Name: _____

Teacher: _____

D&T Group: _____

Tutor Group: _____
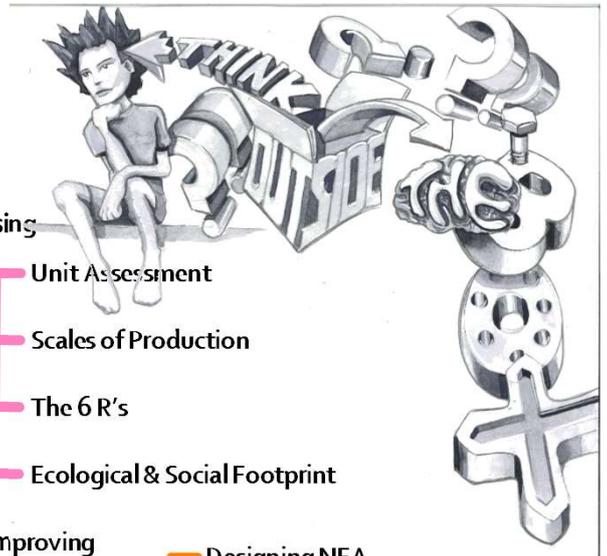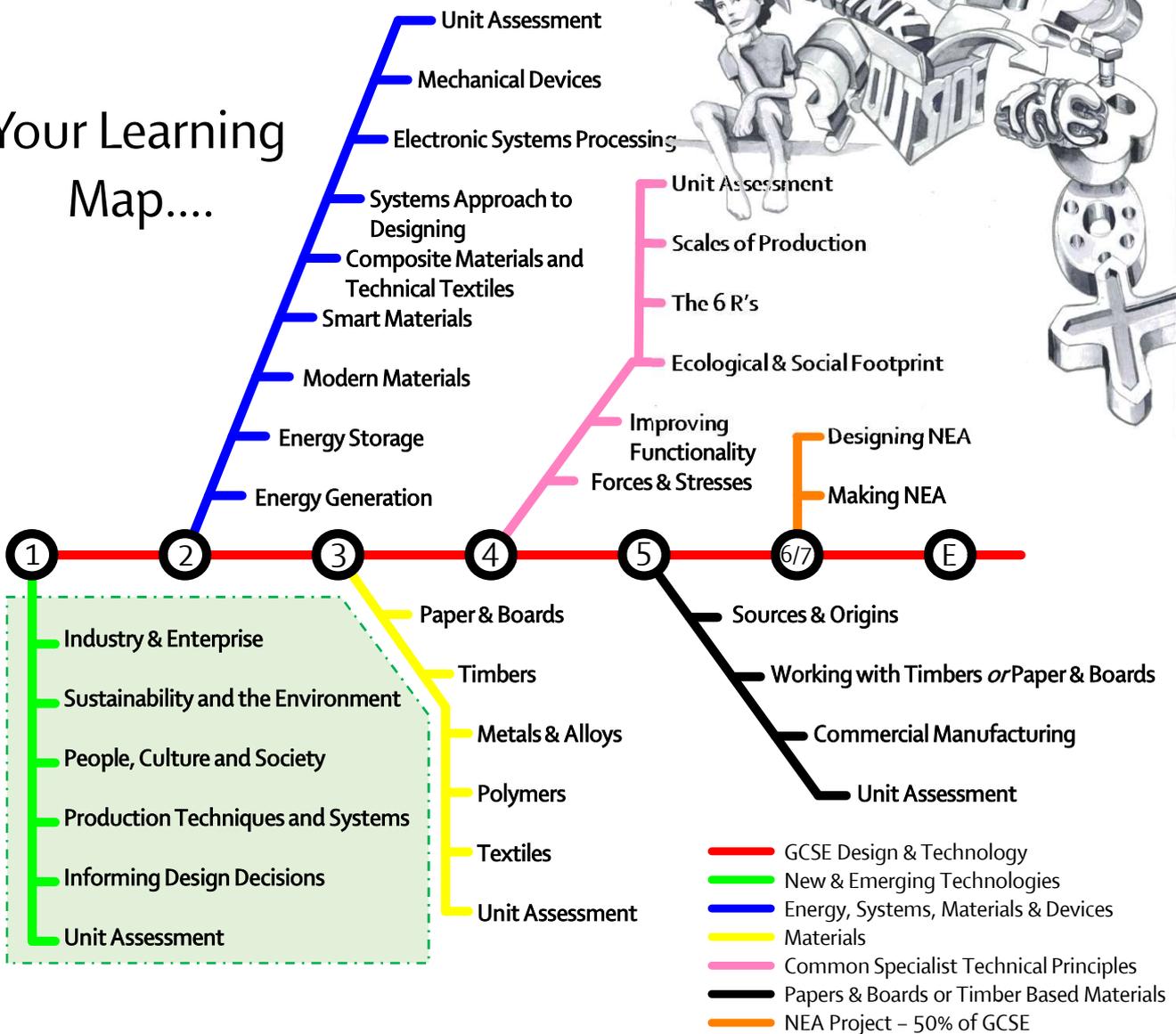
## Subject:   Design & Technology

**Progress band target:** _____
This is the target for the end of Year 11.
Targets will become more specific as you move up the year groups.
Your work will be marked as:
**Below / On / Above / Well Above**
the path to this target.

## Your Learning Map....

Unit Assessment

Mechanical Devices

Electronic Systems Processing

Systems Approach to Designing

Composite Materials and Technical Textiles

Smart Materials

Modern Materials

Energy Storage

Energy Generation

Unit Assessment

Scales of Production

The 6 R's

Ecological & Social Footprint

Improving Functionality

Forces & Stresses

Designing NEA

Making NEA

① ② ③ ④ ⑤ 6/7 E

Industry & Enterprise

Sustainability and the Environment

People, Culture and Society

Production Techniques and Systems

Informing Design Decisions

Unit Assessment

Paper & Boards

Timbers

Metals & Alloys

Polymers

Textiles

Unit Assessment

Sources & Origins

Working with Timbers *or* Paper & Boards

Commercial Manufacturing

Unit Assessment

| | |
|---|---|
| ▬▬ | GCSE Design & Technology |
| ▬▬ | New & Emerging Technologies |
| ▬▬ | Energy, Systems, Materials & Devices |
| ▬▬ | Materials |
| ▬▬ | Common Specialist Technical Principles |
| ▬▬ | Papers & Boards or Timber Based Materials |
| ▬▬ | NEA Project – 50% of GCSE |

## The place of work:

The development of the internet, improvements in communication technology and the speed of data transfer across the world allows teams of people to collaborate remotely—they don't have to be in the same, single place of work. Software designed to enable collaborative working allows teams of designers to work on one project from different parts of the world at the same time. Designs can be sent to machines to be tested using CAM techniques including CNC machines (i.e. laser cutters) and RPT machines (i.e. 3D printers).

