Chair Lift Challenge

Provided by TryEngineering - www.tryengineering.org

Lesson Focus

Lesson focuses on unique challenges in transportation engineering, such as devising a method for skiers or hikers to get to the top of a mountain. Students work in teams to design a "chair lift" out of everyday items that can transport a ping pong ball in a chair of their own design from the bottom of a "valley" to the top of a "mountain" along a clothes line or wire without the ball falling out. Students design their chairlift and chair on paper, execute their design, test it, reflect on the challenge, and share their experiences with the class.

Lesson Synopsis

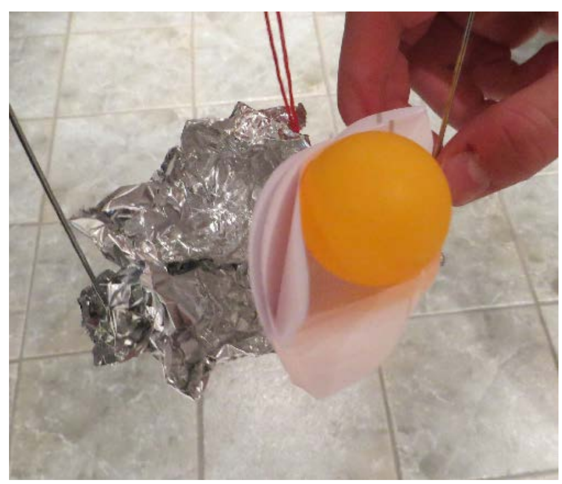
The "Chair Lift Challenge" explores how engineers develop transportation systems to operate in different and sometimes challenging environments. Students work in teams to design a chair lift made out of everyday materials that can carry a ping pong ball up a rope line and back down in a controlled manner so that the ball does not fall out of a chair the team has also designed. They sketch their plans, consider material selection, build their system, test it, reflect on the challenge, and present their experiences to their class.

Age Levels

8-18.

Objectives

- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.



Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- civil engineering
- engineering design
- teamwork

Lesson Activities

Students explore how engineers work to provide safe transportation options in different environments and climates. Students work in teams to construct a chair lift or system to move a ping pong ball up a line from the valley of the floor to the mountain at the top of a chair. Teams build their system out of everyday materials, test their design, reflect on the experience, and share with the class.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Aerial People Movers (http://aerialpeoplemovers.com/)
- Doppelmayr (http://www.doppelmayr.com)
- National Science Education Standards (www.nsta.org/publications/nses.aspx)
- ITEA Standards for Technological Literacy (www.iteaconnect.org/TAA)

Optional 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.

Extension Ideas

- Have students transport a golf ball up and down the lift instead of a ping pong ball -- or require the chair lift to have two seats (two ping pong balls or a ping pong and a golf ball) -- or have one basket going up while another is going down.

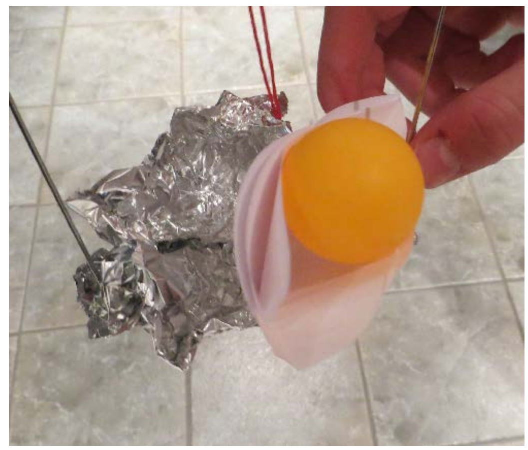
Chair Lift Challenge

For Teachers:
Teacher Resources

◆ **Lesson Goal**

The "Chair Lift Challenge" explores how engineers develop transportation systems to operate in different and sometimes challenging environments. Students work in teams to design a chair lift made out of everyday materials that can carry a ping pong ball up a rope line and back down in a controlled manner so that the ball does not fall out of a chair the team has also designed. They sketch their plans, consider material selection, build their system, test it, reflect on the challenge, and present their experiences to their class.

