

## Industry and Enterprise Knowledge Organiser

There are various initiatives and new technologies which drive industry and manufacture. The Circular Economy is perhaps the most important new initiative.

### Design/Manufacture

Up to 80% of a product's potential impact on the environment is locked in to the design stage. By looking at ways of reducing materials, reusing materials and components and using recycled materials, this stage can make a big difference to the cycle

### Reuse/Repair/Recycling

The rise of electronic handheld devices and portable electronics have led to huge amounts of waste electronic equipment being sent to landfill. Most devices can be broken down into constituent parts and some of the materials recycled. A large proportion of waste electronic products can actually be reused with minor repair.

### Retailer

Vital reductions can be made at this stage, such as reducing or eliminating food packaging materials (even down to the ink used for printing). An example of this is in all UK supermarkets, where plastic bags are no longer given away free to shoppers.

### Recycling Sector

Materials and some components can be recycled and used again in the design=/ manufacture process. There are incentives nationally and globally to support providers to develop recycling systems to reintroduce materials back into the design and manufacturing process.

### Consumer/Householder/Local Authorities

Local authorities are responsible for ensuring people's domestic waste is collected and recycled as far as possible. Householders can have a big impact on how much is generated by reducing the amount they throw away and by sorting their waste prior to collection.



## What are the impacts of new and emerging technologies when developing design solutions?

### People

#### Lifestyles

New technologies can have a huge positive impact on people's lifestyles.

- A large amount of people's **social interaction** now happens through electronic devices on social media.
- The **sleep cycles** of teenagers are affected by prolonged use of electronic devices.

#### Culture

Many facets of culture have been positively impacted by new technologies.

- In the workplace, there is an '**always on**' culture, which puts extra pressure on employees to perform, and consumers to access the company's facilities.
- Some people worry that as we expect more from our technology, we will expect less of each other.

#### Society

The impact of new technologies on the end user is far-reaching and the benefits are compelling in advancing society in terms of health, communication and economic well-being.

Other factors can be seen as inhibiting: for instance, in manufacturing, new and emerging technology can improve and streamline how a product or component is made, which may reduce the cost. Cheaper materials can be used and fewer people are likely to be involved in its manufacture. In turn, this may result in higher rates of unemployment in a particular area, leaving an economic impact on the society.

### Sustainability

New and emerging technology can be used to create sustainable solutions, with benefits for the user and the environment.

- **Drones:** as drones become more sophisticated, they are being employed in a wide variety of fields. They are used extensively in solar farms, where they can monitor for damaged panels.
- **3D printers:** most 3D printers use filament made from High Density Polyethylene. In India, an environmentally minded businessman has set up a production facility at a local dump, where waste HDPE from plastic bottles is converted into 3D printing filament. The finished recycled product is sold to 3D printing companies.

### The Environment

There are also significant disadvantages, including:

- **Increase in travel leading to greater air pollution:** air travel has a major impact on the environment and new technology, from online booking to autopilot navigation, makes it easier than ever to travel in this way.
- **Excess power consumption:** owing to the high use of technology, power consumption is at all-time high. Electricity is generated through the use of fossil fuels or nuclear fuel.
- **Generating higher levels of waste:** as we upgrade our technology, it becomes more difficult to reuse parts of these increasingly small products.
- **Excessive Wi-Fi zones:** experts believe our ever-increasing wireless internet zones may lead to silent health problems through the radiation emitted.
- **Deforestation and urban developments:** technology makes it easier to clear land, bore tunnels and build homes, but in doing so, parts of the established natural environment are destroyed.



1983



Lisa Mouse

1984



Macintosh Mouse

1



Desktop

1986



Desktop Bus Mouse

1998



USB Mouse

2000



Pro Mouse

0

2006

2009



Wireless Mighty Mouse



Magic Mouse

# Smart & Modern Materials Knowledge Organiser

## Awareness of developments in new materials to aid design decisions.

As advances in technology create added functionality, new demands are placed on manufacturing to create materials that can complement the sophisticated electronics that are available.

### Grapheme

Technically not a new material, but only used in commercial production since 2017, this 'material of the future' is the strongest material ever tested. Made from 100% carbon, the wonder of grapheme comes from the fact that it is an incredibly thin sheet material – it is one atom thick! The material is an excellent semi-conductor, making it useful for micro-electronics and touchscreen technology. It can be used to coat other materials, providing strength and protection to products such as helmets whilst reducing weight.