A manufacturing company also needs to consider the layout of it's buildings. The workflow will need to be logically designed to ensure each stage of designing, manufacturing and delivering a product to market is as efficient as possible. This allows a company to minimise unproductive time, unnecessary movement and the waste of materials, making the company as efficient and therefore profitable as possible.

## Enterprise

Enterprise in relation to design means that an idea is cultivated into a business proposal that has a commercial viability as a production. The use of the internet and the boom in social media platforms allows creative people to get their ideas noticed by potential investors rather than visiting bank managers or sending proposals out to existing companies.

A number of agencies look out for start-up businesses to invest in, one of the biggest growth areas is in app design and development for smart devices. The ensure that original ideas and inventions remain the intellectual property of the person who invented them a patent can be applied for. This legal process proves that you are the first person to have registered the ideas. In theory it stops individuals or other companies using a patented idea without permission. You could see a registered logo on a product to show that it has been registered.

## Crowdfunding

This is a popular way for designers and entrepreneurs to raise money to enable the manufacture of their products. Crowdfunding is an internet based way to gain small contributions from many different investors who believe in the product or idea. Blogs and Vlogs are also targeted to new audiences. A more subtle form is search engine optimisation—companies make efforts to boost their website higher in search engine results. It can also include paid for advertisements in social news feeds or on search results.

## Virtual Marketing and Retail:

This means using websites, social media and digital marketing t reach a wider audience to promote a product or idea. Virtual campaigns can use social media to spread the word and have become a popular way to launch product. www.kickstarter.com is an example of a crowdfunding site for design and technology based ideas.

A cooperative is an enterprise that is owned and run by its members—the members may comprise its workforce or its customers. They enable a group of people with the same business interest to have greater protection, they can be cost effective way to sell goods, and services are usually based around a community. They are set up to protect the rights of its members.

Fairtrade is about better prices, decent working conditions and fair terms of trade for workers in less economically developed countries. It is based in partnership between those who grow the food and those who consume it. The Fairtrade mark means the ingredients in the product have been produced by small-scale farmer organisations that meet Fairtrade standards.

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## Key Questions:

- Which inventions do you feel have significantly changed the way people live their lives? Justify your responses with examples.
- Which technological developments in agriculture have led to fewer people being needed within the industry?
- How could automation have affected the hierarchical structure of an organisations staffing? Give examples.
- Why is the ability to sketch and design by hand still considered important by many designers despite the advancement of Computer Aided Design?
- List the positive effects that full automated robotic production lines have had on employment.
- List the negative effected that full automated robotic production lines have had on employment.
- Explain the low-cost methods of self-promotion and advertising that could be used by young designers to get their ideas as noticed.
- How might the staff-owners of a worker co-operative be motivated differently to the staff of a non-cooperative style organisation?

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The way in which designers, architects, engineers work has altered dramatically with the introduction of computers and specialist software.

Sketching of initial ideas and designs is still seen as the best way to get thoughts on to a page to communicate them, the development of those designs will almost always involve the use of COMPUTER AIDED DESIGN (CAD). By using specialist software packages the detailed analysis and manipulation of designs can be achieved quickly—saving valuable time and money.

Software can also work out very complex tasks including virtual stress tests, flow dynamics and the manufacturability of a product. This is called computer-aided testing (CAT)

**Key words:** (Find out what these mean!)

| | | |
|---|---|---|
| Virtual Marketing | Computer Aided Design | CAD |
| Virtual Retail | Computer Aided Testing | CAT |
| Fairtrade | Flow Dynamics | RPT |
| Crowdfunding | Computer Aided Manufacturing | CAD |
| Enterprise | Rapid prototyping | CNC |
| Automation | Collaborative working | Commercial viability |

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## Industry and Enterprise

### What you need to know:

- Understand how new and emerging technologies have changed the way we live and how they continue to shape the modern world
- Be aware of how computers and automation have impacted upon the design and organisation of the workplace through the use of robotics
- Understand how innovation can drive product development

### New and Emerging Technologies Introduction:

Design and Technology is the practical application of Science. Design technologists utilise discoveries from Science and turn these into new ideas, materials and products to fulfil human needs. As a Design Technologist your role will be to embrace change and turn ideas into reality. The driving force behind many new inventions is the human instinct to strive for a better and easier life.

To stay at the cutting edge of design and development—designers and manufacturers need to keep up to date with the latest inventions and ideas in materials development, electronics and designing.

The Industrial Revolution began around 1760—it began with the discovery of how to harness water power to drive machinery leading to the invention of the steam engine. This invention led to greater automation and since then an ever-increasing number of new technologies has helped to shape and improve the way we live. For example, electricity was discovered, this led to the invention of the light bulb, the telephone, the internal combustion engine, the computer, the internet...

The first personal computer was built in 1975, a significant number of people didn't have access to one on a regular basis until the mid 1990's. Within the last 20 years there has been a huge change in how computers have been included into our lives—especially when we consider the introduction of the smartphone. It is impossible to consider how our society could exist without computers in our daily lives, but this was the case not so long ago!

### Industry and Automation

Prior to the industrial revolution most people lived in the countryside working on the land. As automation developed and led to larger workshops and factories, more people moved away from the countryside to find work in these environments. Gradually a society based on consumerism and enterprise developed around areas of manufacturing—people had money to buy goods and so services and manufacturing areas boomed. This was the start of the society that exists today.

