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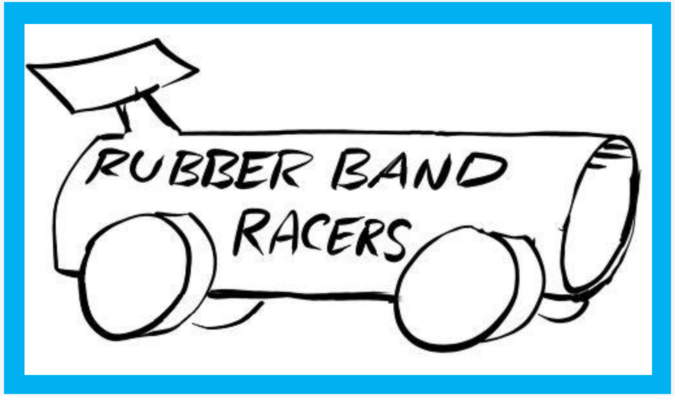
TRY Engineering

Lesson Plan:

Rubber Band Racers



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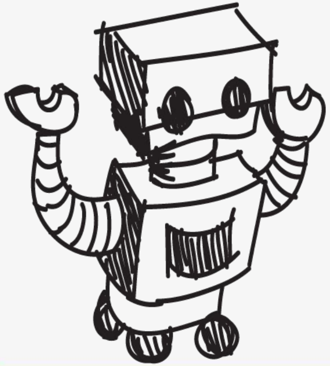
Real-World Application



Adult-Sized Rubber Band Car

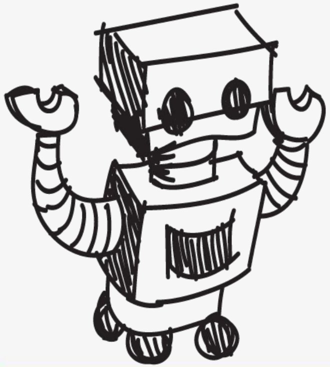
Have you ever seen an adult-sized rubber band car? *(Video, 0:34)*

- At the 2007 Maker Faire™ in Austin, TX, Brian Watt demonstrated his experimental, adult-sized, rubber band car. His design used 80+ layers of cardboard, about 1 1/2 gallons of glue, and six 84-inch x 1-inch rubber bands. He based his design on the *Amazing Rubber Band Cars* book by Mike Rigsby.

Photo: Brian Watt

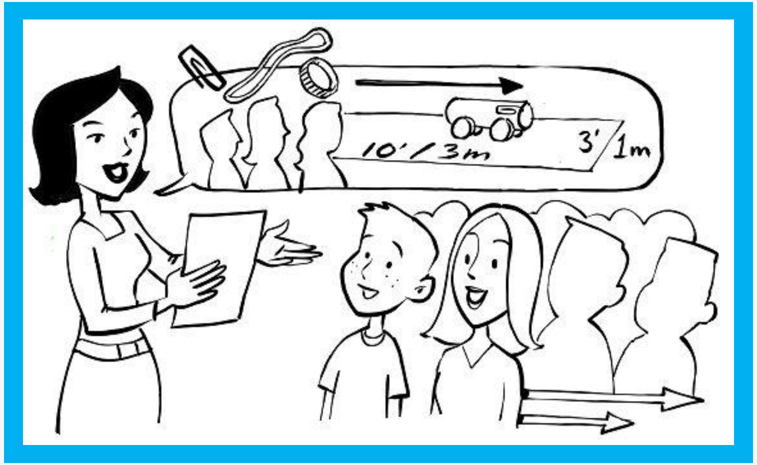
Source: You Tube: http://www.youtube.com\watch?v=DYCu4i1daPI

The Design Challenge



The Design Challenge

- You're a team of engineers given the challenge of designing a rubber band car out of everyday items. The car must be able to travel in a straight line within a track for a distance of at least 10 feet (3 meters) within a 3 foot (1 meter) wide track.



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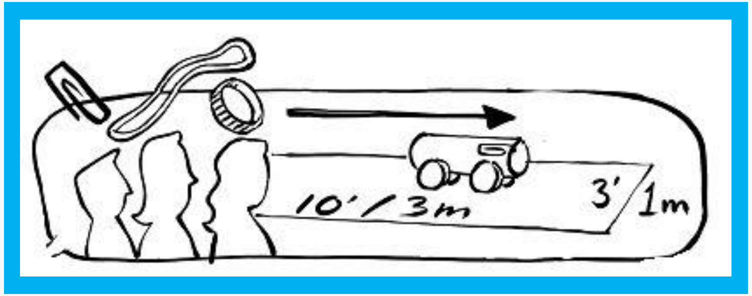
Defining the Challenge: Criteria & Constraints

Criteria

- Must be able to travel in a straight line within a track for a distance of at least 10 feet (3 meters) within a 3 foot (1 meter) wide track.
- The car that can travel within the track for the greatest distance is the winner.



