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Lesson Plan:

Chair Lift Challenge



Real-World Application



Okemo Mountain Resort's Heated Chair Lift

Learn how the seats are heated on Okemo Mountain Resort's Sunburst Six orange-tinted bubble chair lift in central Vermont. *(Video 2:59)*



Source: NJ.com YouTube Channel: <https://www.youtube.com/watch?v=orwm0r0Yh-0>

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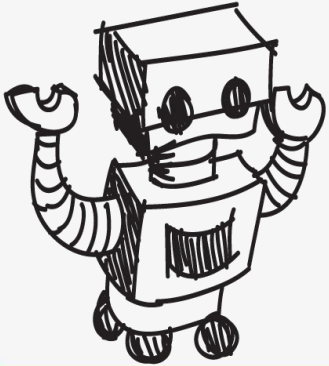
How Detachable Chair Lifts Work

On this tour, you'll learn the basic principles of what makes the Drive Terminal of the Duncan Express (Doppelmayr Quad Detachable Chair lift) work. (Video 5:28)



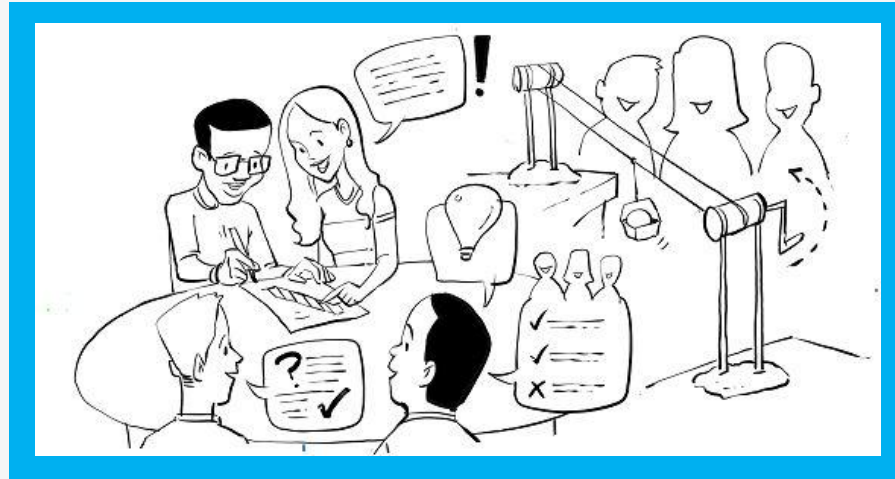
Source: SlopeEdge YouTube Channel: <https://www.youtube.com/watch?v=589uRM4Ty4&t=71s>

The Design Challenge



The Design Challenge

- You're a team of engineers given the challenge of designing and building a chair lift out of everyday materials. The chair lift must carry a ping pong ball up a rope/wire line from the valley to the mountain and back down from the mountain to the valley without the ball falling out of the chair.



Defining the Challenge: Criteria & Constraints

Criteria

- Chair lift must carry the ball up a rope/wire line and back down without the ball falling out of the chair.

Constraints

- Can use only the materials provided.
 - Unused materials may be shared with other teams or materials may be traded.



Material

Required for Build

- Ping pong ball or super ball

Optional for Build – Trading/Table of Possibilities

- String or yarn
- Pipe cleaners or bendable floral wire
- Straws
- Paper towel tubes
- Paper clips
- Pulley or thread spool to make pulley
- Balloons
- Foil, plastic wrap



