Conveyor Engineering

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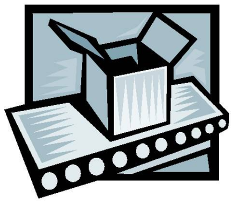

Lesson Focus
Lesson explores the engineering behind the conveyor belt and considers the impact this invention has had on transportation and the coordinated shipping and delivery of goods. Students work in teams to design and build a conveyor system out of everyday materials that can transport some lollies120cm. 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 some lollies 120cm including a 90 degree turn. They sketch their plans, build their system, test it, reflect on the challenge, and present to their class.

Year Levels
Year 5 – 10 Science Inquiry Skills and Science as a Human Endeavour.

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 than can move some lollies 120cm including a 90 degree turn. They evaluate their results, and the results of other teams, and share their reflections 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)
- Ford Motor Company History - The Assembly Line (http://fordmotorhistory.com/history/assembly_line.php)
- Curriculum links (www.acara.edu.au)

Recommended Reading

- Conveyors: Application, Selection, and Integration (Industrial Innovation) (ISBN: 978-1439803882)
- Belt conveyors and Belt Elevators (ISBN: 978-1177755047)
- 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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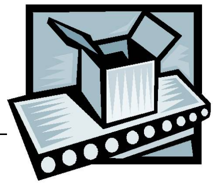


For Teachers:
Teacher Resources

◆ 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

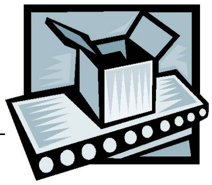
- Student Resource Sheets
- Student Worksheets
- Classroom Materials (candy or similar sized items)
- Student Team Materials: tubes (can be paper towel rolls, or pvc piping or other similar materials - or even rows of soda bottles or pencils) rubber bands, ball bearings, balls, fabric sheets, string, 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

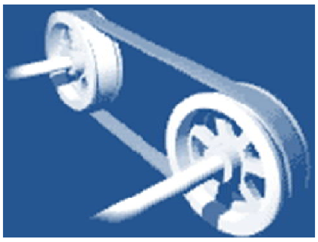
1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students if they have been to an airport to consider how their luggage was sorted or delivered. Ask them to think about 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.



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 efficience 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?

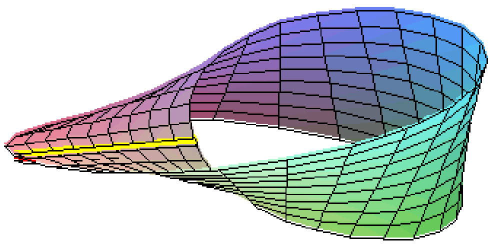
Mass Production involves making many copies of products, very quickly, using assembly line techniques to send partially complete products to workers who each work on an individual step, rather than having a worker work on a whole product from start to finish.

Student Resource:
Conveyor Belt History and the Assembly Line

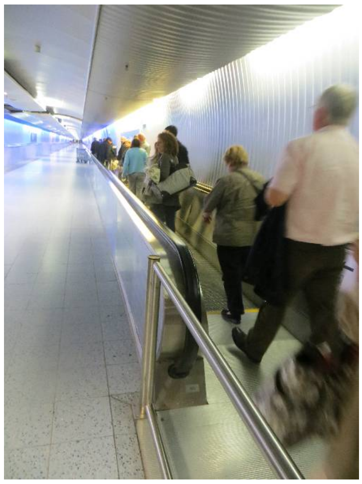
◆ History and Inventors

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.

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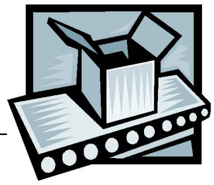


Student Worksheet:

◆ **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 lollies 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. Lollies cannot be glued or affixed to the belt surface, 2. Lollies 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:

◆ 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:

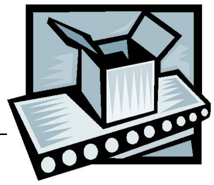
1. How similar was your original design to the actual conveyor your team built?

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?



For Teachers:
Alignment to Curriculum Frameworks

Science Inquiry Skills
Year 5
With guidance, select appropriate investigation methods to answer questions or solve problems (**ACSIS086**)

Use equipment and materials safely, identifying potential risks (**ACSIS088**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS091**)

Year 6
With guidance, select appropriate investigation methods to answer questions or solve problems. (**ACSIS103**)

Use equipment and materials safely, identifying potential risks (**ACSIS105**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS108**)

Year 7
Collaboratively and individually plan and conduct a range of investigation types including fieldwork and experiments, ensuring safety and ethical guidelines are followed (**ACSIS125**)

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS126)**

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of data collected, and identify improvements to the method **(ACSIS131)**

Year 8
Collaboratively and individually plan and conduct a range of investigation types including fieldwork and experiments, ensuring safety and ethical guidelines are followed (**ACSIS140**)

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS141)**

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of data collected, and identify improvements to the method **(ACSIS146)**

Year 9

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS165)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS166)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS171)**

Year 10

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS199)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS200)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS205)**

Science as a Human Endeavour

Year 5

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE081)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE083)**

Year 6

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE098)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE100)**

Year 7

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE223)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE224)**

Year 8

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE226)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE227)**

Year 9

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE158)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE161)**

Year 10

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE192)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE195)**

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
• Process data using simple tables • Data analysis skills (graphs) • Analysis of patterns and trends • Use of metric units	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives and how science knowledge develops from many people's contributions.

Students follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise and identify patterns. They use patterns in their data to suggest explanations and refer to data when they report their findings. They describe ways to improve the fairness of their methods and communicate their ideas, methods and findings using a range of texts.

Year 6

By the end of Year 6, students compare and classify different types of observable changes in materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another to generate electricity. They explain how natural events cause rapid changes to the Earth's surface. They decide and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge is used in decision making and identify contributions to the development of science by people from a range of cultures.

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using graphic representations and construct multi-modal texts to communicate ideas, methods and findings.

Year 7

By the end of Year 7, students describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.

Students identify questions that can be investigated scientifically. ***They plan fair experimental methods, identify variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions***. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.

Year 8

By the end of Year 8, students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. They identify different forms of energy and describe how energy transfers and transformations cause change in simple systems. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborate to generate solutions to contemporary problems.

Students identify and construct questions and problems that they can investigate scientifically. ***They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled***. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. ***They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others***. They use appropriate language and representations to communicate science ideas, methods and findings in a range of texts types.

Year 9

By the end of Year 9, students explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions. They describe models of energy transfer and apply these to explain phenomena. They explain global features and events in terms of geological processes and timescales. They analyse how biological systems function and respond to external changes with reference to interdependencies, energy transfers and flows of matter. They describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives.

Students design questions that can be investigated using a range of inquiry skills. ***They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trend in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence***. They evaluate others 'methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

Year 10

By the end of Year 10, students analyse how the periodic table organises elements and use it to make predictions about the properties of elements. They explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They explain the concept of energy conservation and represent energy transfer and transformation within systems. They apply relationships between force, mass and acceleration to predict changes in the motions of objects. Students describe and analyse interactions and cycles within and between Earth's spheres. They evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their view.

Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of their data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.