◆ **Lesson Objectives**

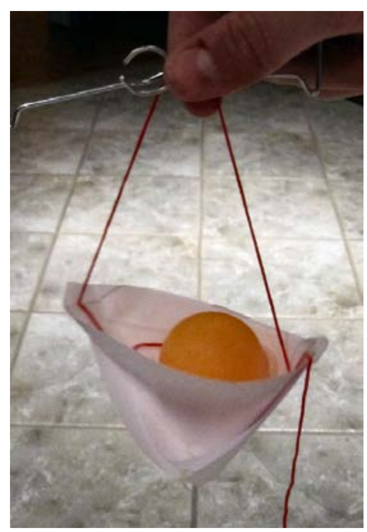


- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

◆ **Materials**

- Student Resource Sheets
- Student Worksheets
- Student Team Materials: ping pong ball, string, floral wire, pipe cleaners, bendable aluminum wire, straws, paper towel tubes, paper clips, tape, balloons, glue, string, foil, plastic wrap, pulley, other items available in the classroom.

◆ **Procedure**



1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students if they have ever seen an aerial lift or ski lift. Have them consider the engineering challenges of building such a transportation system.
3. Teams of 3-4 students will consider their challenge, and consider how the available materials might be used to create a chair lift.
4. Teams will develop a detailed drawing showing their lift design including a list of materials they will need to build it and the chair the ping pong ball will ride in.
5. Students build their lift, and test it under teacher supervision. Each lift must be able to transport the tennis ball "up the mountain" and "down the mountain" without the ball dropping out of the chair they develop to hold the ping pong ball.
6. Students should observe the chair lifts that other teams create.
7. Teams reflect on the challenge, and present their experiences to the class.

◆ **Time Needed**

One to two 45 minute sessions.

Student Resource:
What is a Chair Lift?

An elevated passenger ropeway, or chairlift, is a type of 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. They are used extensively at ski areas, but are also found at amusement parks as well. Depending on carrier size and loading efficiency, a passenger ropeway can move up 4000 people per hour, and the swiftest lifts achieve operating speeds of up to 12 m/s (26.8 mph; 43.2 km/h).

◆ **Aerial Lifts**

An aerial lift is an increasingly popular means of transportation in which cabins, cars, gondolas or open chairs are hauled above the ground by means of one or more cables. These are becoming popular in urban environments where ground space is at a premium. Over 600 years ago aerial systems were used in China to help move people and goods over streams. During the 1800's, the technology was improved by the by the mining industry to assist in the transport of minerals over difficult terrain. Aerial lifts are being installed in some cities to assist with urban transportation.

Safety is always a concern on chair lifts, which is why engineers have incorporated many safety features into them including lift bars (which provides the passenger with a horizontal bar to hold onto, and locking devices so the cable cannot move backwards.

The mechanism at the top of a chairlift allows for the steel rope to wind horizontally, returning empty chairs down a mountain. The image to the right is the ski lift mechanism in the resort of Tsakhkadzor, Armenia.

Chair Lift Challenge

Student Resource:
News Release:

◆ New Ropeway to be Built on Top of the Highest Mountain in Europe

In early 2011, Doppelmayr Italia GmbH was awarded the contract for the construction of the new ropeway on the Mont Blanc. The new installation will replace the old ropeway from the 1940s and 1950s. The installation is located on the Italian side at the foot of the Mont Blanc and connects the tourist resort Courmayeur with the Pointe Helbronner.

The future ropeway to the Mont Blanc scales the Pointe Helbronner at approximately 3,500 m above sea level in two new sections. The three line sections of the old installation will be demolished upon completion of the building works for the new ropeway. Glass and steel will set architectural highlights for the station buildings and the futuristic cabins. The stations are spacious and allows for views over the impressive mountain scenery by means of observation platforms.

The cabins have a round shape, are completely glazed and rotate about their centre axes. Doppelmayr has already implemented this advanced technology in other famous locations: for example in Cape Town, Palm Springs, at the mountain Titlis in Switzerland and at the Monte Baldo at the Lake Garda. But it is still a challenge for Doppelmayr: Never before has a rotating cabin been used in such height.

