



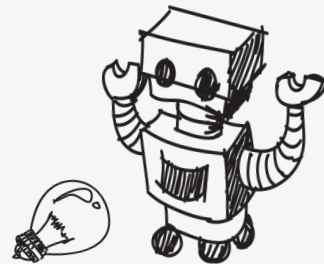
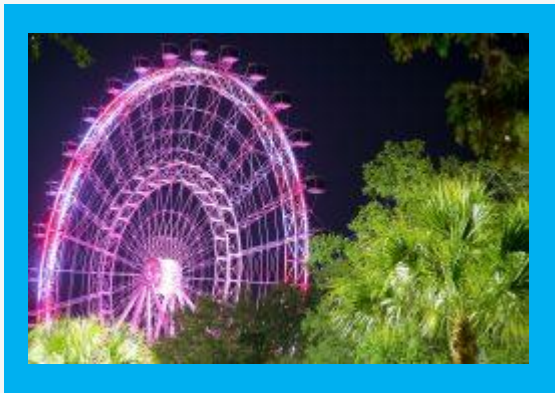
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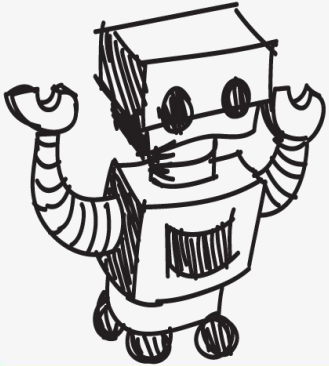


Lesson Plan:

Build a Big Wheel



The Design Challenge



The Design Challenge

- You are a team of engineers working together to design and build a big wheel (aka Ferris wheel).



Defining the Challenge: Criteria & Constraints

Criteria

- Wheel must turn

Constraints

- Must use only the materials provided.
- May trade unlimited materials with other teams.



Material

Required for Build

- Pasta (several bags in various shapes)
- String
- Glue

Optional Materials (Trading/Table of Possibilities)

- Paperclips
- Paper
- Cardboard
- Cardboard Tubes (paper towels/toilet paper)



Testing Material Process

Testing Material

- 4-8 Teabags

Testing Process

Test each design by having the student team demonstrate how their wheel turns. As an added challenge, you can have the teams attach teabags to their design to act as seats.



Consider...

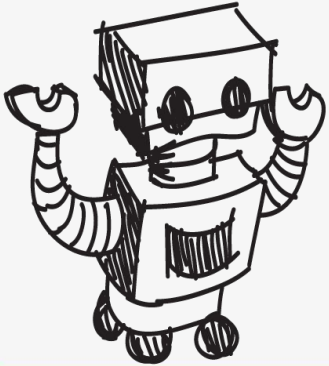
Before you get started building, discuss how the London Eye works. Also see the topics in the Background Concepts section.

- <https://adventure.howstuffworks.com/london-eye.htm>



continued on next page

Reflect & Debrief



Reflection

- Did you succeed in creating a "big wheel" that could turn? If not, why did it fail?
- Did you need to request additional or different shapes of pasta while building the wheel? If so, what happened between the design (drawing) and the actual construction that changed your material needs?
- Do you think that engineers have to adapt their original plans during the manufacturing process? Why might they?
- If you had to do it all over again, how would your planned design change? Why?



Reflection

- What designs or methods did you see other teams try that you thought worked well?
- Did you find that there were many designs in your classroom that met the project goal? What does this tell you about engineering plans?
- Do you think you would have been able to complete this project easier if you were working alone? Explain...
- How do you think the engineering designs for "big wheels" have changed over time?
- What impact has the development of new materials had on the engineering plans for "big wheels?"

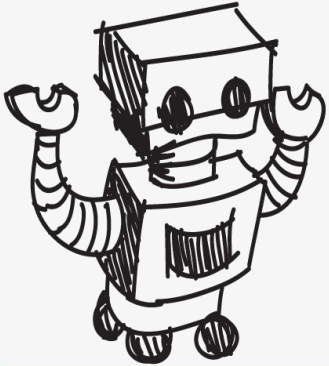


Reflection

- How have these engineering improvements changed the experience of those riding on the "big wheels?"
- What engineering considerations are needed in big wheel design to accommodate riders in wheelchairs?
- Do you think that the expectations of riders have impacted the designs of "big



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

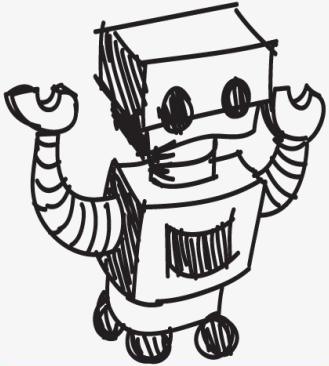


Productive Failure

- 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

- Big wheel: An amusement-park or fairground ride consisting of a giant vertical revolving wheel with passenger cars suspended on its outer edge (also known as a Ferris Wheel)
- Central hub: Middle of wheel connecting the spindle and spokes.
- 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.