### Super Alloys

This family of metals are alloys with enhanced properties. Nickel, chromium and aluminium are often used in the production of super alloys to give the resulting metals high performance capabilities. Applications tend to be in areas where weight, strength and durability are important factors, such as jet engines, space travel and energy production.

### Biopolymers

These are polymers produced by living organisms and are considered important future materials, as they are sustainable, carbon neutral and renewable. Most biopolymers come from non-food agricultural crops, including sugar beet. Cellulose acetate can be produced from sugar starch and used in a wide variety of packaging applications. Its main advantage over oil-based polymer packaging is that it bio-degrades.

### Nano-Materials

This family of materials are tiny particles that are designed to be added to products to give enhanced properties or characteristics. They can be found in many applications, such as cosmetics, paints, healthcare and filtration systems. Engine lubricants make wide use of nano-materials to provide protection and longevity to moving parts.

### Quantum Tunnelling Composites

QTCs are a new and novel product developed in the 1990s. The composite material is a type of semi-conductor. Electrons are able to pass through the material when it is compressed; as such is it used in clothing to allow wearers to control electronic devices beneath the material. The NASA Robonaut used QTC on its fingertips whilst in use at International Space Station. Some believe that materials such as QTC lend themselves to 'artificial skin' uses.

## Smart Materials Used in Schools

### Nichrome

Nichrome wire is made from an alloy that allows it to heat up without melting. It does so because it does not conduct energy well. It has many uses as a heating element and can also be used in ignition systems and detonators.

### Shape Memory Alloy (SMA)

These metals can be deformed and will return to their original form when heated. This principle means design engineers can predict particular forces that the material will exert under heat and use this feature in a design solution. Most commonly available as wire and rod, they are useful in systems control projects as actuators when used in combination with electronic circuits.

### Polymorph

This novel polymer is interesting to use because, although it is a true plastic which is resistant and machineable, it becomes malleable, like clay, between 30 and 60 degrees Celsius. It is useful in projects because durable iterative models and prototypes can be made quickly; because it can be shaped by hand, ergonomic solutions can also be created. Available in granular form, it becomes a soft solid when hot water is added.

### Electroluminescent Material

These materials emit light when a current is applied. Available as a coated wire, easy-to-cut sheet, adhesive tape and in paint form. It has lots of potential for systems and control and textiles projects.

### Thermochromic/Photochromic Materials

Photochromic pigment changes colour in strong sunlight or UV light, making it useful in situations where the user needs to be aware of the dangers of direct sunlight.

Thermochromic pigment changes colour dependant on ambient temperature.



## Composite Materials

These materials are a combination of two or more different materials, brought together in such a way that the key properties of all materials work together to give a higher performing composition. Creating and using composites is almost as old as building and construction, but as new technologies in manufacturing and science advance, new ways to bring materials together are developed.

### Concrete

Concrete is a mixture of cement (powdered limestone and clay), sand, stones and water. A chemical reaction occurs when the water is added that leads the concrete to set hard. This method has been used since at least the times of the Roman Empire. In the twentieth century, steel manufacturing techniques allowed thin rods or mesh to be made and set into the concrete, giving the material a much higher tensile strength. This enabled engineers, architects and builders to use concrete's quick-casting properties with much larger, adventurous forms, such as bridges, high-rise buildings and skate parks.

### Manufactured Sheet Timber

Engineered timber products such as plywood, MDF and particleboard are constructed for particular uses by combining and fixing different timber elements with resins or adhesives. Almost exclusively manufactured in sheet form, most composite wood is used in construction and furniture production.

- Plywood: thin sheets of solid wood known as veneers are glued together to create stiff and light sheet material.
- MDF: fibres of timber are turned into a pulp and fixed with formaldehyde resin. The lightweight product is used extensively in flat-pack furniture.
- Particleboard: wood chips recycled from timber processing are bonded together into sheets. Whilst it has a relatively low tensile strength, it has good compressive strength and insulating qualities, so is often used in flooring and loft cladding.

