A Century of Plastics

Provided by TryEngineering - www.tryengineering.org

Lesson Focus

Lesson focuses on how plastics of all sorts have been engineered in to everyday products over the past century, with emphasis on materials selection and engineering.

Lesson Synopsis

The Century of Plastics activity explores how the development of plastics -- and the engineering of plastic components into everyday products -- has impacted the world. Students learn about the history of plastics, what plastics engineers do, and how many products have been enhanced through the addition of plastic components. Students work in teams to identify products without plastic, and products they think could not exist in a pre-plastic world. They work as teams of "engineers" to see if they can redesign a product to use 50% less plastic components than in current designs.

Age Levels

Year 8 – Term 1; Year 10 – Term 2

Objectives

- Learn about plastics.
- Learn about how plastics have been engineered into so many common products.
- Learn about teamwork and the engineering problem solving/design process.

Anticipated Learner Outcomes

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

- plastics
- materials and plastics engineering
- impact of engineering and technology on society
- engineering problem solving
- teamwork

Lesson Activities

Students learn about how the development of plastics and the engineering of plastics into everyday products have impacted our world. Topics examined include problem solving, teamwork, and the engineering design process. Students work in teams to identify products which they think could not exist without plastics and redesign to use fewer plastic components to make it easier to recycle, then present to class.

Resources / Materials

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

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- History of Plastics (www.bpf.co.uk/Plastipedia/Plastics_History/Default.aspx)
- The History of the Pen (www.rickconner.net/penspotters/history.html)
- Curriculum Links (www.acara.edu.au)

Recommended Reading

- American Plastic: A Cultural History by Jeffrey L. Meikle (ISBN: 0813522358)
- Plastics Engineering by R J Crawford (ISBN: 0750637641)
- Plastic: The Making of a Synthetic Century by Stephen Fenichell (ISBN: 0887308627)

Optional Writing Activities

- Write an essay or a paragraph describing whether you think spaceflight would be possible without the introduction of plastics. Give examples to support your point of view.
- Write an essay or a paragraph describing how recycling works in your town. Give examples of how engineers incorporate recycled materials into new products.

A Century of Plastics

For Teachers:
Teacher Resources

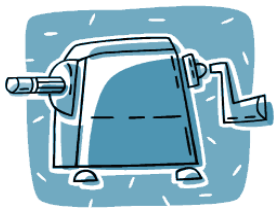
◆ Lesson Goal

Explore how the development of plastic -- and subsequent engineering of products and machines with plastic component parts -- has impacted our world. Students learn about plastics, explore how plastics are in just about every product, and work as an "engineering" team to redesign a product to see if it could be made with less plastic than in the original product to improve how it might be recycled.

◆ Lesson Objectives

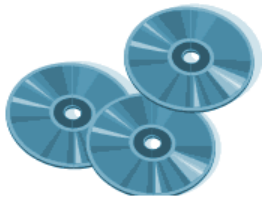
- Students learn about plastics.
- Students learn about how plastics have been engineered into so many common products.
- Students learn about teamwork and the engineering problem solving/design process.

◆ Materials



- Student Resource Sheets
- Student Worksheets

◆ Procedure



1. Show students the various Student Reference Sheets. These may be read in class or provided as reading material for the prior night's homework. They may also be directed to look for examples of products that do not include any plastic from their kitchen and bathroom.
2. Divide students into groups of 3-4 students. Ask students to work as a team to complete the student worksheets: the first allows students to brainstorm on how plastics have been engineered into so many everyday products, the second has students work in teams as "engineers" to redesign a product to see if it could be made with fewer plastic component parts than the original product to improve its ability to be recycled.
3. Each student group presents their product to the class.

◆ Time Needed

One to two 45 minute sessions.

A Century of Plastics

Student Resource: What are Plastics?

