



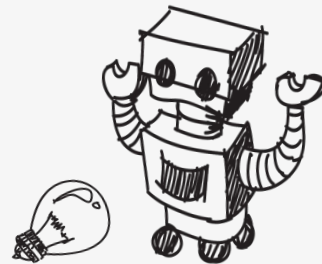
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TRYEngineering



Lesson Plan:

Here Comes the Sun



The Design Challenge



The Design Challenge

You are a team of engineers given the challenge of disassembling a solar powered calculator and exploring the component parts. You'll then study the solar panel and see how it is connected to the other parts of the calculator. As a team, suggest design enhancements to the calculator to improve performance.



Defining the Challenge: Criteria & Constraints

Criteria

- Remove all the small screws that hold the top and bottom together
- Unscrew the circuit board from the front panel
- Be careful touching the solar panel and the LCD (liquid crystal display) as the glass edges may be sharp.

Constraints

- Use only the materials provided.



Material

Materials – Required (Each team)

- One old or new calculator (many are less than \$5) -- look for ones with screws on the back for easy disassembly
- Eyeglass Repair Kit or mini screwdriver (must be very small gauge)

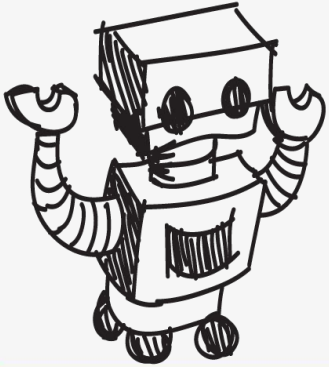


Consider...

- Before you get started building, be sure that you remove all the small screws that hold the top and bottom of the calculator together, some are often hidden under pads or rubber strips. You will need to unscrew the circuit board from the front panel of the calculator too -- there are many screws. You should also be very careful touching the solar panel and the LCD (liquid crystal display) as the glass edges may be sharp.



Reflect & Debrief



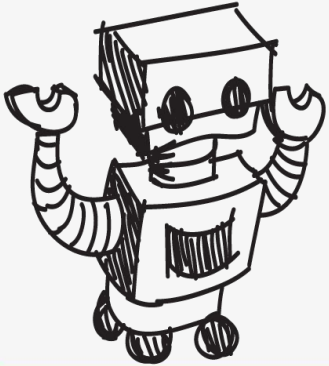
Reflection

Is there anything you would recommend, as part of an engineering team, to improve the functionality of the calculator you disassembled? Attach a drawing or sketch of your proposed component part or improvement, and answer the questions below:

- What new materials will you need (if any)
- What materials or parts will you eliminate (if any)
- How will this new product improve the functionality of a calculator?
- How do you think your new design will impact the cost of this calculator? Why?



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

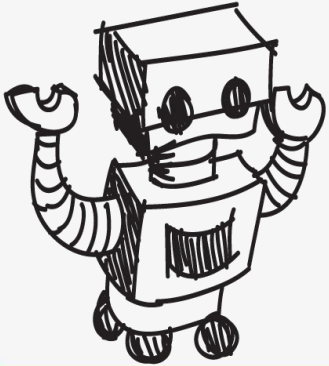


Productive Failure

- 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

- 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).
- 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.

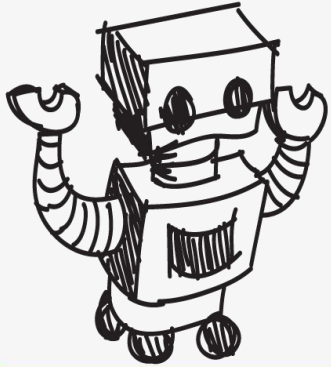


Vocabulary

- Solar cells: Make electricity directly from sunlight.
- Solar energy: Energy generated directly from sunlight
- Solar panel: Made of solar cells, which is the part that turns the solar energy in sunlight into electricity.