Greater demand for products originally created jobs as the machines needed manual labourers and operators to keep them running. Today with the introduction of intelligent machines and robotic production lines many of these jobs have been lost. Fully automated production lines only require a few highly skilled engineers to ensure that smooth running is maintained.

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## Worksheet 1: Industry and enterprise

### Task 1

Cars manufacturers are steadily producing new electric vehicles. One day, we may see the end of the internal combustion engine and the 'traditional' motor car.

Why is battery technology crucial in the development of electric vehicles?

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What could the government do to encourage electric vehicle ownership given the shorter range that they have compared to fuel-powered cars?

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A small independent car maker hand builds cars in a large garage space. As the company grows more space is needed for manufacture and a new premises is required.

The stages of manufacture and assembly are as follows:

External parts assembly

Lacquering

Raw materials received

Quality control

Metal sheet bending

Shipping

Painting

Interior parts assembly

Using the new warehouse plan below, put the stages in order and suggest where each stage should appear on the plan.
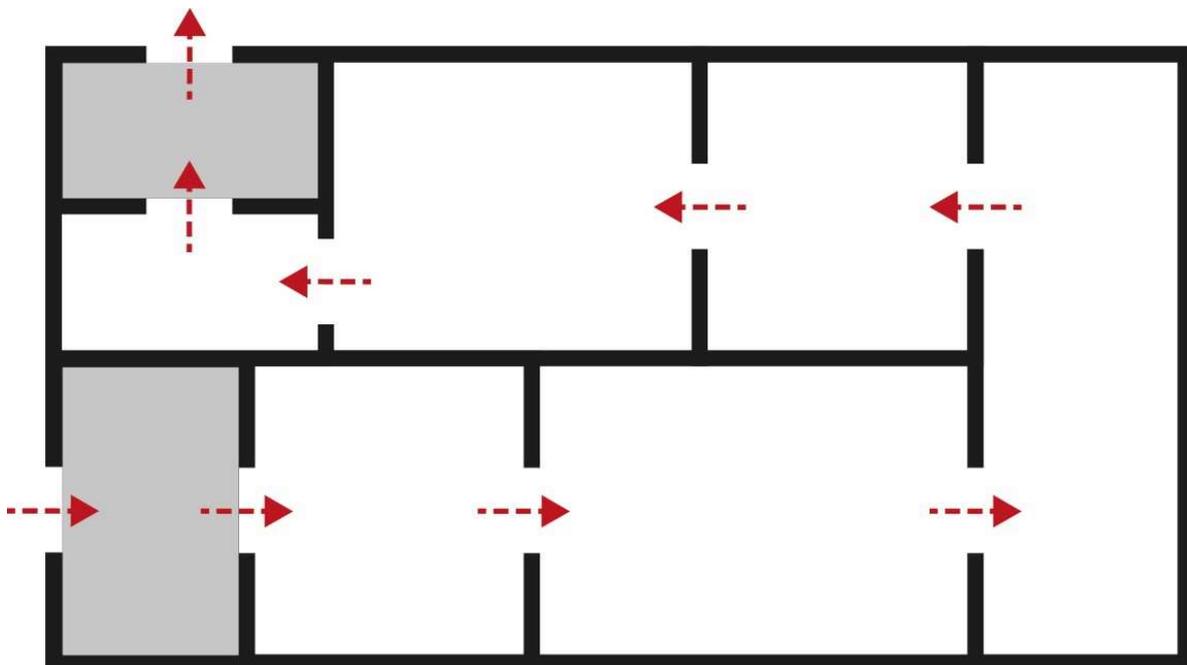
## Task 2 The impact of new technology on enterprise

3D printing technology has been around for over a decade, but it is now starting to become widely accessible. One day all households may have a 3D printer with the ability to print anything to a similar quality as current manufacturing standards.

How might 3D printing change the spare parts industry for small household appliances?

How might this affect the sale of new tools and equipment?

How might a small repairs company benefit from becoming a cooperative?

1. The automotive industry makes use of robotics in production line manufacturing.

   (a) Describe **two** factors that make the production of cars suitable for automated
   assembly line manufacture. [4]

   (b) The introduction of robotics and automation in industry has impacted the design of the
   workplace.

   (i) Explain **one** way in which automation may affect the physical layout of a
   parts warehouse. [2]

   (ii) Explain **one** way in which automation may have changed systems and procedures in
   picking and packing items from the warehouse. [2]

2. The invention of a new and emerging technology often requires significant investment for
product development and advertising before it can become mainstream.

   Explain **one** method a small organisation might employ to increase funding or awareness of
   their new product. [2]

This work is
**Below / On / Above / Well above**
your minimum target path

## Sustainability:

Our planet has to provide all of our basic human needs—food, shelter, warmth. We use and manipulate many of the Earth's natural resources to provide these. The sustainability of the planet's resources is at the forefront of responsible designers' minds when new technologies are created or discovered.

**Resources fall into two categories:**

⇨ FINITE RESOURCES: Are in limited supply or cannot be reproduced. These should be avoided or used only in small amounts for important reasons.

⇨ NON-FINITE RESOURCES: Are in abundant supply, they are unlikely to run out as they can be grown and replaced at the rate they are being used.

We need to measure the impact that the use of resources has on the planet, this includes:

* $CO_2$ emissions—energy needed to produce materials and while they are in use
* Transportation and the distance travelled
* Impact through mining or harvesting to get the resource/material
* Impact on availability—What will be left to use next time?
* Maintenance and repair costs
* Welfare of workers in supplying the material e.g. fairtrade
* Ethical and Moral issues

## POPULATION GROWTH

Population has grown quickly since the start of the 20th century leading to accelerated use of all natural resources, less than a century ago the population of the planet was less than 2 billion.... in 2017 it was 7.5 billion. The impact on the environment due to a larger population using up the resources is increasingly noticeable. New technologies are being developed to try and reduce the negative impact.

## Carbon Off-setting:

It is impossible that goods being produced will have no negative impact on the environment BUT companies can promote their products as sustainable and environmentally friendly if they OFF-SET any negative impact by investing in positive activities that reduce carbon emissions.

A product is considered CARBON NEUTRAL if it produces zero net emissions when the life cycle assessment (LCA) has taken all actions into consideration.