Testing

Testing Material

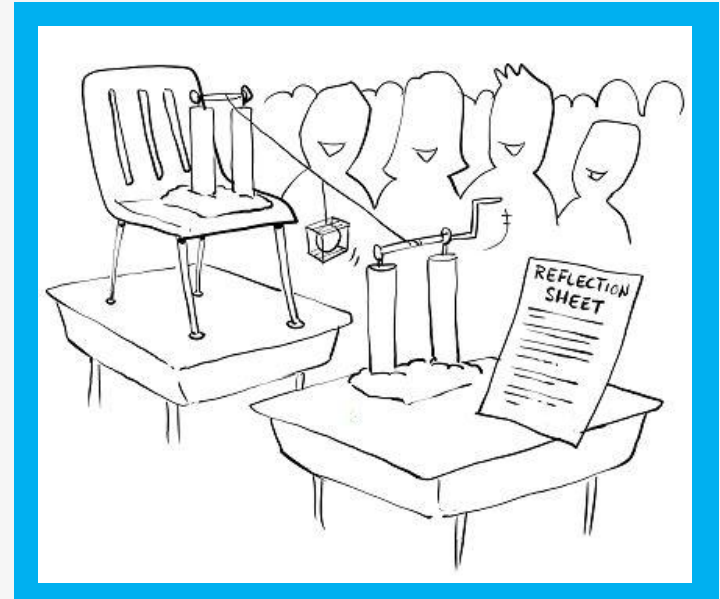
- Student desks, small tables or chairs
- Duct tape or other strong tape

Testing Process

Teams test their designs by attaching the bottom of their chair lift to the “valley” (floor, chair, desk or small table). Then, attaching the top of the chair lift to the “mountain” (chair, desk or small table).



Be sure there is an incline between the bottom and the top.



Consider...

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

- How an aerial chair lift works
- Weight your chair lift must carry
- Safety features

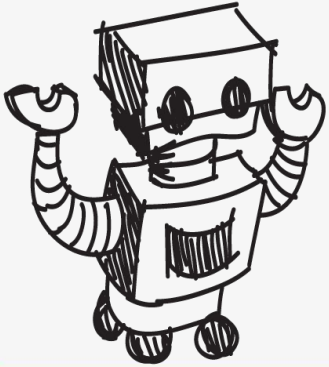


Variations

- Design a chair to transport a golf ball up and down the lift. Then, try a tennis ball....a baseball...
- Design a chair lift that has two seats (carrying two balls up and down)
- Try having one seat going up while another is going down

