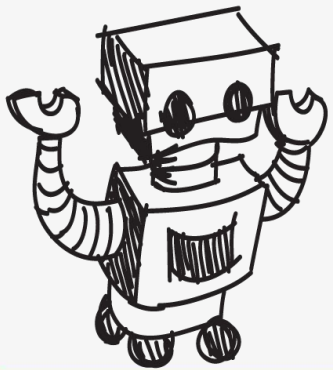
Vocabulary

- Passive Solar Design: Involves selecting and placing design elements and materials to help keep a building warm during the winter months and cool during the summer months.
- Photovoltaics: Refers to the field of science that is concerned with the application of solar cells to generate electricity for use by people
- Prototype: A working model of the solution to be tested.
- Solar: Produced or made to work by the action of the sun's light or heat solar energy.
- Solar cells: Make electricity directly from sunlight.
- Solar energy: Energy generated directly from sunlight.

Vocabulary

- Solar panel: Made of solar cells, which is the part that turns the solar energy in sunlight into electricity.
- Thermal mass: Absorbs and stores the sun's energy as heat for an extended period of time.

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Passive Solar Home (https://www.mnn.com/search?q=passive-solar-homel)
- Carbon Footprint Calculator (https://www.carbonfootprint.com/calculator.aspx)

Recommended Reading

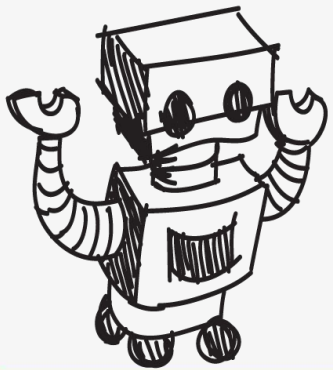
- Passive Solar House: The Complete Guide to Heating and Cooling Your Home. (ISBN: 978-1933392035)

Dig Deeper into the Topic

Writing Activity

Write a real estate advertisement marketing your passive solar house's selling points.

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)

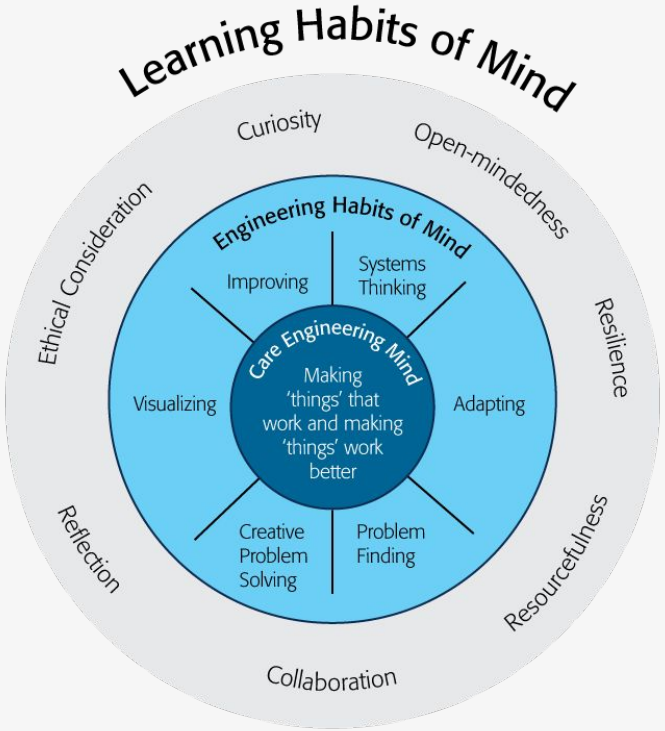
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with solar panels and solar energy. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Electrical 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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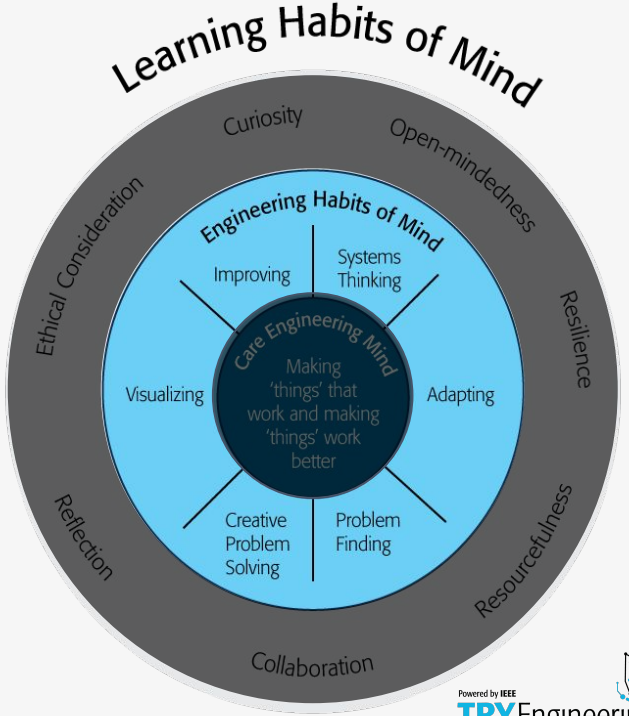
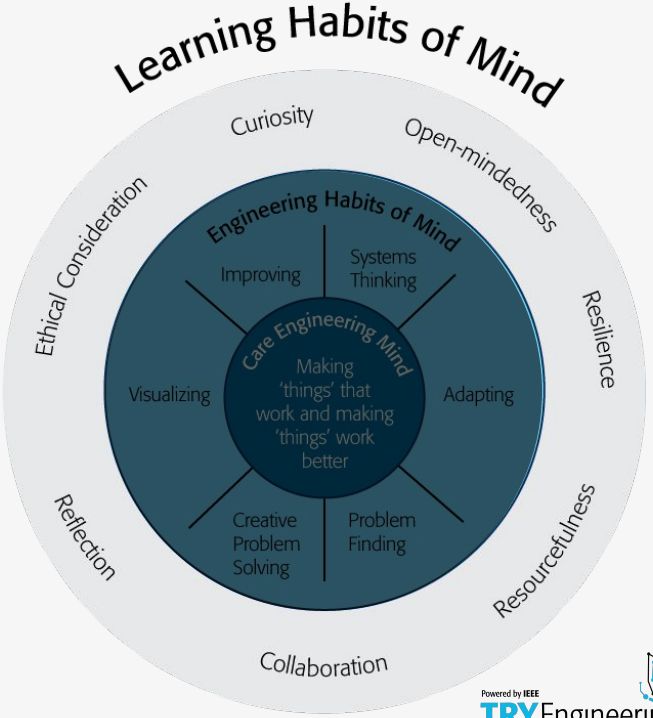
Engineering Habits of Mind Checklist

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



Learning Habits of Mind Checklist

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

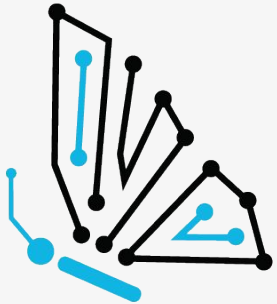


Greatest Engineering Achievements of the 20th Century

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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