*A carbon footprint is the amount of greenhouse gases ($Co_2$) released by making, using and disposing of a product. The more energy required—the bigger the carbon footprint.*

Key words: (Find out what these mean!)
* Carbon Footprint
* Life Cycle Assessment (LCA)
* Finite
* Non-Finite
* Sustainability

## Key Questions:

* Give two examples of finite resources and two examples of non-finite resources.
* Why should finite resources be avoided or used in limited amounts?
* What can a company learn by conducting a life cycle assessment?
* What are the 5 stages of the life cycle assessment? What impact can each stage have on the environment?
* Explain what the carbon footprint of a product is.
* Explain how carbon off-setting helps to reduce $CO_2$ emissions of a company.
* Define the term sustainability.
* State two factors that could influence the sustainability of a product.
* Find out what the 6 R's are.
* Research The Paris Agreement of December 2015—the first global climate agreement. Find out the main aims.

### How carbon emissions can be reduced...

Reduce energy use and $CO_2$ emissions through more efficient user behaviour

Improve energy efficiency with more efficient appliances and buildings

Incorporate renewable energy

Purchase carbon off-sets

### Waste disposal:

We need to recycle to ensure that the resources we have will last as long as possible. Strict limits are set in many areas of manufacturing, especially for consumer electronics and the automotive industry. Businesses are charged additional fees to dispose of waste so a reduction in waste will save a company money.

## Sustainability and the Environment

### What you need to know:

* Understand that new technologies need to be developed and produced in a sustainable way
* Be aware of the impact that resource consumption has on the planet
* Understand how the environment can be protected by responsible design and manufacturing
* Understand how waste can be disposed of with the least impact on the planet
* Understand the positive and negative impacts new products have on the environment

### Life Cycle Assessment (LCA)

A company can use a life cycle assessment to assess the environmental impact of a product during the different stages of its life. This is known as 'cradle to grave'. There are 5 main stages.

⇨ Extraction and processing—how much energy is used to extract raw material from the earth or produce it through farming and process it for manufacturing.

⇨ Manufacturing and production— The energy needed to manipulate the raw and refined materials into a product

⇨ Distribution— Packaging and transportation of the product to the end user

⇨ In use— The energy that the product and any related consumables used during its working life

⇨ End of life– The energy that is required to recycle the product and/or dispose of any waste
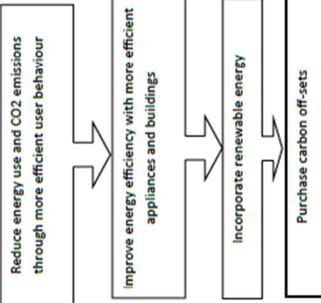
A company could then consider:

* Where can energy be saved?
* Where can working conditions be improved?
* Where can emissions be reduced?
* Where can material be saved?
* Where is there a negative effect on communities or natural environments?

Material processing — Product manufacturing — Resources — Distribution — Use — End

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## Task 1

Look at the product label below for a pair of shoes. List all of the factors that contribute to the manufacturing footprint of this product and state how they affect the environment.

| **8** (US SIZE) | **Style #7653-DC** | | | |
| --- | --- | --- | --- | --- |
| | USA | UK | EU | JAPAN |
| | 8 | 6.5 | 39 | 25.0 |

**Style #7653-DC**
**Leather upper: made in China**
**Rubber sole made in USA**
**Manufactured in Canada**
**Steel lace eyelets**
**Patent finish**

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What finite resources may be used in the production of a pair of training shoes?

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How could these be replaced by non-finite resources to make production 'greener'?

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## Task 2 Life Cycle Assessment

Use the labelled diagram below to help you conduct a Life Cycle Assessment on a plastic supermarket shopping bag.



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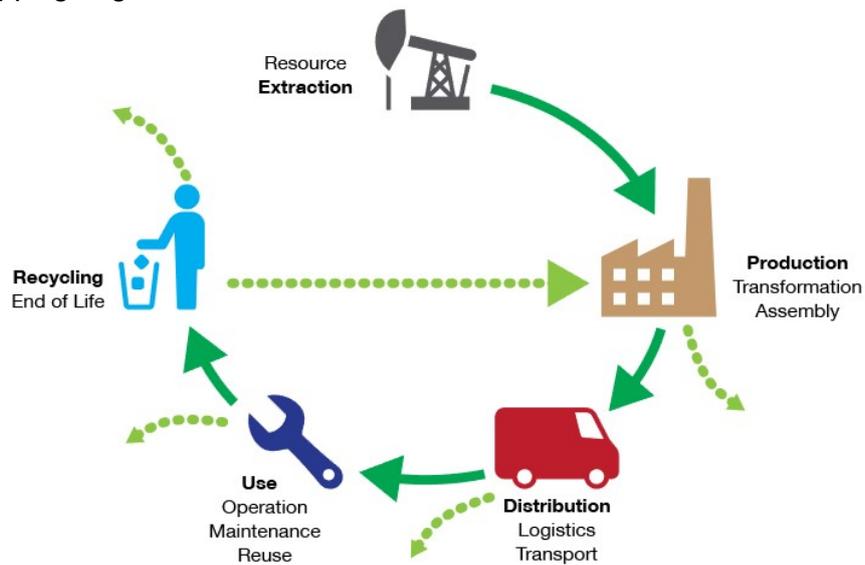
What could you do to improve the environmental impact of a shopping bag?

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How might plastic bags contribute to pollution in the air and water?

How does this impact global warming?

What new material is being used to provide an alternative solution?

How is the consumption of plastic bags being reduced in the UK?

## Homework 2: Industry and enterprise

1.  Energy sources can be categorised as either finite or non-finite.

    (a)    State what is meant by a finite resource.                                    [1]

    (b)    Give **one** example of a non-finite energy source.                          [1]

    (c)    Explain **one** benefit to the environment of using non-finite energy resources.   [2]

2.      Manufacturers frequently make choices about their suppliers of raw materials based on their impact on society and the environment. Examples include the use of recyclable components, fair trade textiles and biodegradable packaging.   Discuss how these choices may improve the ethical image of a company.                                                                 [6]

3.  The Japanese 'Kaizen' culture describes continuous improvement.

    (a)  Describe what is meant by 'continuous improvement'.          [2]

    (b)       State how employees are commonly involved in the continuous improvement process.          [1]

4.  State **one** way in which manufacturing and consumption affects:

    (a)  pollution levels          [1]

    (b)  global warming          [1]

This work is
Below / On / Above / Well above
your minimum target path

## PUSH

Designers, engineers and technologists often use new technological discoveries in the development of new products. Often there is no consumer awareness or demand for the product. This is called technology push. Current thinking is driven forward and new, exciting developments are created. Research and Development (R&D) departments in large companies ensure new and exciting products can be created.