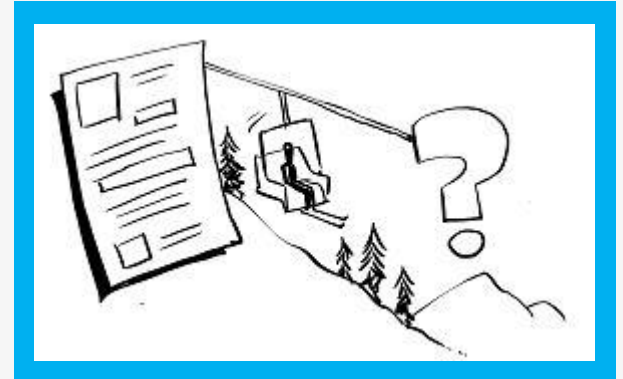


Reflect & Debrief



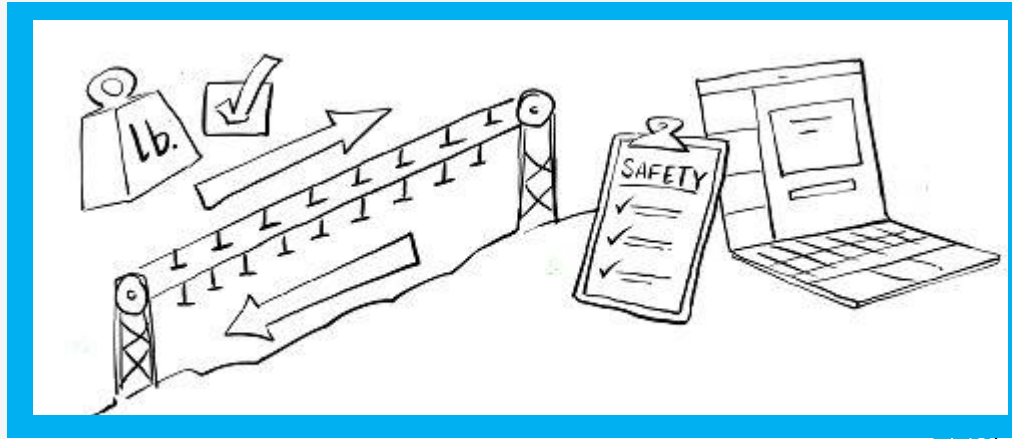
Reflection

- How similar was your original design to the actual chair lift your team built?
- If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.
- Was your chair lift able to carry the ping pong ball up and down the mountain without it falling out of the chair?

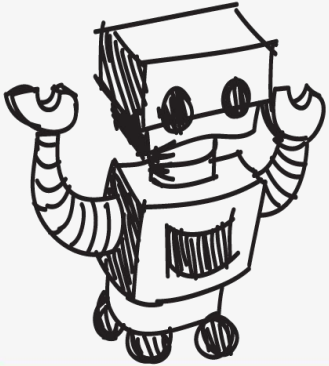


Reflection

- Which chair lift system that another team developed was the most effective or interesting to you? Why?
- If you could have used one additional material, which would you choose and 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>

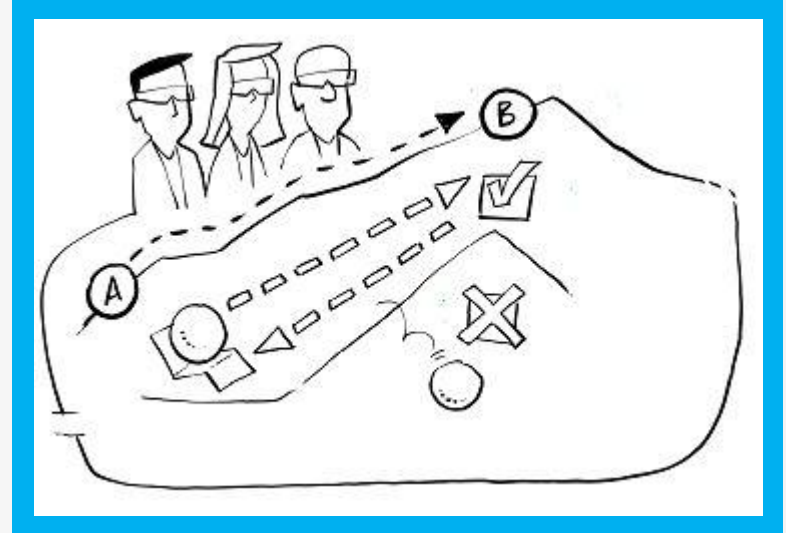
Engineering Design Process

- Divide into teams of 3 or 4
- 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

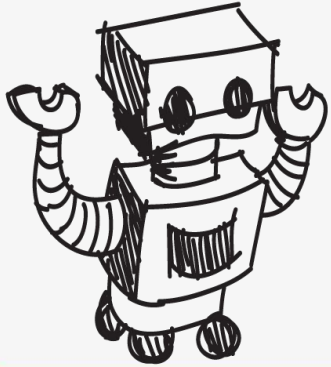


Productive Failure

- 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

- Aerial Lift: Means of transportation in which cabins, cars, gondolas or open chairs are hauled above the ground by means of one or more cables.
- Cable: A thick rope of wire or nonmetallic fiber, typically used for aerial lifts.
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Chair Lift: A type of elevated passenger aerial lift, which consists of a continuously circulating steel cable loop strung between two end terminals and usually over intermediate towers, carrying a series of chairs.
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering ([see infographic](#)).