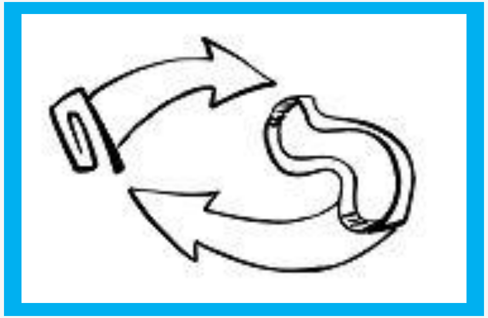
Constraints

- Can only use the materials provided.
  - Teams may trade materials to develop their ideal parts list.

Build Material

Required for Build

- 16 in. x 16 in. piece of corrugated cardboard (or a cereal box/smaller piece of cardboard)
- 4 Rubber Bands



Optional for Build – Trading/Table of Possibilities

- Paperclips
- Plastic bottle, yogurt or takeout lids
- CD's or DVD's
- Paper/styrofoam plates
- Unsharpened pencils
- Thumbtacks

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Consider...

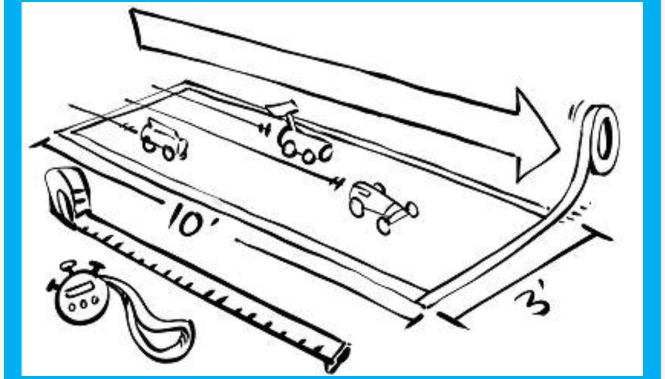
Before you get started brainstorming...consider the following...

- How does a rubber band work?
- What might make one car go faster than another?
- Does friction impact the design in addition to force?
- How does weight impact the design?

Testing Material and Process

Testing Material

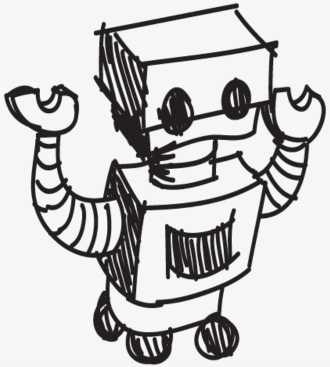
- Masking tape or other colored tape
- Measuring tape/stick
- Stopwatch



Testing Process

- Use masking tape to create a 3ft wide by at least 10ft long track on the floor. Allow the teams to launch the cars, which must travel in a straight line for a distance of at least 10 feet.
- Measure the distance and calculate the speed.
- Each team calculates their car's velocity
  - Distance traveled divided by the time it took to travel that distance in a forward direction within the track.

Reflect & Debrief



Reflection

- Did you negotiate any material trades with other teams? How did that process work?
- Did you decide to revise your original design or request additional materials while in the construction phase? Why?
- If you could have had access to materials that were different than those provided, what would your team have requested? Why?

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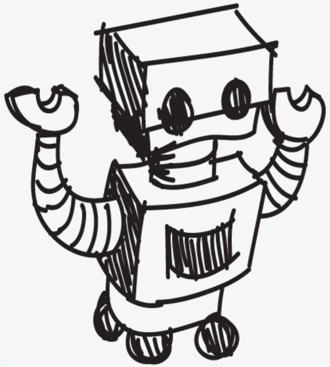
Reflection

- 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?

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

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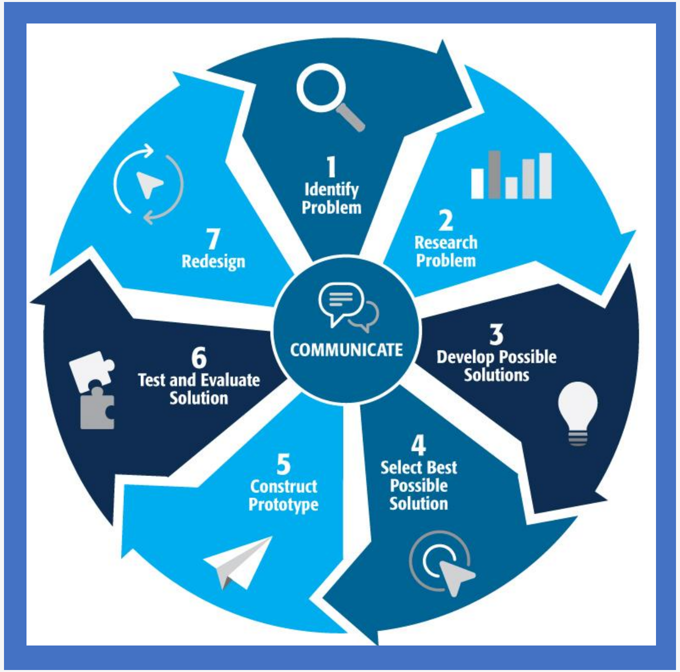
Engineering Design Process