New products need to be developed so that a company is able to be first to the market and therefore keep their market share… rather than consumers going to the competitor because they got there first!

Without R&D many products would never have made it to market.

## PULL

*Market pull* is when consumer demand is the driving force behind the development of a new product. If a designer can analyse the consumer market to understand the needs and desires, a 'gap in the market' can be filled. Market pull puts pressure of companies to update and improve their product. They can then keep their share of the market through brand loyalty AND with new products also attract new customers.

Smartphones are a great example of market pull leading to development of a product e.g. combination of features, improved battery, miniaturisation of electronic components.

## Digital Development

New technologies are being developed faster than ever before. The growth in digital and social media has begun to impact the sustainability of traditional job roles. Automation is leading to a decreased need for manual labour and therefore a change in job roles and working conditions is inevitable. The human workforce needs to and will up-skill—the jobs people train for will be of a higher value. The workforce will need to be flexible and workers of the not so distant future will be performing tasks that do not exist today. The way we work will be driven by technological change and advances.

The population is ageing. As advances in medical care, and other factors now lead to people living longer than ever before, the design of new products using new technologies to meet these needs is increasingly important. Not everyone who lives longer will be as strong or as healthy as the younger generations. Products that address specific difficulties or offer a better quality of life will find a growing market.

### Key Questions:

- List 3 products that would sell well in one country but not in another. Give reasons for your answers.
- Explain what the positive and negative factors of a global market place are for the manufacturer.
- Explain what the positive and negative factors of a global market place are for the consumer.
- How can a company keep up to date with the latest trends in their sector?
- What is market testing?
- Why is market testing important?
- Why would being first to market a new product give a company a competitive advantage?
- How could market push affect the development of smartphones in the future?
- Explain the advantages and disadvantages of crowd funding.
- Why might a company choose robots over humans?
- Evaluate how research and development contribute to new technologies or products being developed.

## Society

Most societies are trying to become more inclusive and cater for the needs of the disabled and elderly. New technologies have enabled designers and manufacturers to create products such as tools and household gadgets, building access, and transportation methods that will drastically improve the lives of disabled and elderly people. A designer should consider inclusive design when developing any product—the more people a product will appeal to the more popular it will be. Designers need to be aware of who could be excluded from a product and consider any modifications which could make it more accessible.

Modern technologies play an important role, for example, the use of carbon fibre has allowed disabled people to take part in activities previously not open to them e.g. sports—equipment for Paralympians is at the cutting edge.

**Key words:** (Find out what these mean!)
Manufacturer
Consumer
Culture
Marketing
Technology Pull/Market Push
Inclusive Design

## People, Culture, and Society

**What you need to know:**

- Understand how technology push and market pull affect consumer choice and employment
- Understand changes in job roles due to the emergence of new ways of working
- Be aware of changes in fashion and trends and how they affect designers and manufacturers
- Understand how new products can have both a positive and negative impact on society

### People and Culture

Understanding the market place and the people who will buy and use new products and technologies is important for all designers and manufacturers. When launching a product designers and manufacturers need to consider many different factors. This is because people across the world can have very different needs and tastes. Products selling well in one country can become a complete failure in another.

Culture is the combination of ideas, beliefs, customs and social behaviours of a society or group of people. This can be shown through rituals, fashion and art. Designers need to be aware of the society around them and the cultures within it.

Some parts of the world are still dominated by a single culture, designing in these cultures can be seen as easier as there is less diversity and the majority of the population have similar lifestyles. A negative for manufacturers is that they may require a more limited range of products. In the UK and especially in large cities there is a wide range and mix of cultures—selling a product in this market could be challenging as many more factors need to be considered.

The product design market can quite often be influenced by the 'latest thing'. Consumers want to be part of a group, to fit in, or to buy into a lifestyle. Designers and manufacturers buy into peoples insecurities and design and make products that people feel they 'must-have'. Fashion is a great example—the latest designs are only meant to last a season before they are outdated or people have moved on to the next new thing.

Designs influenced by a fashion trend are common… Marketing a product to the correct audience is the key. The font used in an advert could be chosen to give the impression of an expensive product, or a rival company could use a font to imitate a brand leader.

Products can fail for many reasons, one of the easiest mistakes to make is the use of a brand name that means something else in a different language, or using a brand name that when turned into a web address creates a new word with different meaning. This is why market testing is vital!

The £5 note was replaced recently. The new polymer Bank of England £5 note contains tallow— this is an animal fat-based substance. Hindu, Sikh and some other faith based communities often choose to follow a vegetarian diet as part of their culture and beliefs, as well as not eating meat some will also choose to avoid using animal products in their every day lives as well. This is also the case for some vegetarians and vegans. Why could the new £5 note cause issues?

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## Task 1

Modern technology has enabled a wealth of new products and functionality.

a)  State whether each of the following items has been developed from either market pull, or technology push forces.

   Give a reason for your each of your choices.

| Technology | Market pull / Technology push | Reason |
| --- | --- | --- |
| Reusable shopping bag | | |
| Digital camera | | |
| 3D TV | | |
| Car airbag | | |
| Flash memory sticks | | |
| Robotic vacuum cleaner | | |

Factories manufacturing mobile phone technology are becoming more and more automated, using robots for parts assembly and warehouse control. Despite this, they employ hundreds of thousands of people.

b)      What makes a role more or less likely to be replaced by a robot or an automated process?

_____

_____

_____

c)      Put the following job roles in order of those that are most under threat from automation:

| Job role | Order 1 (Most under threat) - 10 |
|---|---|
| Personal assistant or secretary | |
| Graphic designer | |
| Sewing machinist | |
| Large goods vehicle driver | |
| Vehicle assembler | |
| Teacher | |
| Pilot | |
| Mechanical engineer | |
| Packer, bottler, canner or filler | |
| Routine inspector and tester | |

d)      Discuss how the roles of people in manufacturing will have changed with the introduction of robotics and automated procedures.