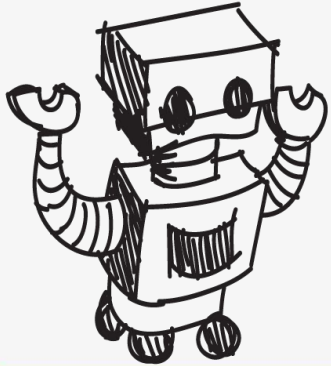


Vocabulary

- 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).
- Loading Efficiency: How quickly and safely a chair lift loads riders.
- Prototype: A working model of the solution to be tested.
- Safety Features: Engineers incorporate many safety features into a chair lift (lift bars, locking devices, etc.)
- Terminals: The continuously circulating steel cable loop of an aerial lift is strung between two end terminals and supported by a tower



Dig Deeper



Dig Deeper into the Topic

Internet Connections

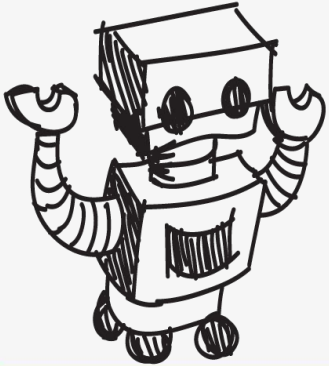
- Aerial People Movers: <http://aerialpeoplemovers.com>
- Doppelmayr Chair Lifts: <http://www.doppelmayr.com>

Writing Activity

- Write an essay or a paragraph about an environment or location where you think an aerial lifts could help lessen ground traffic congestion.



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)



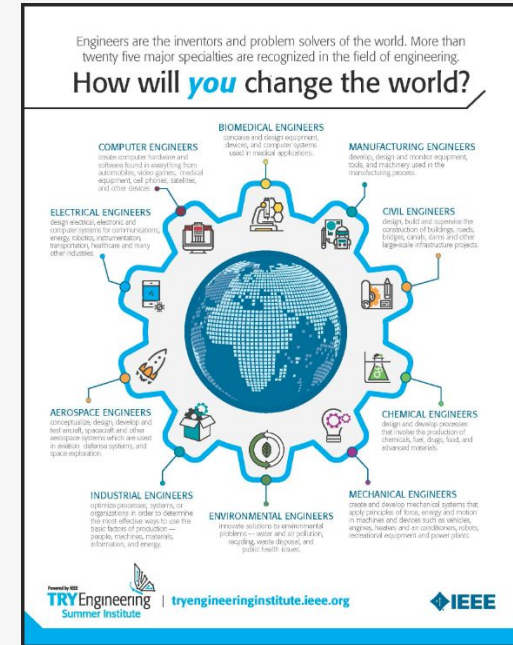
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvGmVo>

Related Engineering Fields

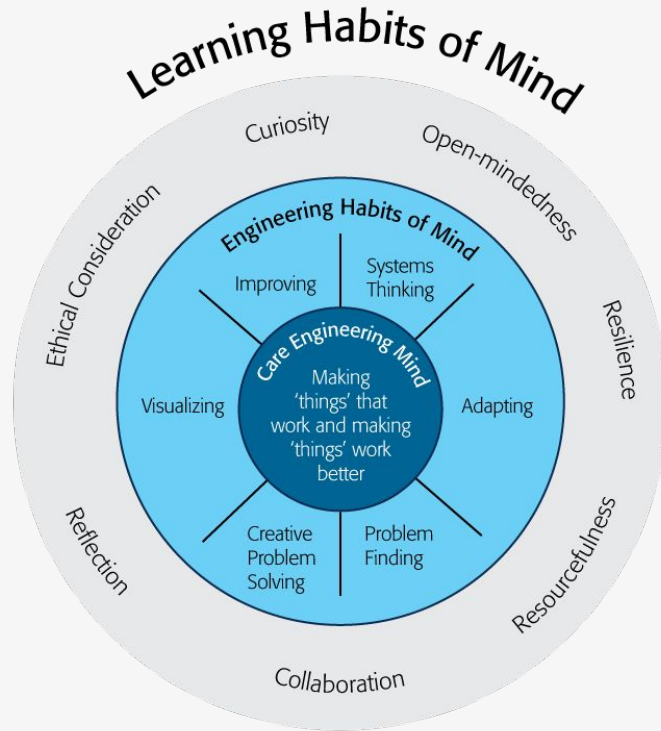
- There are several types of engineering fields that are involved with designing chair lifts. Here are just some of the related engineering fields.