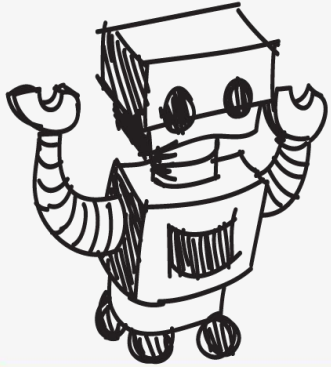


Vocabulary

- 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.
- Spindle: A slender rounded rod with tapered ends where the spokes attach.
- Spokes: Each of the bars or wire rods connecting the center of a wheel to its outer edge



Dig Deeper



Dig Deeper into the Topic

Internet Connections

- London Eye (United Kingdom) (www.londoneye.com)
- Singapore Flyer (Singapore) (www.singaporeflyer.com)

Recommended Reading

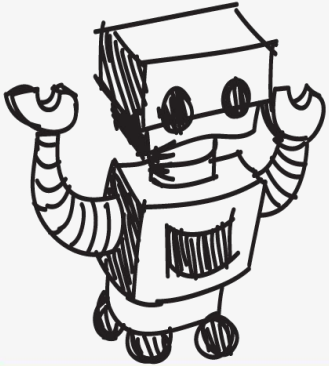
- The 50 Biggest Ferris Wheels Ever Built (ISBN: 978-1517634704)
- Ferris Wheels: An Illustrated History (ISBN: 978-0879725327)
- The Fantastic Ferris Wheel: The Story of Inventor George Ferris (ISBN: 978-1627790727)

Writing Activity

- Write an essay or a paragraph about the engineering challenges faced during the construction of either the London Eye or the Singapore Flyer.



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.

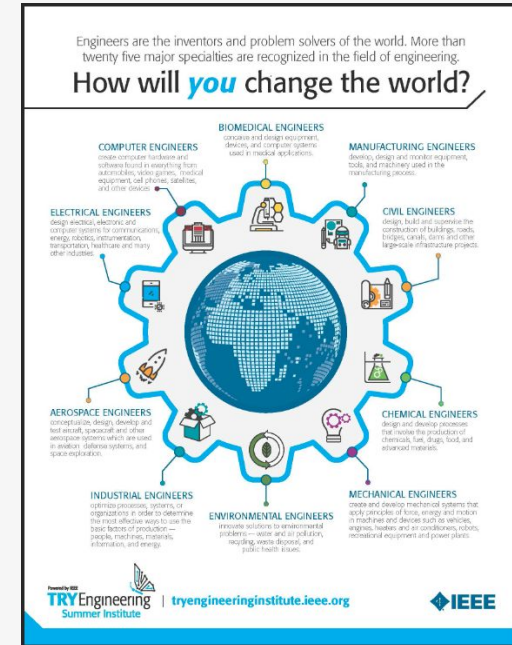
(Video 3:43)



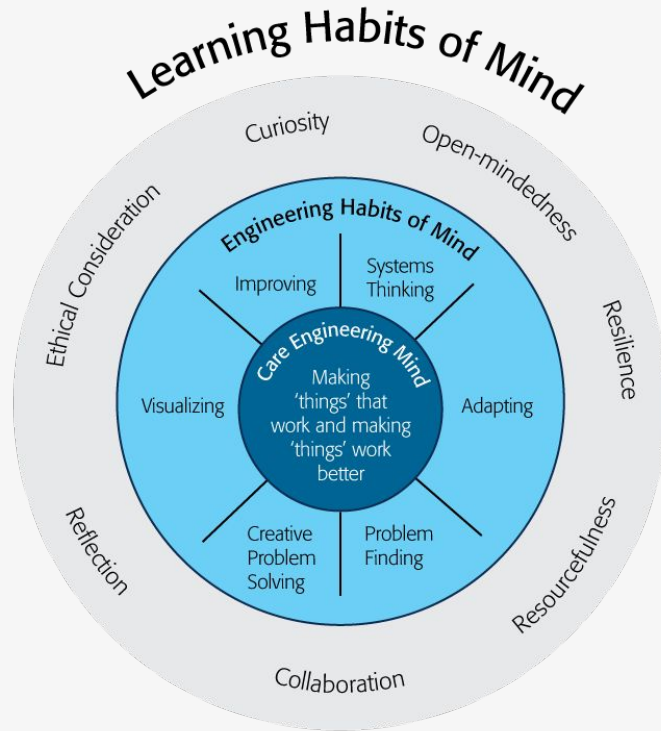
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvGmVo>

Related Engineering Fields

- There are several types of engineering fields that are involved with Ferris wheel engineering and design. Here are just some of the related engineering fields.
 - Civil engineering
 - 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.