### Fibre-Reinforced Plastic

Commonly known as glass-fibre, this family of materials is versatile and important in large-scale product design. Traditionally, fibres of glass, which are strong and flexible, are set into a polymer resin and it put into a mould. In more recent times, carbon fibre has been used instead of glass, as it has the advantage of being much lighter and stronger, albeit more expensive. Some applications include car bodywork, boats, children's playground furniture and bicycle frames.

### Robotic Materials

This field of composites are materials that incorporate sensing, communication, computing and actuation (movement). Highly sophisticated and expensive to produce, the materials are often developed to fulfil one specific role in a product. There are numerous robotic materials in existence, including plastic coatings for vehicles that allow them to camouflage themselves, as well as 'skin' for prosthetic limbs that sense touch.

## Technical Textiles

Activities where physical performance is paramount, such as sports and dance, have always driven the need for not only better designed clothing, but better performing fabrics. Elastane (commonly known as Lycra™) has been a dominant material in cycling and many other sports since the 1970s, but before that, wool was considered a high performing material. As people's lifestyles change and more adventurous pursuits can be accessed by a wider audience than ever before, the demand for new fabrics that perform to exact requirements increases. Technical fabrics can also be driven by occupation; many outdoor jobs involve working in extreme conditions and technical clothing solutions can serve to improve working conditions or help make the wearer more effective at their job. Whatever the need is, what makes true technical textiles stand out is that they have outstanding properties which are particular to the context in which they will be used.

### Softshell Jersey

Usually has two textile layers, most commonly polyester and polyester fleece, bonded together producing a heavy but very flexible fabric. Breathable and waterproof, softshell jersey is found in mid-season outerwear.

### Airflow Mesh

This mesh fabric is 100% polyester but ingenious manufacturing makes it a very different fabric. A mesh is knitted into a lattice, giving it a strength and elasticity, as well as making it ideal for areas where structural integrity is important. Given it is a loose mesh, it is lightweight and breathable.

### PowerNet

Typically a blend of polyester and Lycra, this lightweight, breathable fabric is often used in underwear owing to its body sculpting abilities.

### Neoprene

A synthetic rubber, Neoprene is most commonly recognised as the fabric of wetsuits. The expanded foam textile has excellent insulating properties- meaning swimmers body heat is absorbed by the fabric along with the water, locking out cold water. It is flexible and easily bonded, which makes Neoprene useful in other applications including laptop bags, mouse mats, pipe insulation and gloves.

### Ripstop

A specially woven nylon that prevents rips from spreading and ruining the fabric. Lightweight with excellent strength, the fabric has a distinctive checked pattern as a result of the heavy yarn used to reinforce the thin fabric. Used in tents, outerwear linings and bags.

### Breathable Waterproof

There is a growing range of brand-named fabrics in this field of lightweight outdoor textiles. Depending on weight, these fabrics give a waterproof rating – which covers everything from showers to torrential downpours. Well-known examples include Gore-tex, Isodry and DryVent.



# Energy Sources in D&T Knowledge Organiser

## The Generation of Energy

One of the big problems surrounding design and technology is the use of electrical energy. Nearly all modern and emerging technology relies on electrical energy and it is therefore crucial that efficient ways of generating electricity are developed and used. This is a global problem.

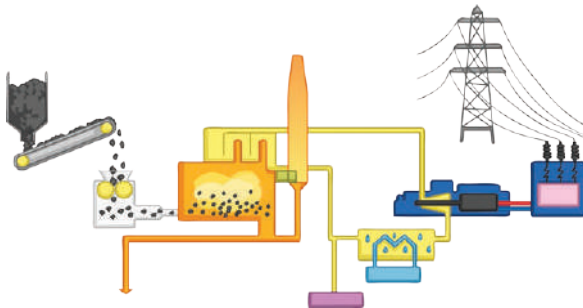
There are two main ways in which electrical energy is produced:

- through the burning of fuels;
- through the use of the natural environment (green energy).

Although nuclear and fossil fuels differ, the way that electricity is generated from the energy that they release is similar.

1. The energy is used to heat water.
2. The steam powers huge steam turbines, creating movement energy.
3. This powers an electrical generator.
4. The electricity is then passed on to the national grid via a transformer.

Energy from power stations cannot be stored. It is simply generated on demand for consumers.