◆ A Century of Plastics

The 19th Century saw enormous advances in polymer chemistry. However, it required the insights of chemical engineers during the 20th Century to make mass produced polymers a viable economic reality. When a plastic called Bakelite was introduced in 1908 it launched the "Plastic Age." Bakelite was engineered into many products from electric plugs, to hairbrushes, to radios, clocks, and even jewellery. The bakelite products from this era are now highly collectable! Today, plastics are found in almost every product. It's difficult to find many machines that do not incorporate several types of plastic.

◆ What Are Plastics?

Plastics are polymers: long chains of atoms bonded to one another. Plastic is a term that actually covers a very broad range of synthetic or semi-synthetic polymerisation products. They are composed of organic condensation or addition polymers and may contain other substances to make them better suited for an application with variances in heat tolerance, how hard it is, colour, and flexibility. Plastics can be moulded or formed into particular hard shapes, or be developed as a films or fibres. At some stage in its manufacture, every plastic is capable of flowing. The word plastic is derived from the fact that many forms are malleable, having the property of plasticity. Engineers often turn to a plastic as component parts in many products because it is lightweight, relatively inexpensive, and durable. It has reduced the cost of many products, and many products would not exist today without plastic.

◆ Plastics Engineers

The development of plastics launched a new field of work: Plastics Engineers! They study the properties of polymer materials, and develop machines that can shape plastic parts. They explore ways to mould plastics to meet the needs of other engineers who need parts, such as mobile phone covers, soles of shoes, and backpack wheels. They also work to improve the performance of plastics, looking for new materials that react better to high or low temperature or repetitive motion.

◆ Short Timeline

1907:	the first plastic based on a synthetic polymer -- Bakelite -- was created by Leo Hendrik Baekeland. Bakelite was the first plastic invented that held its shape after being heated.
1908:	Cellophane was discovered by Swiss chemist Jacques Brandenberger.
1920's:	Cellulose acetate, acrylics (Lucite & Plexiglas), and polystyrene are produced.
1957:	General Electric develops polycarbonate plastics.
1968:	Consumption of man-made fibres tops natural fibres in U.S.
1987:	Nipon Zeon develops plastic with "memory" so that it can be bent and twisted at low temperatures, but when heated above 37 Celsius it bounces right back to its original shape!
1990's:	Plastics recycling programs are common, offering new use for old plastics.

A Century of Plastics

Student Resource:
Pre-Plastic History of Everyday Objects

◆ Toothbrush

The earliest known toothbrush was a "chew stick" made of chewed or mashed twigs. This style of dental hygiene dates back thousands of years. More recently, toothbrushes were manufactured with bone handles with the bristles or hair of pigs wound together using wire. This style was popular from as early as the 1600's well into the mid 1800's, though the handle was sometimes made of wood. The next major design change was prompted by the introduction of Nylon. This synthetic material was first applied to the toothbrush around 1938. By 1939 engineers began to develop electric toothbrushes to improve the effectiveness of brushing. The first real electric toothbrush was developed in Switzerland in 1939. In the United States, Squibb introduced an electric toothbrush in 1960, followed by General Electric introducing a rechargeable cordless toothbrush in 1961. A rotary action electric toothbrush was introduced by Interplak in 1987. Even dental floss, which originally was made of silk threads wasn't popularised until the advent of plastics and synthetic materials.

◆ Pen

For the first three thousand years since the invention of paper, the writing instrument most people used was a quill of a bird -- usually a goose -- which was dipped in a well of ink. Mass-produced steel pen points began to appear in the early 1800s, which provided more control over the line. During World War I, pens began to be made of a hard, usually black, rubber substance knows as vulcanite. Early coloured plastics were introduced in the 1920's. Sheaffer introduced pens made from celluloid in different colors. These were very expensive, but proved so popular that within a few years most fountain pen manufacturers were offering pens in the new synthetic material, replacing some metal and wood designs. However, it was the widespread use of plastics and the engineering of the non-leaky ball point pen that brought the cost of fine writing instruments down and within reach of most people. By the 1960s, disposable, ball point pens took over, and while fountain pens remain available, they have only a very small share of the market today.

