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Lesson Focus

Lesson explores the engineering behind the conveyor belt and considers the impact this invention has had on transportation and the coordinated shipping and delivery of goods. Students work in teams to design and build a conveyor system out of everyday materials that can transport pieces of candy 4 feet (120cm). The conveyor must make a 90 degree turn as it moves along. Student teams design their system, build and test it, evaluate their designs and those of classmates, and share observations with their class.

Lesson Synopsis

The "Conveyor Engineering" lesson explores how engineers work to solve the challenges of a society, such as moving goods and people. Students work in teams to devise a conveyor system using everyday materials that can move pieces of candy 4 feet (120cm) including a 90 degree turn. They sketch their plans, build their system, test it, reflect on the challenge, and present to their class.

Age Levels

8-18.

Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about manufacturing processes and conveyor systems.
- ◆ 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:

- ◆ engineering design
- ◆ manufacturing and distribution
- ◆ conveyor systems
- ◆ teamwork

Lesson Activities

Students explore how engineers have solved societal problems such as moving goods, materials, and people using conveyor systems. Students work in teams to develop a conveyor system out of everyday materials that can move pieces of candy 4 feet (120cm) including a 90 degree turn. They evaluate their results, and the results of other teams, and share their reflections with the class.

Conveyor Engineering

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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)
- ◆ Ford Motor Company History - The Assembly Line (http://fordmotorhistory.com/history/assembly_line.php)

Recommended Reading

- ◆ *Conveyors: Application, Selection, and Integration (Industrial Innovation)* (ISBN: 978-1439803882)
- ◆ *The Invention of the Moving Assembly Line: A Revolution in Manufacturing* (ISBN: 978-1604137729)
- ◆ *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (ISBN: 978-0801829758)

Optional Writing Activity

- ◆ Write an essay or a paragraph about three existing and one imagined application of a conveyor belt system.

Extension Activity

- ◆ Have advanced or older students power their conveyor systems with motors or gear systems.

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For Teachers: Teacher Resource

◆ Lesson Goal

Lesson explores the engineering behind the conveyor belt and considers the impact this invention has had on transportation and the coordinated shipping and delivery of goods. Students work in teams to design and build a conveyor system out of everyday materials that incorporates a 90 degree turn and transports pieces of candy 4 feet (120cm). Student teams design their system, build and test it, evaluate their designs and those of classmates, and share observations with their class.

◆ Lesson Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about manufacturing processes and conveyor systems.
- ◆ Learn how engineering can help solve society's challenges.
- ◆ Learn about teamwork and problem solving.



◆ Materials

- ◆ Student Resource Sheets
- ◆ Student Worksheets
- ◆ Classroom Materials (candy or similar sized items)
- ◆ Student Team Materials: tubes (can be paper towel rolls, toilet paper rolls, or pvc piping or other similar materials - or even rows of soda bottles or pencils) rubber bands, ball bearings, balls, fabric sheets, string, gears, handles, paper cups, straws, paper towels, paper clips, tape, soda bottle, glue, string, foil, plastic wrap, pens, pencils, paper, hose or tubes, crayons, 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 been to an airport to consider how their luggage was sorted or delivered. Ask them to think about any "moving sidewalks" they have traveled on (airports, malls, other large buildings).
3. Teams of 3-4 students will consider their challenge, and conduct research into how conveyor belt systems operate.
4. Teams then consider available materials and develop a detailed drawing showing their conveyor system including a list of materials they will need to build it.
5. Students build their conveyor system, and test it, and also observe the systems developed and tested by other student teams.
6. Teams reflect on the challenge, and present their experiences to the class.

◆ Time Needed

Two to three 45 minute sessions.

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Student Resource: **What is a Conveyor Belt?**

Conveyor belts can be made out of many different materials, but in its most basic form is a frame with rollers installed that move materials on top. It can be motorized so that the rollers move at a set speed, be manually powered, or move with the force of gravity.

There is also an application called a sandwich belt in which two basic conveyors run in parallel -- one on top of the other, leaving enough space to sandwich a box between. It is used frequently to move items up steep inclines and was developed in 1979 to improve efficiency when removing rocks and other materials from mines.



◆ **Who uses conveyor systems?**

Conveyor systems are commonly used in many industries, including shipping, automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, and packaging. Although most materials can be conveyed, some of the most common include food items in boxes, bottles, and cans; automotive components; mining materials and scrap; and grain or animal feed. They are also used to move people and materials (such as boxes and luggage) at airports. A common installation site for conveyor belts are packaging departments and also throughout manufacturing areas. Belts are usually installed at waist height to make it easier for people to oversee the operation and observe materials moving through the system. And...in many countries sushi restaurants are using conveyor belts to route dishes of sushi through customer tables, so they just see what goes by and pick up the plate that looks good!

◆ **How does it work?**

A conveyor system usually consists of a metal frame with rollers installed at various intervals along the length of the conveyor belt. Usually these are covered with a smooth or rubbery material that covers the rollers and helps materials move along without being stuck between rollers. Some roller systems are straight and some are curved. Some are flat, and some move materials up or down between floors or even into underground mines.

◆ **What is mass production?**

Mass Production involves making many copies of products, very quickly, using assembly line techniques to send partially complete products to workers who each work on an individual step, rather than having a worker work on a whole product from start to finish.