In each section a total of 4 carriers with a capacity of 80 passengers each is planned. The overall line length is 4.3 km and a difference in height of 2,140 m is overcome with an operating speed of 9 m/s (approx. 30 km/h). The track ropes are approximately 7 cm thick.

The drive consists of two electric motors with an output of 600 kW each. Per hour 800 and respectively 600 passengers (section 1 and section 2) can be transported.

The interior fittings of the cabins are of state-of-the-art design: heating elements integrated into the cabin floor and walls, sound system, and video screens. On these screens pictures made by the camera that is attached to the outside of the cabin floor are shown through a wireless connection. In addition, the screens show information such as weather data and event tips. Other features the high-tech cabin offers are air conditioning, adjustable LED lighting and intelligent sway dampers – to only name a few.

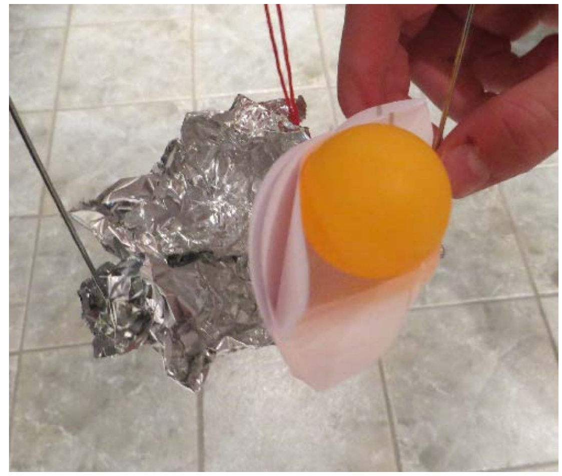
The construction period of the new ropeway on the Mont Blanc is four years, the start-up is scheduled to take place in 2014.

(Source: Doppelmayr Italia GmbH www.doppelmayr.com)

Student Worksheet: Build a Chair Lift

◆ Research and Planning

You are part of a team of engineers who have been given the challenge of building a chair lift to carry a ping pong ball up the mountain (from the floor of your classroom to the top of a desk or chair) using materials provided to you. Your lift must both carry the ball up the mountain and also back down without the ball dropping out. How you design your chairlift and the chair that will carry the ball, and what materials you use are up to you!



◆ Design Phase

You have been provided with many materials from which to design and build your own chairlift and chair. Consider which materials you would like to use, and list them in the box below. On a separate piece of paper, draw a diagram of the system you intend to build.

Parts Required:

◆ Build it! Test it!

Next build your chairlift and test it. You may share unused building materials with other teams -- and trade materials too. Be sure to watch what other teams are doing and consider the aspects of different designs that might be an improvement on your team's plan.

You may decide to completely change your design when in the manufacturing phase -- and you may ask for additional materials, or try different solutions as you build.

Student Worksheet: Build a Racquet

◆ **Reflection**

Complete the reflection questions below:

1. How similar was your original design to the actual chair lift your team built?

2. If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.

3. Was your chairlift able to carry the ping pong ball up and down the mountain without it falling out of the chair you designed?

4. Which chairlift system that another team developed was the most effective or interesting to you? Why?

5. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

6. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

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For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ✦ Properties of objects and materials
- ✦ Position and motion of objects

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Abilities of technological design
- ✦ Understanding about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ✦ Changes in environments
- ✦ Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ✦ Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ✦ Motions and forces
- ✦ Transfer of energy

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- ✦ Abilities of technological design
- ✦ Understandings about science and technology
- ✦ Science and technology in society

For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Populations, resources, and environments
- Risks and benefits

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- History of science

◆National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Historical perspectives

◆Next Generation Science Standards Grades 3-5 (Ages 8-11)

Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Energy

Students who demonstrate understanding can:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3.Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆Next Generation Science Standards Grades 6-8 (Ages 11-14)

Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 2: Students will develop an understanding of the core concepts of technology.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

- Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.