Dig Deeper



Dig Deeper into the Topic

Internet Connections

- U.S. Department of Energy, Solar Energy Technologies Program (<https://www.energy.gov/eere/solar/solar-energy-technologies-office>)
- National Renewable Energy Laboratory (www.nrel.gov)
- History of Solar Energy (www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf)

Recommended Reading

- Solar Electricity Handbook, 2010 Edition: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems by Michael Boxwell (ISBN: 978-1907670008)



Dig Deeper into the Topic

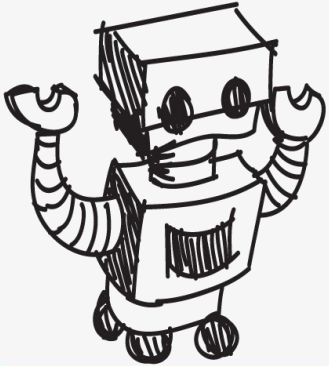
- Power from the Sun: A Practical Guide to Solar Electricity by Dan Chiras (ISBN: 978-0865716216)

Writing Activity

Write an essay or a paragraph describing how solar panels have been engineered into a product you find in your home or school. Explain why solar energy is a good choice for powering this 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)



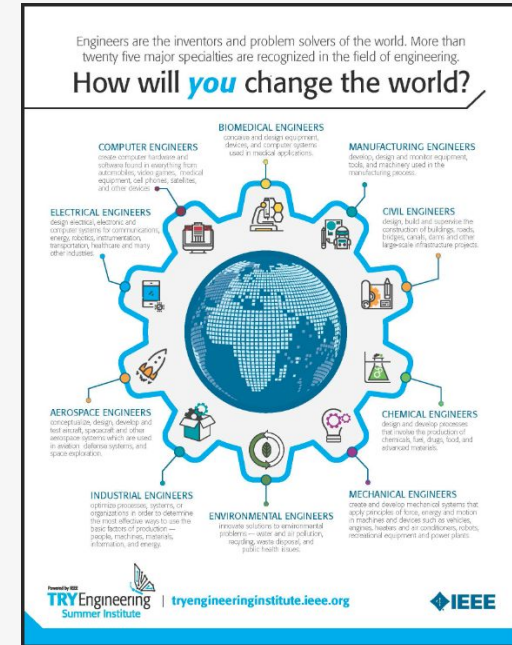
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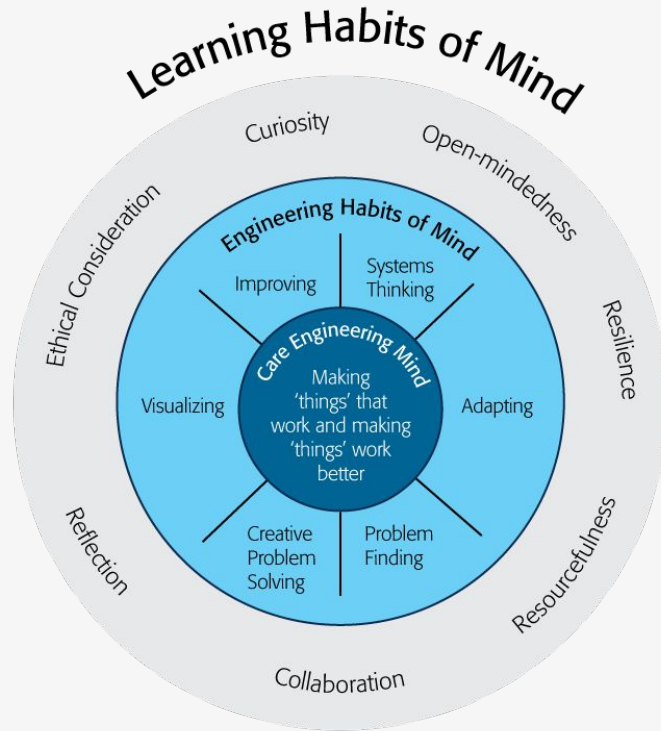


Related Engineering Fields

- There are several types of engineering fields that are involved with solar energy. Here are just some of the related engineering fields.
 - Electrical Engineering
 - Materials Engineering
 - Mechanical 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.