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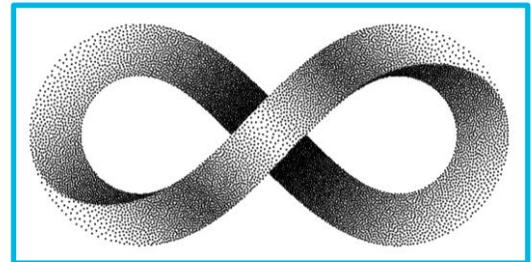
Student Resource:
Conveyor Belt History and the Assembly Line

◆ **History and Inventors**

Primitive conveyor belts have been in use since the 1800s -- initially used in transporting goods to and from mines, which had a great impact on improving the speed with which mined materials could be brought to the surface. In 1913, Henry Ford introduced conveyor-belt assembly lines at Ford Motor Company's Highland Park, Michigan, US factory. The assembly line developed by Ford Motor Company between 1908 and 1915 made assembly lines famous in the following decade through the social ramifications of mass production -- and the conveyor belt was a key component of the system, allowing parts to be moved in from of workers.



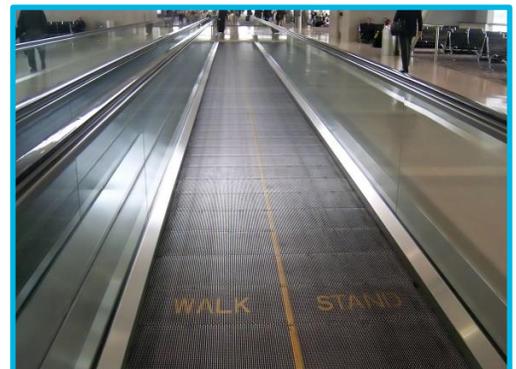
In 1957, the B. F. Goodrich Company patented a conveyor belt ultimately called the Turnover Conveyor Belt System. It incorporated a half-twist on the belt called a Möbius Strip (see diagram at right). This design had a big advantage over conventional belts because it exposed all of its surface area to wear and tear and so lasted longer. Now, möbius strip belts are no longer manufactured because untwisted modern belts made from several layers of materials are more durable.



The longest belt conveyor system in the world as of 2012 is 98 km long, connecting the phosphate mines of Bu Craa to the Western Sahara coast. For baggage applications, the longest conveyor system at 92 km is in the Dubai International Airport.

◆ **Moving Sidewalks**

Another type of conveyor system is the moving sidewalk, which transports people instead of goods or suitcases! The first moving walkway debuted at the World's Columbian Exposition of 1893, in Chicago, IL, US. Now these transport systems are used in airports, malls, and any area where people may be expected to walk long distances. The first moving walkway in an airport was installed in 1958 at Love Field in Dallas, Texas, US. The animated TV series The Jetsons depicts moving walkways everywhere, even in private homes.



Conveyor Engineering

Student Worksheet:

◆ **Engineering Teamwork and Planning**

You are part of a team of engineers given the challenge of developing your own conveyor belt out of a range of materials. You will need to convey candy along your belt which has to include a 90 degree turn. You can use any materials you like that are provided to you....and can share or trade materials with other student teams. , There are a few rules:
1. Candy cannot be glued or affixed to the belt surface, 2. Candy cannot fall off.



◆ **Research Phase**

Read the materials provided to you by your teacher. If you have access to the internet, explore examples of conveyor systems and consider how groceries are moved along to the cashier in a market or grocery store.

◆ **Planning and Design Phase**

Draw a diagram of your planned conveyor belt on the back of this page and make a list and quantity of all the materials you think you will need in the box below. You'll need to consider how you will make the conveyor belt move -- you can use your hands to move rollers, gears, or you could use a motor -- just don't touch the cup!

Materials you will need:

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Student Worksheet:**◆ Presentation Phase**

Present your plan and drawing to the class, and consider the plans of other teams. You may wish to fine tune your own design.

◆ Build it! ...and Redesign if you need to!

Next build your conveyor belt 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.

◆ Test it!

Next, the class will test their conveyor belt systems. Be sure to watch all the tests so you can see the advantages or disadvantages of other systems.

◆ Reflection

Complete the reflection questions below:

1. How similar was your original design to the actual conveyor 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. Which conveyor system that another team engineered was the most interesting to you? Why?
4. 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?
5. 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
- ◆ Understanding about 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

- ◆ Types of resources
- ◆ 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

- ◆ Properties and changes of properties in matter
- ◆ Motions and forces

CONTENT STANDARD E: Science and Technology

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

- ◆ Abilities of technological design

CONTENT STANDARD F: Science in Personal and Social Perspectives

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

- ◆ Risks and benefits
- ◆ Science and technology in society

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For Teachers:
Alignment to Curriculum Frameworks (continued)

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

CONTENT STANDARD G: History and Nature of Science

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

- ◆ Science as a human endeavor
- ◆ 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
- ◆ Conservation of energy and increase in disorder
- ◆ Interactions of energy and matter

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

- ◆ Personal and community health
- ◆ 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 - (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.

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 (continued)

◆ **Next Generation Science Standards - (Ages 11-14)**
Engineering Design

- ◆ 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.

Technology and Society

- ◆ Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- ◆ 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.