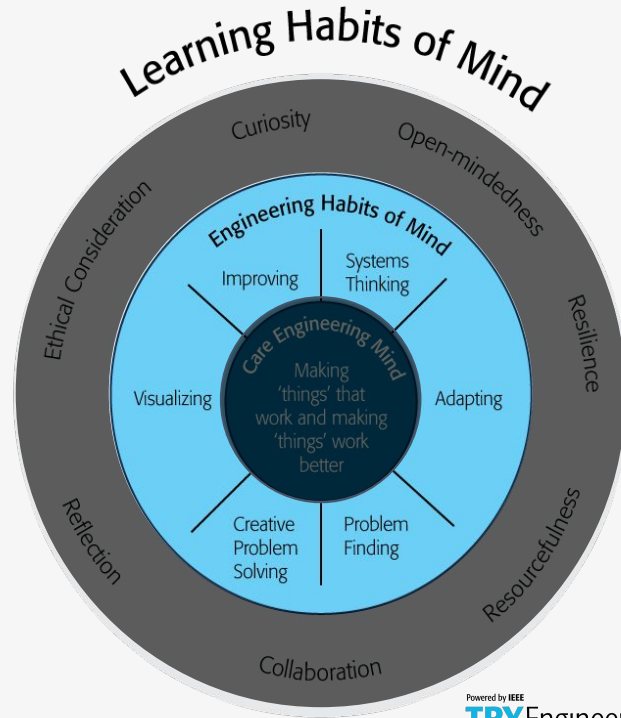
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<https://online-journals.org/index.php/i-jep/article/view/5366>



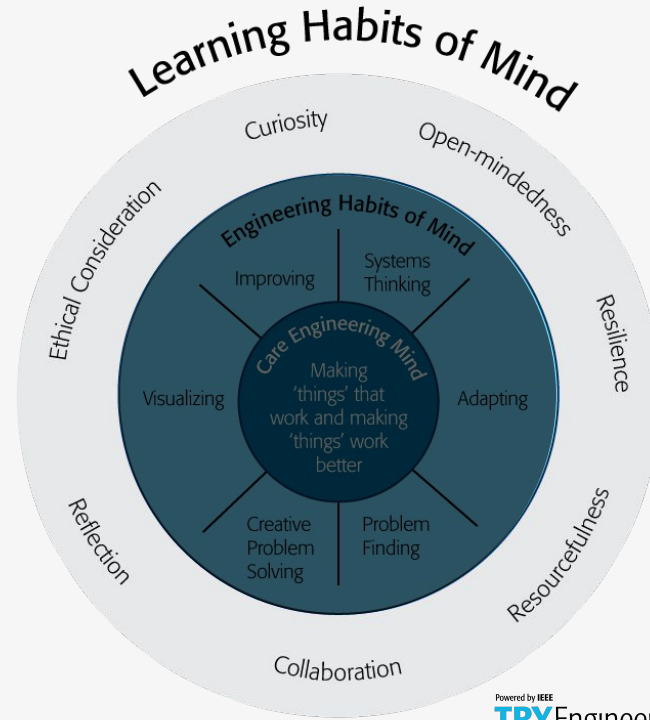
Engineering Habits of Mind Checklist

- ❑ 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

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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 in blue, green, and yellow) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" and "NATIONAL ACADEMY OF ENGINEERING". Navigation buttons for "Challenges", "News", and "Community" are in green. The main visual is a large green puzzle piece on the left with a white atomic symbol, and a network of glowing green lines radiating from a central point on a dark background. Below this, the text "Provide energy from fusion" is displayed, followed by a paragraph about scaling up fusion. A row of 15 diamond-shaped icons represents various engineering challenges, including a smartphone, VR, a lightbulb, a bridge, a water drop, a nuclear symbol, a CO2 canister, a microscope, a brain, a laptop, a padlock, a gear, a circular arrow, and a DNA helix.

NAE GRAND CHALLENGES
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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
[TryEngineering.org](https://www.tryengineering.org)

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