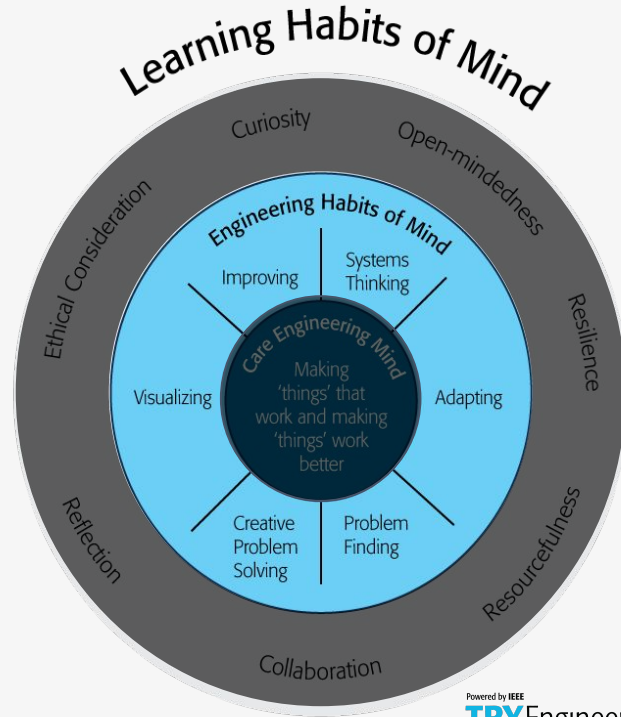
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<https://online-journals.org/index.php/i-jep/article/view/5366>



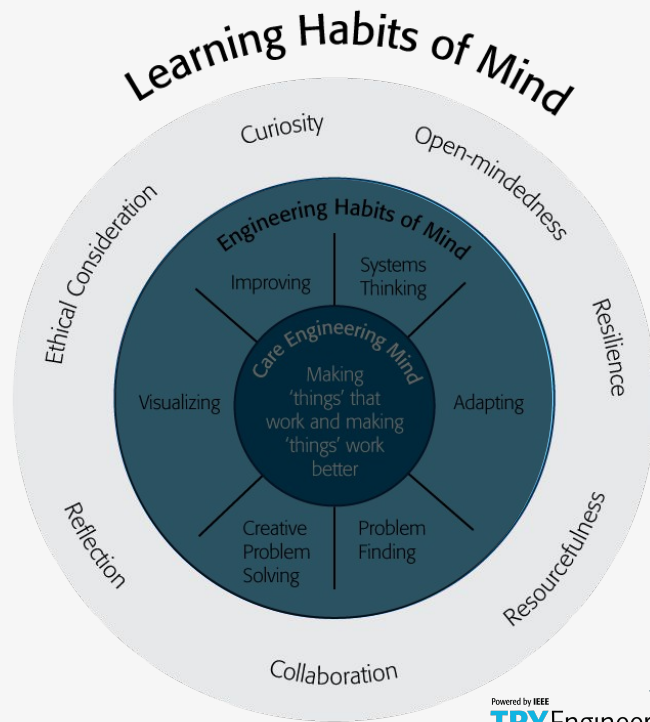
Engineering Habits of Mind Checklist

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



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 20TH 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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Learn more about how engineers make the world a better place



The banner features the NAE logo (three interlocking puzzle pieces) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" and "NATIONAL ACADEMY OF ENGINEERING". Navigation buttons for "Challenges", "News", and "Community" are in the top right. The main visual is a large green puzzle piece on the left containing a nuclear fusion icon, and a network of glowing green lines radiating from a central point on the right. Below the puzzle piece, the text "Provide energy from fusion" is displayed, followed by a paragraph about scaling up fusion. A row of 14 diamond-shaped icons representing various engineering challenges is at the bottom.

NAE GRAND CHALLENGES
FOR ENGINEERING
NATIONAL ACADEMY OF ENGINEERING

Challenges News Community

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.



For more engineering lesson plans and
resources like games, engineering careers,
and STEM opportunities visit IEEE's
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