## How Energy Is Stored and Transferred

### Alternating Current

Although electrical energy from power stations cannot be stored in the same way direct current energy can be stored in batteries, there are ways that electricity suppliers ensure emergency energy is available:

### Dammed Hydroelectricity

Water is stored in huge lakes and either released or pumped into hydroelectric turbines to create energy.

### Rail Potential Energy Storage

Rail cars carrying huge weights are moved up a track on an inclined plane before being released. The motors on board act as generators and feed electricity back into the power grid. This emerging technology is considered a viable compliment to wind farms and solar farms, where the cars can be released in the event of no wind or sun.

### Batteries

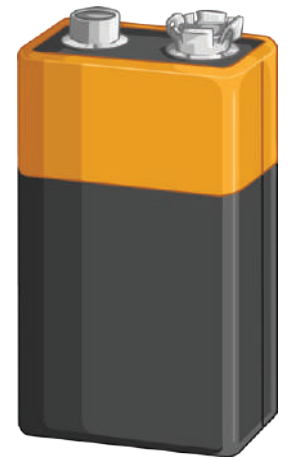
Most domestic electronic devices can be powered from direct current batteries. These are all electrochemical in their construction.

### Flywheels

Generator motors use the weight of a mechanical flywheel to turn movement energy into electrical energy.

### Compressed Air

A compressor can fill a chamber with a large amount of pressurised air, which can be released to power pneumatic devices.



## Non-Renewable Energy

This group of energy sources is the traditional group of energy sources used in the UK to power manufacturing, homes and energy production. They are seen as more convenient and more readily available than non-renewable sources.

### Fossil Fuels

Fossil fuels are finite natural resources. All fossil fuels are derived from the remains of plants and organisms that lived millions of years ago. Scientists can identify areas in the geography where it is likely fossil fuels exist and the fuels are mined or drilled and pumped from their location. The three fossil fuels are:

- coal
- oil
- natural gas

Energy is released when these fuels are burned. Heat energy is then used to power other devices. For instance, in domestic use, oil is used to fire heating boilers. In the UK the production of electricity is still reliant on fossil fuels, with 75% of power stations using fossil fuels to generate electricity,

### Disadvantages

- **Finite:** these fuels are a one-time-only resource.
- The burning of fossil fuels contributes to **higher temperatures in the environment** owing to carbon dioxide being released.
- **Health and environmental** damage is caused by the release of sulphur dioxide.

### Nuclear Fuels

The main nuclear fuel is uranium. This naturally occurring element is mined from the earth's crust and refined before being turned into special pellets that are used in the nuclear reactors. Heat is released through a process called fission. The heat is then used to boil water and electricity is created through huge steam turbines. Nuclear energy production does not release carbon dioxide or sulphur dioxide unlike the burning of fossil fuels, so many believe that this is the best form of energy production for our growing population.

### Disadvantages

- **Finite:** like fossil fuels, **uranium** will eventually run out.
- **Hazardous:** the waste products of nuclear fission are highly radioactive and can cause long lasting catastrophic damage to life and the environment if it is not contained properly.

### Bio-Fuel

This family of fuels come from the processing of living plants that are farmed specifically for the production of the fuel. They are seen as an important alternative to traditional vehicle fuels as the crops are sustainable and the burning of these fuels do not emit the dangerous gases that petrol and diesel vehicles do.

- **Biodiesel** is made from the oil from Rapeseed plants and most diesel cars can run on this.
- **Bioethanol** is a petrol-like fuel made from sugar-cane. Cars need to be modified to run on bioethanol.



# Influences in D&T Knowledge Organiser

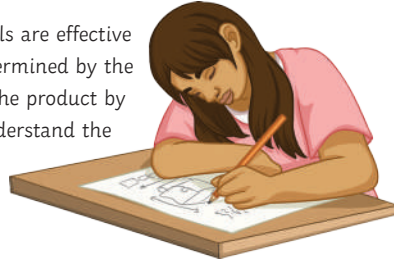
What are the opportunities and constraints that influence design and making requirements?

## Learning from Existing Products and Practice

When beginning a design project, designers can learn from existing products and practice through the exploration and critique of existing designs, systems and products to identify features and methods.