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## Task 2

Colour can be used to indicate meaning, but this meaning can be understood differently in different cultures.

a)      Suggest a suitable colour indicator for ecology, or safe passage such as a fire escape.

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b)      What emotions or meaning does this colour convey?

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c)      Find out what meaning the colour green has in various societies.

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d)      How might this affect your choice of colour for the packaging of a new environmental product designed for sale internationally?

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## Task 3

Amazon Air launched their first UK drone delivery in December 2016. A package was safely delivered to its destination in Cambridge in just 13 minutes after the order was placed.

Amazon drones take off and fly completely autonomously along preset flightpaths at 400m above ground level, guided by GPS. They are capable of carrying orders weighing up to 2.7KG.

a)      How might the new Amazon Air delivery service affect those offering a traditional delivery service for Amazon?

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b)      What restrictions might there be on the operation of delivery drones?

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c)      How might the new service affect delivery services offered by competitors?

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d)      What negative impacts might this service have on society?

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1.  'Technology push' and 'market pull' are forces that bring new invention and discovery to the market place.

    (a)  Give **two** reasons why a competitive advantage can be gained by a company in being the first to push a new technology onto the market. [2]

    (b)  (i)  State what is meant by 'market pull'. [1]

         (ii)  Give one example of a market pull force. [1]

2.  A supplier is discovered to be selling clothing items of a similar quality significantly cheaper than any of its competitors.

    (a)  Discuss any ethical questions that retailers might ask before purchasing stock? [4]

(b) The supplier reports that its materials are produced in a factory that is entirely automated.

Explain **one** reason why automation might enable a factory to reduce production costs? [2]

(c) Suggest **one** cost that may increase with an increase in automation. [1]

3. A new supermarket is being built on the outskirts of a town.

Discuss how its design might incorporate features to avoid negative impact on minority groups including the disabled and the elderly. [4]

This work is
**Below / On / Above / Well above**
your minimum target path

Total 15 Marks

## Production Techniques and Systems

**What you need to know:**

- Understand contemporary and potential future use of automation, Computer Aided Design (CAD), and Computer Aided Manufacture (CAM).
- Be able to recognise and characterise the use of Flexible Manufacturing Systems (FMS)
- Understand how Just in Time (JIT) and lean manufacturing contribute to manufacturing efficiencies

### Automation

The use of computers in production lines make them flow more easily and lead to less human interaction needed. In the past manual production lines were slower and more expensive to operate than the automated production lines used today. Despite this, some traditional manufacturers still rely on skilled manual labour. Products made in this way tend to be bespoke, low volume and high cost items, including sports cars or high-end furniture.

Most manufacturing is still becoming increasingly automated. Automation involves computers using complex software systems that have an overview of many aspects of the production. Production data management is the term used to describe these software systems. All of the data is stored centrally, is updated live and is accessible by all employees who need the most up to date information. This reduces mistakes, ensures that all teams in the company can work together, leads to accurate costing and forecasting production progress.

### Computer-Aided design and manufacturing

Computer aided design (CAD) and computer aided manufacture (CAM) are essential to ensure smooth transition between the designing and manufacturing stages of creating products. CAD is used in the design of new products using specialist computer based software. CAM is uses the CAD files to turn these designs into prototypes or finished products. Many designers still prefer to start sketching an idea using pen and paper in order to express ideas more freely. Once the design has been created CAD can be used to re-sketch accurately and can be used to manipulate and test the design until it is finalised.

Both CAD and CAM work through the use of computer numerical control (CNC). This is when the CAD software generates a series of machine codes which are interpreted by the CNC machine into movements of the machine bed or other actions such as motor speeds to control needles or cutters.

In schools common CAM equipment includes laser cutters, vinyl cutters, computerised sewing and embroidery machines, CNC routers and lathes.

### Flexible manufacturing systems (FMS)

This refers to a collection of automated machines that are adaptable and used in production lines where the products being made may change on a regular basis. Manufacturers can respond quickly to changes in the market and consumer demands, it also allows for a reaction to trends and fashion. FMS machines are flexible and adaptable, they are best equipped for batch production. The need for flexibility could add further set up costs to the production. CNC machines are frequently used in FMS as they can be reprogrammed easily so changes are quick, simple and cost effective. Robot arms are also used because they can be programmed to do many tasks. They can also perform multiple tasks while on one production line, making the FMS capable of real time changes and greater flexibility during manufacture.

### Lean Manufacturing

Lean manufacturing is based on an ethos of eliminating waste in manufacture. An increasing number of responsible manufacturers now adopt this principle to save money and resources. This first began in Japan during the 1990's but has grown in popularity across the world. Manufacturers are cutting down on the waste they produce by changing the way they operate. An example of this is to use Just In Time production methods (JIT)

### Just In Time Manufacturing (JIT)

Using Just In Time production methods manufacturers are able to respond to customer demands more effectively. JIT manufacturing ensures that customers get the right product at the right time and at the right price. A customer's order will trigger the production proves and the manufacturer makes the product specifically to meet the order. Stock is not ordered until the product will be made, reducing waste and making production more economical as stock is not ordered of not needed.

### Key Questions:

- Which types of products would be best produced using the JIT production method? Why?
- Find out about the term KAIZEN.
- How could Kaizen be used to support the lean manufacturing philosophy?
- How would FMS allow a company to respond to trends and market changes?
- Explain the term Product data management.
- Why is it a good idea for companies to invest in product data management software?
- Why do some people still prefer to purchase hand-built items instead of mass produced products? What kind of products may sell better if made by traditional methods?
- What is meant by a machine being 'computer numerically controlled'?
- How can CAD/CAM save on shipping costs for a business?
- Find out about CAM equipment available in school—what are the advantages and disadvantages of these?
- Find out about design software—download a free access one and trial use of it!

