Science
LEARNING CENTRES

Engineering Case Study

The Paper Cup Company

Industrial Story

This is the story of relatively simple technology in a very competitive industry.

The American Lawrence Luellen first became interested in an individual paper drinking cup in 1907. It was realised that healthy and diseased people were all drinking from public water barrels, wells or pumps with a communal cup; this was a source for the spread of micro-organisms and disease.

Since then, the paper cup has evolved from simply a healthy option to an everyday convenience object upon which many companies advertise their products and services.

Cups for cold drinks are made to handle cold drinks only and often have a waxy coating inside to keep the paper from becoming wet and collapsing from the absorption of liquid. They can be easily emblazoned with logos etc. because the outside surface is smooth. Some companies have discontinued the use of wax and replaced with Polyethylene (PE) board; PE produces a better, more waterproof cup, a better print quality for logos, and unlike wax, PE can be recycled.

Cups that need to hold hot drinks have to be specially engineered to withstand the heat that cold cups cannot. They can be insulated to help keep drinks warm and stop hands from getting burnt.

Hands burn very quickly when hot drinks are placed in thin, single walled paper cups because the heat energy passes easily through the thin walls.

Manufacturers started to make the single paper/cardboard walls thicker to slow down the energy transfer, but the temperature inside and outside the cup still became the same, although more slowly.

Single walls of varying thickness were then engineered into a paper cup of double walled construction with an air pocket between the walls.

Another recent development for hot cups has been the hot paper cup sleeve. This sleeve is slid onto the cup to help prevent fingers from getting burned by the heat of the drink.

Subsequent engineering developments included double-walled cups, and then the multi-layered paper cup designed with a corrugated middle layer of tiny air pockets. Like the vacuum between the walls of a thermos, the air pockets in the cup slow down the rate of heat loss, keeping drinks hot longer and hands cooler. The smooth outer surface enables sharp, clear graphics so sponsors' logos really stand out.

Some manufacturers have produced cups with ridged outer surfaces called Ripple cups. They are excellent at insulating hands from the heat of the drink due to their increased surface area but are not good for sponsorship because the image is distorted.

Fully biodegradeable cups are in demand, but there are many issues to consider here. PE that has been used for many years to make the paper water resistant and is melted onto the seams to prevent leaks, is an oil based plastic, but is not biodegradeable. Some companies are starting to use Polylactic acid (PLA), a plastic that is derived from corn starch, and is biodegradeable.

However, PE coating represents only a very small % of the total weight of the cup, and is completely stable, and it could be argued that corn starch should be being used for feeding people.

Some cup companies sell cups with dried ingredients in the base, so consumer needs only add boiling water e.g. instant cappuccino with 'froth' or white tea

Each type of cup has its own problems, and engineers continue with their research and development.

Resources for teachers

Cup Company to illustrate the types of cups they sell. They have Silver Mercury Award 2007 for 'IN CUP' with poducts already loaded into cups. Download from their web site:
http://www.cupcompany.com/acatalog/index.html

Engineering Case Study - The Paper Cup Company

KS3 Sci links

1 Key Concepts 1.1a 1.1b 1.2b
2 Key Processes 2.1a 2.2b 2.3a
3 Range & Content 3.1 3.4c
4 Curriculum Opportunities 4a 4f 4g 4h

You can link to the full programme of study at:
http://curriculum.qca.org.uk/key-stages-3-and-4/subjects/science/keystage3/index.aspx

Activity

Dragon's Den type scenario, where the Dragons represent Managing Director, Transport Director, Marketing Director and Production Manager of a paper cup company who are looking to manufacture and sell a new type of cup.

Teacher-led at the start, where pupils (engineers) are encouraged to conclude for themselves that the following characteristics should be considered when engineering a new cup:

1. Ergonomically good (looks nice)
2. Practical (meets consumers' needs)
3. Cheap to manufacture (single wall preferably because only needs one machine)
4. Easy to manufacture (" " ")
5. Good branding possible because easier to sell
6. Environmentally sound (ideally should be fully bio-degradeable)
7. H&S considerations(e.g. if FULLY insulated then customers don't know the contents are hot until liquid touches their lips)
8. Producible in large volumes

Pupils in groups and given 20 minutes to come up with a good product.

They then need to pitch their design to the Dragons, hoping for sales

Finally, the teacher shows the pupils what products are actually on the market.

http://www.cupcompany.com/

Need some web site examples here other than Paper Cup Company to show the full range. eg
http://www.thepapercupcompany.co.uk/content_home.php
http://www.ripplecups.com/
http://www.solocupeurope.co.uk/products.asp
http://www.printedcupcompany.co.uk/

Science
LEARNING CENTRES

Other suggestions

Start pupils off showing them a single walled paper cup and ask them what's wrong with it. Let pupils' suggestions lead through the actual development story (and have examples of these types of cups hidden to bring out as they suggest them! Collect them as you find them!).

Homework: recount the story of the development of the paper cup. Imagine that you are the manufacturer and consider any dilemmas you may face.

Discussion document below could be used to start a class debate or set as a homework where both sides of the argument need to be considered:
http://en.wikipedia.org/wiki/Paper_cup

'Paper cups have an environmental impact. Although the cups themselves are made from renewable resources (wood chips), paper cups actually consume more non-renewable resources in their manufacture than cups made of polystyrene foam, since converting the wood chips to paper pulp requires energy. During their life cycle, the only significant effluent of polystyrene cups is pentane. In contrast, the manufacture of paper requires several inorganic chemicals and creates large amounts of water effluents. Similarly, recycling polystyrene cups has less impact than recycling paper cups. Paper cups are, however, more biodegradable than polystyrene cups, with the caveat that in an anaerobic landfill paper cups will generally remain undegraded for a long time.'