### Materials, Components and Processes

Through product analysis, a designer can determine which materials are effective or necessary for a particular need. The function of a product is determined by the components used and a designer can evaluate the performance of the product by looking at these. Through careful consideration, it is possible to understand the manufacturing processes used to create parts of a product and to assemble it.



### Fashion, Trends, Taste and Style

All consumer products are subject to fashion, trends, taste and style. Popular colours, shapes, patterns and forms can all be identified through the analysis of existing products. Some materials are more fashionable than others for different products. Market research is an important factor in understanding trends and taste. Designers also need to be aware that trends can change quickly.



### Marketing and Branding

A product's success is partly due to how it is introduced to its target market group. If a consumer is made to feel that they need a product and it will somehow help them, or improve their lives, they are more likely to consider buying it. Some of the best-designed products have not been branded or marketed properly and therefore people are not aware of their existence!



### The Impact on Society

It is possible for a product to have a profound impact on society. This could be a positive or negative effect. Medical products, such as asthma inhalers, undoubtedly have a powerful positive impact on society. Other products, such as mobile devices, have both positive and negative impact on society. Communication is quick and easy, information is available on demand, however, road traffic accidents can occur when drivers use their phones, some people spend more time looking down at their phones than interacting with their surroundings.



### The Impact on Usability

As products evolve, with the use of better manufacturing techniques and new technology, usability is enhanced. This impacts different products in different ways. For devices like mobile phones, the usability of modern smart phones is enhanced beyond measure with the introduction of the internet, app software and Wi-Fi connectivity.



### The Impact on the Environment: Life Cycle Assessment

Designers must be aware of the impact that the manufacturing, use and disposal of their products may have. Understanding the materials used, components and energy sources involved help to build a picture of how environmentally friendly a product's production and use could be.

The main stages of Life Cycle Assessment are:

#### Raw Materials

- product requires reduced amount of raw materials;
- product uses recycled materials extensively.

#### Manufacturing

- production conserves energy;
- production conserves materials/allows recycling of raw materials;
- prevention of pollution to air, water and underground water.

#### Distribution

- product uses simplified packaging;
- product is distributed more efficiently;
- product is delivered by low-emissions vehicle.

#### Consumer Use

- product consumes less power;
- reduced use of additional materials (for instance water, oils, detergents).

#### Post-Consumer Use

- product is designed for disassembly/easier recycling;
- product uses lower amounts of harmful substances.



# Influences in D&T Knowledge Organiser

What are the opportunities and constraints that influence design and making requirements?

## Learning from Existing Products and Practice

When beginning a design project, designers can learn from the work of past and present professionals and companies in the area of design & technology.

### Product Analysis

You can understand a great deal about how a designer has worked by fully analysing one of their products. This will not only tell you about the design decisions that they have made, but it will help you to understand the fashion and trends at the time the product was created.



When you look at the key design features (e.g. colours and form) of products such as upright vacuum cleaners, similarities with contemporary products can be identified. Nearly 30% of all new cars sold in the UK in 2017 were grey or silver, making these metallic tones a safe bet for domestic machines such as vacuums and washing machines.

### Contextual Research

When a product is created, its development will be constrained or supported by a range of factors particular to the time period.

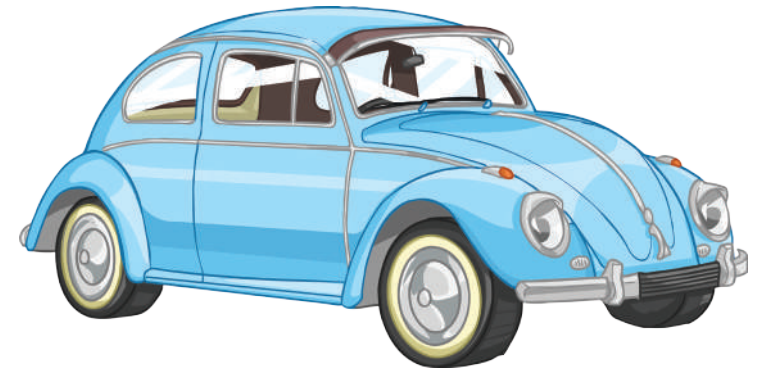
**For example:**

- Products created before 1960 did not have access to the range of polymers that are now commonly available, so exotic hardwoods were commonplace. Today, there are tight restrictions governing the felling and exporting of certain timbers, this has reduced the amount of hardwood products.
- Electronic products are governed in size by the components they use. Until the invention of the transistor, products such as radios were large, bulky items. When integrated circuits were developed in the 1970s many products reduced in size.