- Mechanical Engineering
- Civil Engineering
- Electrical Engineering
- Environmental 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.

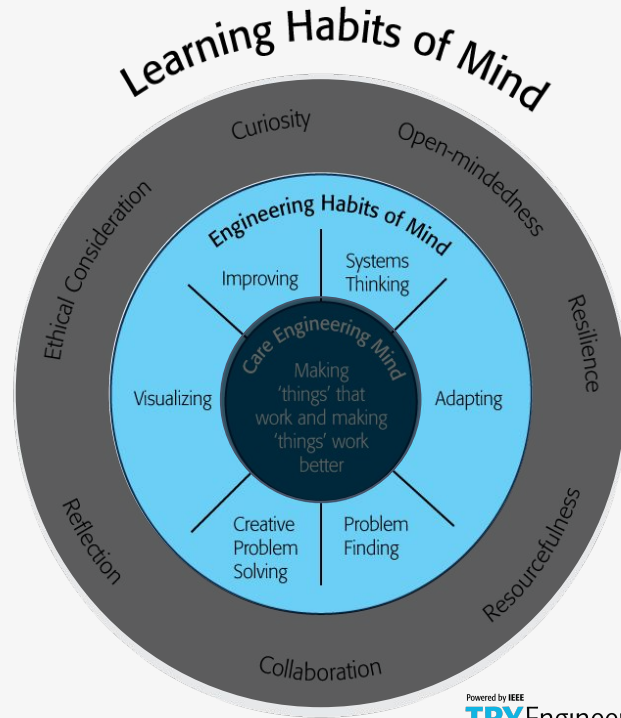
Source:

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



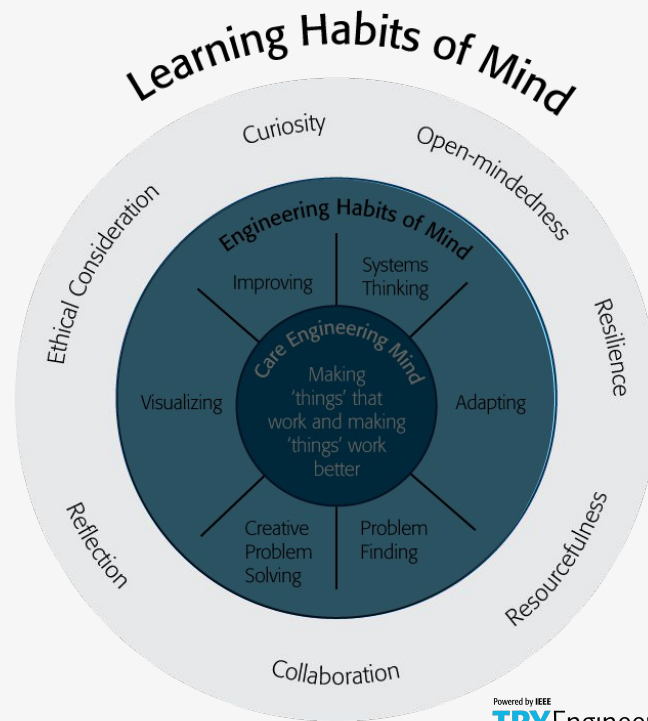
Engineering Habits of Mind Checklist

- ❑ 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



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 green puzzle piece with a fusion symbol on the left and a complex 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 technology. A row of twelve diamond-shaped icons representing various engineering fields 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.



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