- Divide into teams of two (or up to 4 max)
- 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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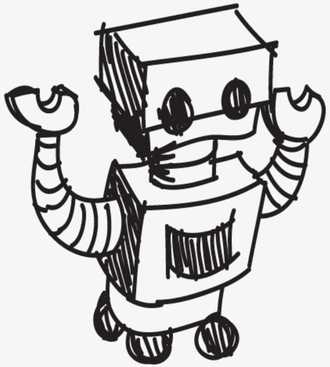
Productive Failure

- 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 and Background Concepts



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.
- Friction: The force that holds back the movement of an object. Anytime two objects rub against each other, they cause friction.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).

Vocabulary

- Kinetic Energy: Moving energy. All moving objects have kinetic energy.
- Potential Energy: Stored energy. For example, potential energy is stored in an arrow stretched back on a bowstring. If the string is let go, it moves forward and pushes the arrow through the air.
- Newton's First Law of Motion: An object at rest will remain at rest and an object in motion will remain in motion at a constant speed unless acted on by an unbalanced force (such as friction or gravity). This is also known as the law of inertia.
- Newton's Second Law of Motion: An object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass.

Vocabulary

- Newton’s Third Law of Motion: For every action there is an equal and opposite reaction.
- Speed: How fast an object is moving.
- Velocity: How fast an object is moving in a particular direction.

Newton’s Laws of Motion

- Learn about Sir Isaac Newton’s laws of force and motion at the amusement park. *(Video 3:02)*

Source: YouTube - Idaho Public Television Channel, PBS Science Trek https://www.youtube.com/watch?v=Vmv_EPKOsxY

Velocity vs. Speed

- Velocity refers to how fast an object is moving in a particular direction. Speed refers to how fast an object is moving. *(Video 8:23)*

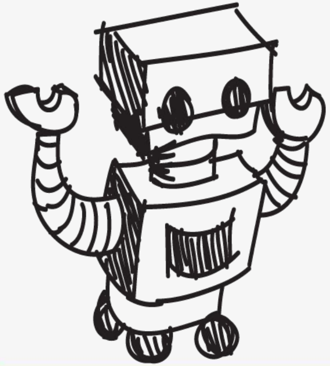
Source: PBS Physics in Motion
https://nj.pbslearningmedia.org/resource/47806460-ec55-4a42-8c5b-ea7d9d417d99/unit-2-segment-b-speed-and-velocity-physics-in-motion/

The Force of Friction

- The push or pull of an object is force. Friction is the force that holds back the movement of an object.

Source: YouTube - Smithsonian Science Education Center *https://www.youtube.com/watch?v=Wg9QNZmlsDY*

Dig Deeper



Dig Deeper into the Topic

Internet Connections

- International Federation of Automotive Engineering Societies: What do Automotive Engineers Do?
  - https://www.fisita.com/yfia/careers/what-does-an-automotive-engineer-do

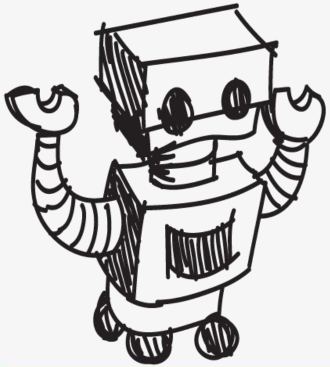
Recommended Reading

- The New Way Things Work (ISBN: 978-0395938478)
- Masters of Car Design (ISBN: 978-8854403376)

Optional Writing Activity

- Write a paragraph or essay explaining what automotive engineers must take into consideration when designing safe vehicles today.

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=H9VDkvgGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved with automobiles and automotive engineering. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Electrical Engineering
  - Computer Engineering
  - Software Engineering

- Download the Engineering Fields Infographic
  How will **YOU** change the world?