### Political Understanding

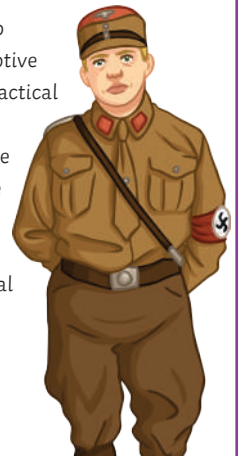
All products are somehow governed by the political/social economic times in which they are manufactured. When investigating an existing product, you can often understand a lot about the time period from which it comes from by analysing the manufacturing processes, materials used and functional features.



The iconic Volkswagen Beetle is synonymous with the 1960s and freedom. The Beetle is popular among young people, surfers and custom car enthusiasts alike.

**Its origins are quite different...**

During the 1930s, as Nazi Germany was preparing to go to war with Europe, Hitler enlisted Germany's leading automotive engineer, Ferdinand Porsche, to design an economic and practical vehicle for the people of Germany. The outcome was the Volkswagen Beetle. In Hitler's Germany, citizens would have been able to buy the car for the same price as a motorcycle through a government savings scheme. Production began in 1938 with manufacturing taking place in Germany until 1979. During that time, more than 21 million original Beetles were produced.



## Wider Influences on D&T Knowledge Organiser

What wider implications can have an influence on the processes of designing and making?

### Environmental Initiatives

#### Global initiatives

There are a range of organisations that fund or promote global initiatives. **United Nations' 17 Goals for Global Sustainable Development** is one of the most wide-reaching, tackling issues such as: no poverty, zero hunger and gender equality.

#### National initiatives

Many countries have their own environmental issues and initiatives designed to research and improve the environment. In the UK, **reducing emissions** from diesel vehicles has been a major priority for the government, with initiatives such as **grants** for sustainable energy powered vehicle manufacturers and **scrappage schemes** for diesel cars.

#### Local initiatives

Different communities **environmental needs** are supported through local initiatives- such as in remote parts of Africa, where fresh running water is unavailable. **Charity groups and sponsors** provide pipelines and pumping equipment to bring much needed water to the area.



### Social and Ethical Awareness

#### Social awareness

A designer must work to understand the needs of the user of their product, including wider social factors, such as religion, gender, family members, wealth and multiculturalism.

#### Ethical awareness

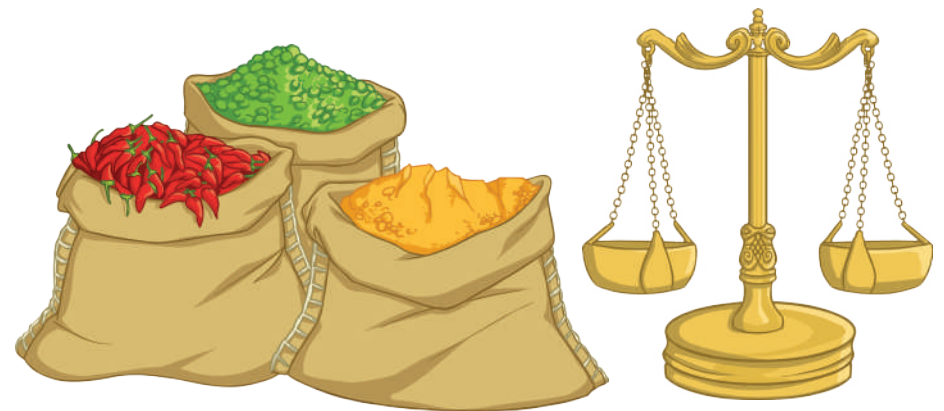
Manufacturers, and therefore designers, are under constant pressure to conduct their activities in the 'right' way. Fair Trade is an example of an organisation that promotes ethically produced products. In recent years, there has been concern that some large clothing outlets have sold garments produced in developing countries, where the workers have not been made to work long hours and paid very low wages.