### Advantages / Disadvantages tables

| Advantages of CAD | Disadvantages of CAD |
|---|---|
| Designs can be altered easily | Software can be difficult to learn |
| Faster to draw complex designs, so saves labour costs and development time | Software can be expensive |
| Design can be saved and historic versions kept and archived. Designs can also be easily copied or repeated. | There can be compatibility issues with the software |
| Work can be sent be email for approval and for manufacture | Security issues—data could be corrupted or hacked |
| Teams of designers can work on the same project simultaneously | Software may need regular updates |
| Designs can be rendered to look photo realistic to gather public or target market opinion | Demand on computer memory |
| Software can process stress testing and associated calculations to predict issues with a product prior to manufacture | Data could be lot in power cuts |

| Advantages of CADM | Disadvantages of CAM |
|---|---|
| Faster than traditional tools | Expensive to set up/buy equipment |
| More accurate than traditional methods | Training costs and time |
| High accuracy and repetition | CAM machines need specialist engineers for maintenance and repair |
| Machines can operate 24/7 | CAM machines can lead to unemployment due to replacing traditional skills/jobs |
| Work can be produced directly from CAD files | |

| Advantages of JIT | Disadvantages of JIT |
|---|---|
| Reduced storage costs as stock is not stored | Relies on high quality, fast and reliable supply chains for materials and components |
| Money is not tied up in unsold stock | All production could stop or be delayed if the supply chain breaks down |
| Orders are secured on a deposit or full payment—money is paid before outlay of materials and production costs | Stock is not ready to be purchased 'off the shelf'. Some customers may not want to wait, so sales could be lost. |
| Materials are supplied as needed, saves financial outlay on unused materials or additional storage | A deposit or full balance usually needs to be paid upfront which may be off-putting for some customers |
| Stock does not become old, obsolete or out of date | Discounts from suppliers for purchasing materials in bulk may not be available |
| Almost all waste is reused or recycled so little landfill waste is produced | |

**Key words: (Find out what these mean!)**

| | |
|---|---|
| Automation | Flexible-Manufacturing Systems |
| Computer-Aided Manufacture | Production data management |
| Computer-Aided Design | Computer numerical control |
| Just-In Time Production | Kaizen |

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## Task 1

Modern production lines at a factory making potato crisps are equipped with automated cameras that take and interpret photos of each crisp as it passes under the camera after being fried. Each time the camera sees a blackened crisp that falls outside the acceptable golden brown colour standard, it is blown off the conveyor by a precise jet of air.

This job was once done by manual quality control inspectors.

a)      Describe the advantages to the manufacturer of using such automated systems?

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b)      Explain the main disadvantage to the manufacturer of using automated machinery?

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c)    Why might a manufacturer advertise their crisps as being 'hand cut'?

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## Task 2

Complete the table to list the advantages and disadvantages of Computer Aided Design over hand drawn designs.

| Advantages of CAD | Disadvantages of CAD |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

## Task 3

Lean manufacturing is based on a Japanese philosophy to eliminate wasteful activities and processes. Match the descriptions with an appropriate area of waste.

| Issue |
|---|
| Stock is kept in a warehouse for up to six months |
| Commonly connected parts are kept in storage bins two metres apart |
| The parts warehouse is three minutes by forklift truck from the assembly area |
| Goods are manufactured at twice the rate they can be finished |
| Goods frequently fail quality control tests |

| Waste area |
|---|
| Overproduction |
| Defects |
| Excessive transportation |
| Unnecessary motion |
| Waiting |

How does Just In Time manufacturing help to reduce areas of waste identified by Lean manufacturing philosophies?

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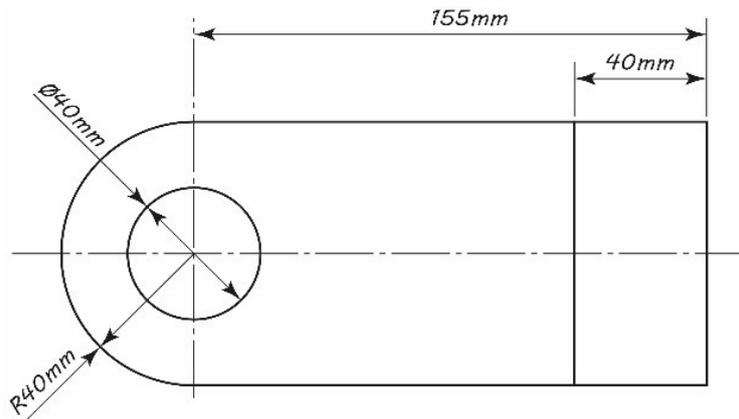## Homework 4: Production techniques and systems

1. Which **one** of the following is a principle of 'lean' manufacturing: [1]
   ◊  Increasing production speed
   ◊  Eliminating waste
   ◊  Reducing quality
   ◊  Improving staff morale

2. Which **one** of the following statements is true? [1]

    ◊   Flexible Manufacturing Systems are largely manual processes

    ◊   Computer Aided Manufacture is slower than using traditional machines and tools

    ◊   Computer Aided Design can only produce two-dimensional designs

    ◊   Computer Numerical Control is used with automated milling machines

3. Describe **one** feature of Flexible Manufacturing Systems (FMS) that make them suitable for producing short runs of a particular part? [2]

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4. A component is shown below.



(a) The part needs to be drawn to a scale of 1:4.
Calculate the diameter of hole **A** on the new scale drawing. [1]

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(b) The part is currently being designed in the UK using a Computer Aided Design (CAD) software package before being manufactured by an automated machine.

   (i)   State **two** advantages of using CAD software to produce the drawing. [2]

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(ii)    Give **one** disadvantage of using CAD to produce the design.                    [1]

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(c)  Explain **two** benefits that just-in-time (JIT) manufacturing could have for the manufacturer of the part.                                                                  [4]

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Total 12 Marks

This work is
**Below / On / Above / Well above**
your minimum target path

| Informing Design Decisions – Notes | GCSE Design & Technology |

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## Planned Obsolescence

When buying products we expect some to last a long time, and others we expect to throw away after just one use. For example a sofa would be expected to last many years, a pair of headphones a year or two, and a ball point pen until it runs out of ink (it is not designed to be refilled and reused). Built-in or planned obsolescence is ensuring that a product will only perform its function for a certain length of time. Designers and manufacturers need to consider this for a number of reasons.

