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TRYEngineering



Lesson Plan:

Engineered Music



The Design Challenge



The Design Challenge

You are a team of engineers who have been given the challenge of building a new musical instrument that can repeat a pattern of three different sounds , three times. The new instrument must be "tunable" and must also be unique from other instruments.



Defining the Challenge: Criteria & Constraints

Criteria

- Repeat a pattern of three different sounds, three times
- Must be “tunable”
- Must be unique from other instruments

Constraints

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



Material

Materials – Required (Table of Possibilities)

- String
- Paperclips
- Paper
- Cardboard
- Cardboard tubes (paper towel or toilet paper rolls)
- Rubber bands
- Wire or pipe cleaners



Material

Materials – Required (Table of Possibilities)

- Aluminum foil
- Plastic wrap
- Empty juice boxes
- Wooden dowels
- Non-toxic glue



Testing Materials and Process

Testing Material

- Instrument designs

Testing Process

Teams test their instrument designs by playing a pattern of three different sounds, three times. Team members may take turns demonstrating the instrument. If the team has designed an instrument that requires the instrument be put in or near their mouth, one team member should be selected to play in the instrument. Students should document how unique their design is.

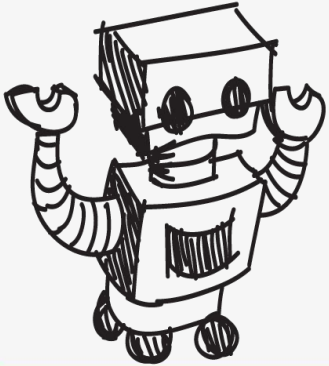


Consider...

- Before you get started building, consider how different instruments work and how you might “tune” them to make sounds.



Reflect & Debrief



Reflection

- Did you succeed in creating an instrument that could repeat a pattern of three different sounds three times? If not, why did it fail?
- Did you need to request additional materials while building your instrument?
- Did you negotiate any material trades with other teams? How did that process work for you?
- Do you think that engineers have to adapt their original plans during the manufacturing process of instruments or other 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...
- How do you think the engineering designs for musical instruments have changed over time? What impact has the development of new materials had on the engineering plans for musical instruments?

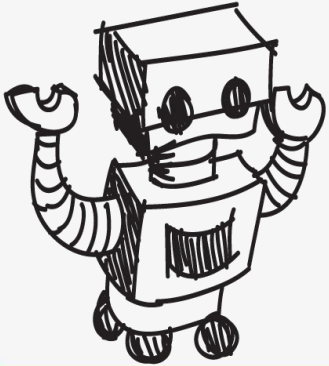


Reflection

- What impact has the development of electronics had on the engineering plans for musical instruments?
- What engineering considerations are needed in musical instrument design to accommodate physically challenged musicians?



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

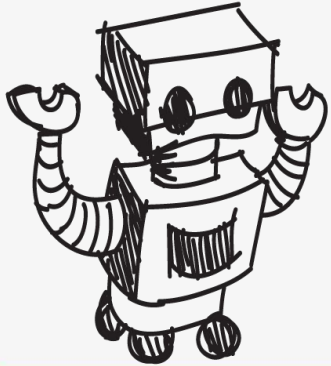


Productive Failure

- 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.
- Key: When the notes of a song are centered around a certain note or class of notes that sound "right" when played.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).

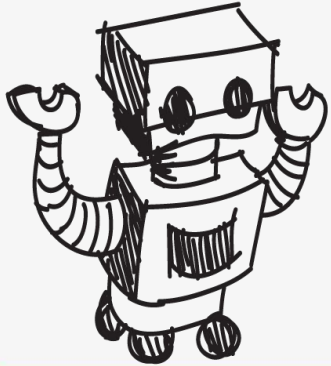


Vocabulary

- Note: A small bit of sound, similar to a syllable in speaking a language
- Pitch: Highness or lowness of sound
- Prototype: A working model of the solution to be tested.
- Tunable: Able to correct musical pitch or key.



Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Musical Instruments of the World (www.asza.com/ihm.shtml)
- Museum of Musical Instruments (www.themomi.org)
- How Recorders Work (www.flute-a-bec.com/acoustiquegb.html)

Recommended Reading

- The Physics of Musical Instruments (ISBN: 0387983740)
- Music, Physics and Engineering (ISBN: 0486217698)
- Teaching Kids Recorder (ISBN: 0595367437)



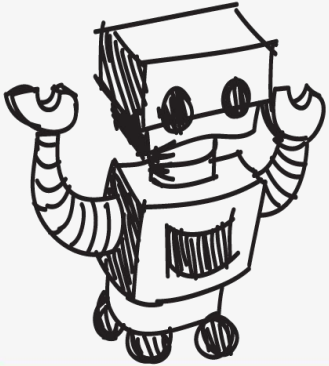
Dig Deeper into the Topic

Writing Activity

Pick a country or culture at a point three hundred years ago and write an essay or a paragraph about the challenges they might face finding materials to make a specific musical instrument (trombone, piano, guitar - for example).



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.