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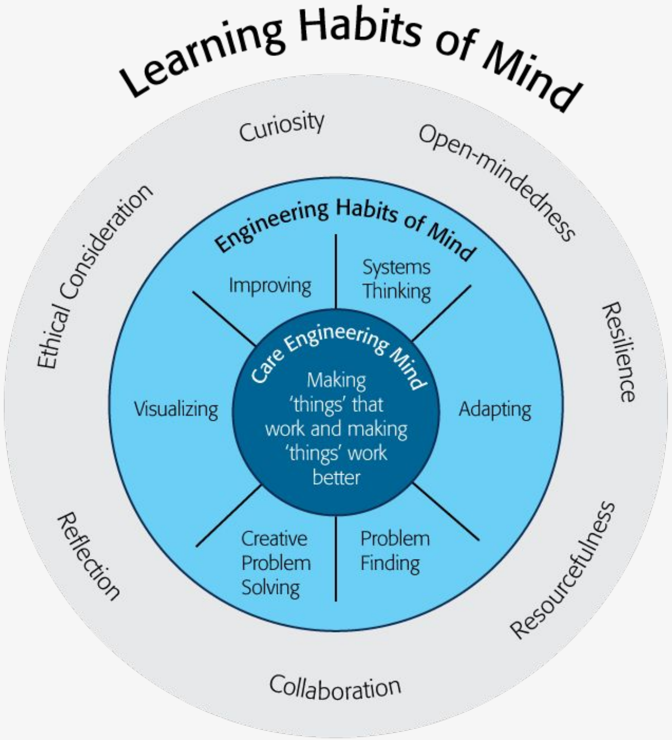
Engineering Habits of Mind

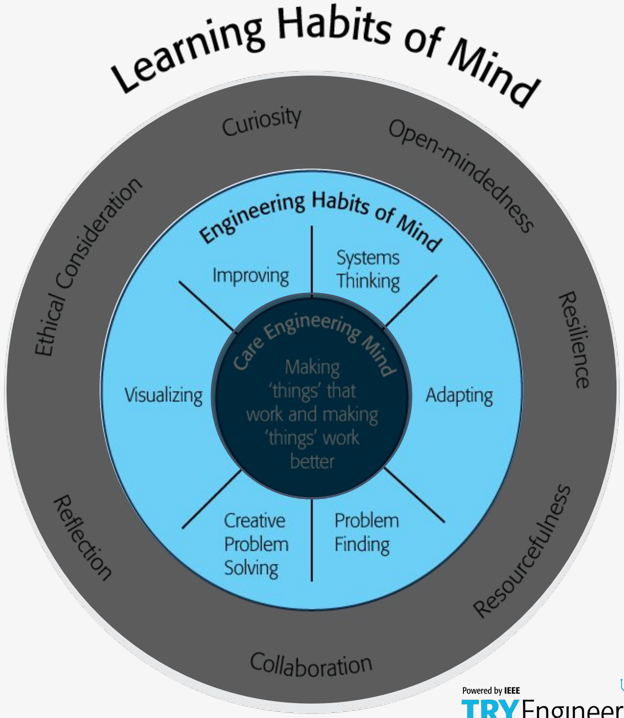


Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

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

Engineering Habits of Mind Checklist

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



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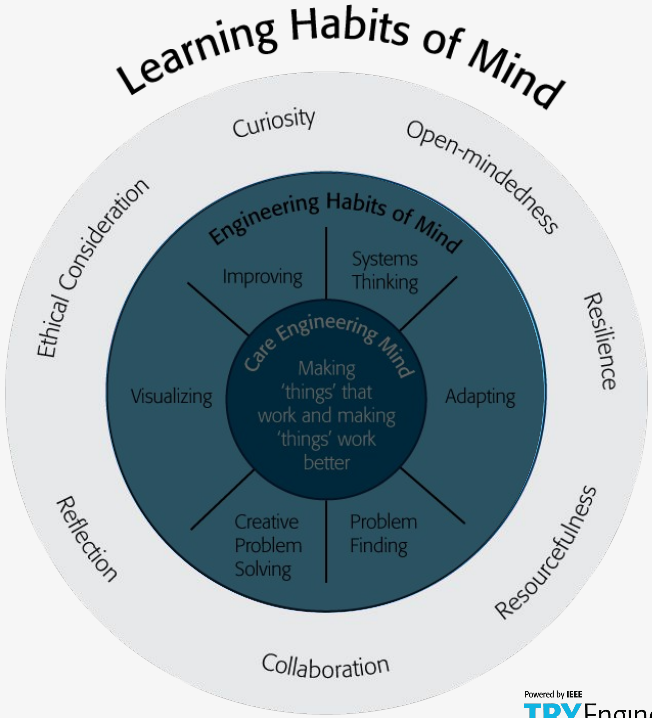
Learning Habits of Mind Checklist

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



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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/

Learn more about how engineers make the world a better place

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

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