1. **Appropriately engineered quality.**

If a product only needs to last a short amount of time it would be a waste of materials and energy to make it robust enough to last a long time. A disposable razor has a plastic handle because the non-replaceable blade will become blunt quickly, a cheap polymer like polystyrene is the best material due to it being cheaper to produce.

2. **Upgrading and function.**

Some products are designed to receive updates or be upgraded. Manufacturers need to decide how upgradeable a product needs to be. If a product can be continuously upgraded the chances of new sales will be reduced as customers will wait for a significant upgrade to become available before purchasing a new model. If the product does not have enough potential for an upgrade, again money and sales could be lost as it isn't seen as good value for money. The smart phone is a great example of this as it can usually be upgraded a few times, but after a while will stop being able to receive updates or certain features will stop working.

3. **New technologies (Technology push)**

Changes in materials, manufacturing techniques, technologies and customer desires are guaranteed. Most manufacturers will avoid producing goods that will last a long time because as technology moves on, customers will want newer versions.

4. **Fashion and Trends**

Many goods are sold as novelty items which are often led by trends in the market, seasons or fashion. The quality of goods will vary depending on how long they need to last for as well as the price point they are manufactured to. Most Halloween or Christmas items are not designed to last more than the current season so getting a couple of years use out of them is considered a bonus!

### Design for Maintenance

Less and less products are now designed to be repaired. Ones that are repairable often require specialist tools and home repair is discouraged and harder to achieve. A reason for this is that many products—especially electronic and mechanical devices have become very complex and therefore are beyond the ability of most people to repair them, without specialist training or tools. For most companies—they also want customers to buy a new product as soon as possible so that they can make money. If a product breaks after the guarantee has expired they may even offer a discount on a new version to keep the customers loyalty and their business.

Companies will have service contracts with repair firms and can make a profit from organising the repairs for their customers—another reason specialists tools are required, they don't want just anybody to be able to offer the repair service because they will lose out on money!

### Key words: (Find out what these mean!)

Planned obsolescence        Social Footprint

Market Research        Ecological Footprint

Trend        Life Cycle Assessment

Maintenance

Social responsibility

## Informing Design Decisions

**What you need to know:**

- Be able to evaluate the advantages and disadvantages of planned obsolescence from different perspectives
- Understand how products can be designed to be repaired and recycled
- Be aware of ethical and environmental concerns when designing with new technologies

### Evaluating the use of new technologies...

When designers first come up with new ideas for a product they also need to carry out a lot of market research. Market research allows the designer and manufacturer to fully understand the task and have detailed knowledge of the marketplace. Through market research, designers will find out about the latest technologies and materials available to them, they will evaluate the use of these technologies and materials against a number of criteria, including;

- Cost
- Reliability
- Longevity
- Sustainability
- Recyclability

Even with detailed research, some potential long term issues may still not be known, which is one of the main risks in using new and emerging technologies.

### Ethics and the Environment

Finding out whether a new technology will have a negative effect on the environment is usually discovered through research and the conducting of a Life Cycle Assessment (LCA). It is becoming more important, and expected, that companies show they are environmentally and socially responsible. Consumers are also more aware through social media and global news access of the issues surrounding pollution of land, air, and sea—making consumers more demanding on companies to closely monitor their social and ecological footprint.

### End of working-life disposal

Considering how a product is to be disposed of at the end of its useful life needs careful consideration. How recyclable or reusable a product is will depend on the materials chosen and how they are joined together—decisions made early in the design process. If a product can be separated into its separate component materials easily is will be easy to recycle and take less time and energy to do so. If the product is also made from fully recyclable materials it potentially means none will end up in landfill or cause contamination to the environment. Some products are designed to be reused, such as glass milk bottles. Other product can be given new life due to inventive people choosing to reuse them in innovative ways. For example old car tyres can be reused in the building of houses, as swings in playgrounds, or to produce high quality oil. When a product is reused instead of recycled it uses less energy and does not degrade in quality from the recycling process .

Responsible end of life design should include; as few materials as possible, recycled or recyclable materials, easy to separate materials and built in re-usability wherever possible.

## Task 1

You have been asked to design a new personal electric scooter.

a)     How might you evaluate the feasibility of the new electric scooter before starting to design it?

b)     What techniques might you use to gather your research?

c)     How might consumer opinion differ from manufacturer preferences in relation to:

## Task 2

The pictures below show two different pencil sharpeners.



**Sharpener A**                    **Sharpener B**

a)      How does the manufacture of **Sharpener A** fit the "repair and recycle" culture?

b)      What factors would designers consider in planning the obsolescence for new products?

c)      Evaluate the lifespan each of Sharpeners A and B should realistically have?

d)      For each of your answers to part (c) state how your expectation meets with reality.

(i) Are you satisfied by the lifespan of these products? _____

(ii) How does each design differ in cost? _____

(iii) Is their cost justified given their function and lifespan? _____

1. Planned obsolescence is used to create products with a deliberately limited lifespan. Which **one** of the following is not a factor in deciding the lifespan of a product: [1]

   ◊ Fashion
   ◊ Colour
   ◊ Available material
   ◊ Function

2. Manufacturers might consider using recycled material in the construction of a new product.

   (a) Identify **three** considerations when sourcing used parts. [3]

   _____

   _____

   _____

   (b) Describe **two** benefits to a manufacturer of designing and making a product from recycled parts. [4]

   _____

   _____

   _____

   The new product should be responsibly disposed of at the end of its life.

   (c) Give **two** ways a company can design a product to improve its recyclability? [2]

   _____

   _____

3. Manufacturers can design products so that can be easily repaired or maintained.

   (a) Give **one** design feature that makes a product easier to repair at home. [1]

   _____

   (b) State **one** advantage and **one** disadvantage to a company of making their products easily repairable by professionals. [2]

   _____

   _____

   (c) Why might it still be cheaper for consumers to purchase a new product rather than having it repaired by a third party? [1]

   This work is
   **Below / On / Above / Well above**
   your minimum target path

Attach your assessment on these pages to keep safe!

Attach your assessment on these pages to keep safe!

Attach your assessment on these pages to keep safe!