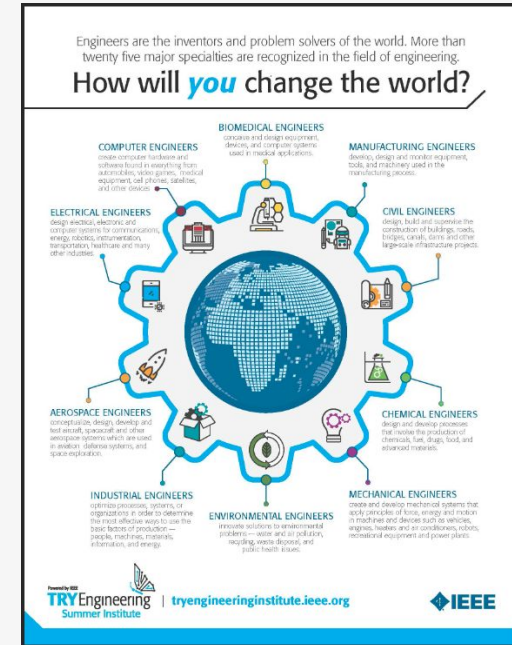
(Video 3:43)



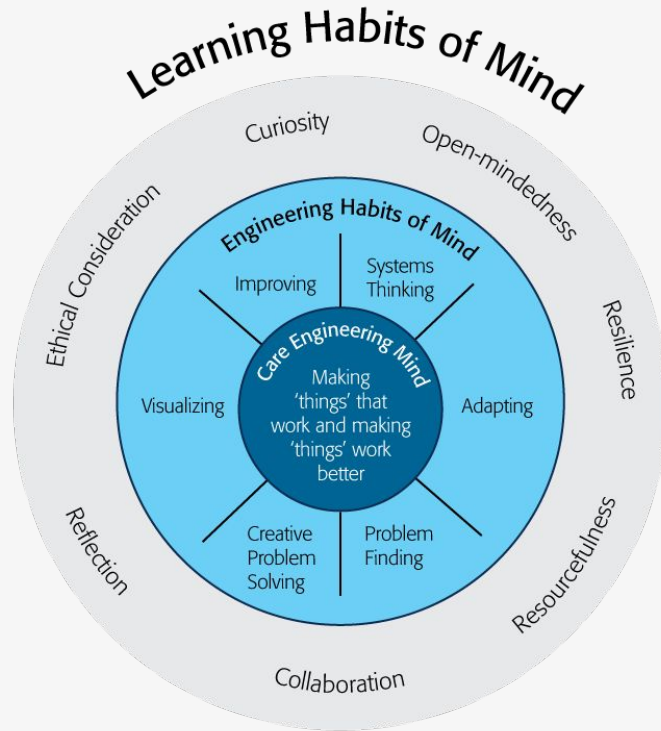
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvGmVo>

Related Engineering Fields

- There are several types of engineering fields that are involved with the design of musical instruments. 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.

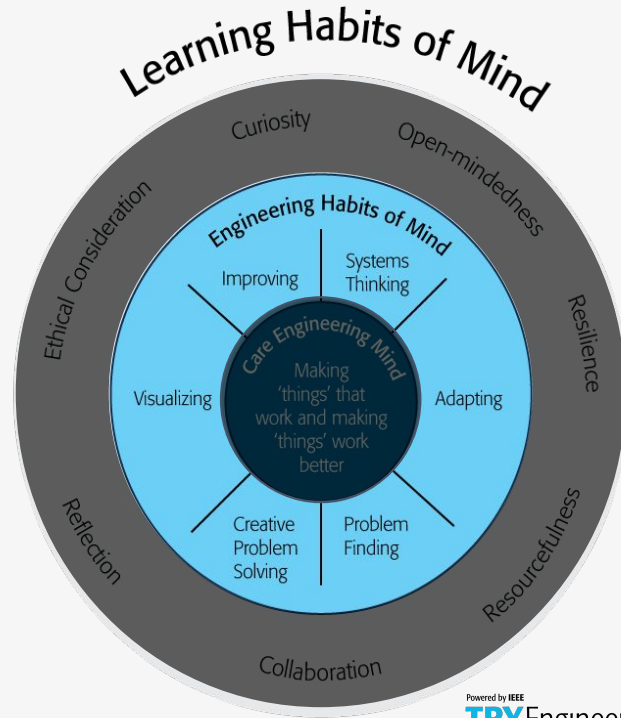
Source:

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



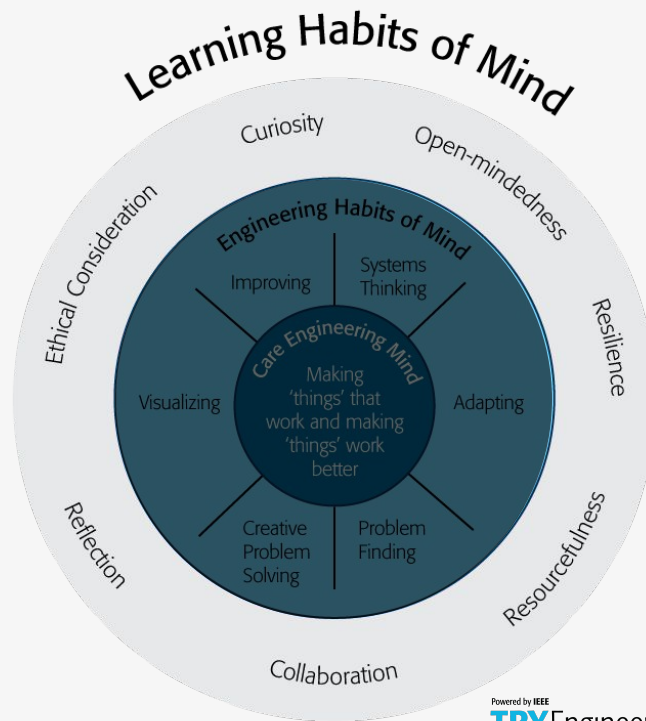
Engineering Habits of Mind Checklist

- ❑ 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 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 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 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
FOR ENGINEERING
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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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