◆ Eyeglasses

Eyeglasses were originally crafted of metal and glass. If someone required a particularly strong prescription, however, the glass would be very heavy resting on the nose. Plastics revolutionised glasses, by replacing the glass lens with lighter weight material, and replacing most of the metal in the frames with lighter, colorful, plastics. There is still metal in the frame however, as most hinges are still made of metal. And, of course, there would be no contact lenses without the development of synthetic materials.

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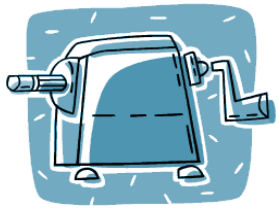
Student Worksheet:
Plastic Hunt!

Step One: As a team think about items you can find in your home, classroom, or on the playground. Can you identify any items that have no component parts made of plastic?

Kitchen Items	Bathroom Items	Classroom Items	Sports Equipment

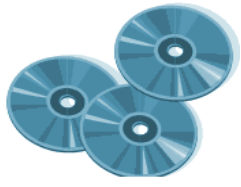
Questions:



1. Was it harder than you thought to find products that contained no plastic?

2. Of the products you found with no plastic, what did they have in common?

3. If you were reengineering one of the products you found, would you change any of the component parts to plastic? Why? Why not?



4. Do you think CDs would be possible without plastics? Why? Why not?

5. Why is recycling important?

Student Worksheet:
You Are the Engineer

Step One: As a team, come up with a list of four machines or products that you think would be impossible without the invention of plastics. For each, answer the questions below:

	What % of product is plastic?	Why would this be impossible without plastic?	How has this machine or product impacted the world?
1-			
2-			
3-			
4-			

Step Two: Your challenge is to work as a team of "engineers" to replace some of the plastic in any of the four products or machines you identified in the first part of this worksheet to make them easier to recycle. Discuss what materials you will use instead, how it will impact performance, price, or aesthetics. Then present your ideas to the class including the following:

- describe what your product does, and the percentage of it you think is plastic.
- explain which components you will replace with other materials, describe how you selected the replacement materials and how the new materials will impact weight, cost, and functionality of the product.
- predict whether this product will be as effective as the current design, whether it might cost more to manufacture, and how it would be easier to recycle.
- describe how your team believes that the engineering of plastics into common products has impacted the world.

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For Teachers:
Alignment to Curriculum Frameworks

Note: All Lesson Plans in this series are aligned to the Australian Curriculum for both Science and Maths.

	Year Level					
	5	**6**	**7**	**8**	**9**	**10**
Science Understandings				Chemical change involves substances reacting to form new substances **(ACSSU225)**		Different types of chemical reactions are used to produce a range of products and can occur at different rates **(ACSSU187)**
Science as a human endeavour			Scientific knowledge changes as new evidence becomes available **(ACSHE119 – Yr 7); (ACSHE134 – Yr 8)** Science knowledge can be developed through collaboration and connecting ideas across the disciplines of Science **(ACSHE223 – Yr 7); (ACSHE226 – Yr 8)**			
Science Inquiry Skills			Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge **(ACSIS124 – Yr7); (ACSIS139 – Yr 8)** Summarise data and use scientific understanding to identify relationships and draw conclusions **(ACSIS130 – Yr 7); (ACSIS145 – Yr8)** Communicate scientific ideas and information for a particular purpose **(ACSIS133 – Yr7); (ACSIS148 – Yr8)**		Formulate questions or hypothesis that can be investigated scientifically **(ACSIS198)** Use knowledge of scientific concepts to draw conclusions that are consistent with evidence **(ACSIS204)** Communicate scientific ideas and information for a particular purpose **(ACSIS208)**	

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

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 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.