#### Fairtrade

The Fairtrade label that you see on fruit, clothing and cosmetics is a certificate that tells you that the product has been produced in a developing country and the producers (usually small-scale independent farmers) have been supported by the Fairtrade organisation to ensure that they receive a fair price for their produce and therefore are able to afford to live, support their families and their business. Fairtrade certified products include:

- coffee
- cocoa
- textiles
- seafood
- diamonds
- gold



## Global Sustainable Development

In 2015, member states of the United Nations agreed to 17 goals for a better world, with the ambitious goal of achieving them by 2030. They are:

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnerships for the goals



Design & Technology has a role to play in all of the goals, but there are four areas that rely heavily on design & technology to be successful.

## Responsible Consumption and Production

The member states have agreed to:

- sustainable management and use of natural resources;
- halve global per person food waste;
- responsible management of chemicals and waste;
- sustainably reduce waste generation;
- promote understanding of sustainable lifestyles;
- encourage sustainable practices for companies;
- support developing countries' scientific and technological capacity for sustainable consumption and production;
- develop and implement tools to monitor sustainable tourism.



## Affordable and Clean Energy

The member states have agreed to:

- ensure access for all to affordable, reliable and modern energy services through new infrastructure and better technology;
- promote energy efficiency- more quickly developing technology that wastes less energy;
- increase the use of renewable energy sources globally compared with other sources of energy;
- work together to research and develop renewable and other clean energy resources.



## Industry, Innovation and Infrastructure

The member states have agreed to:

- develop sustainable and resilient infrastructure to support economic development and human wellbeing;
- provide small businesses with access to credit and technical support for their development;
- ensure the companies promote sustainable development and do not harm the environment;
- allocate resources for research to address that country's specific needs and improve technology;
- ensure all have access to the internet and new techniques, especially those in least developed countries.



## Sustainable Cities and Communities

The member states have agreed to:

- ensure all have access to quality, safe housing and basic services;
- provide safe, organised transportation that is not harmful to the environment and is also specifically designed to serve children, women and vulnerable people;
- engage communities in discussions and planning for improvement of their cities;
- strengthen efforts to protect and safeguard the world's cultural and natural heritage;
- increase resilience to disasters;
- ensure monitoring of waste management and air quality;
- prepare communications to manage their resources properly and to tackle climate change.



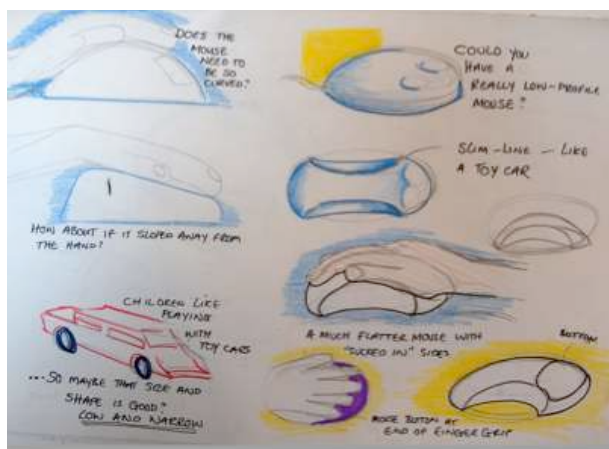
Source: <https://www.globalgoals.org/>



# Design: Thinking & Communication Knowledge Organiser

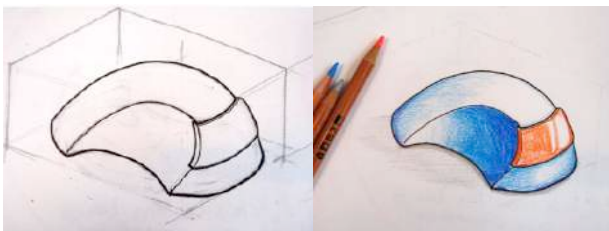
How can design solutions be communicated to demonstrate their suitability to a third party?

## Clear 2D and 3D Sketches with Notes



A designer can use a range of techniques to make their initial sketching clear:

- use of colour behind the sketch;
- bold outlining of sketches;
- sketching in different colours;
- annotation;
- crating of 3D sketches (see below).



## Mathematical Modelling

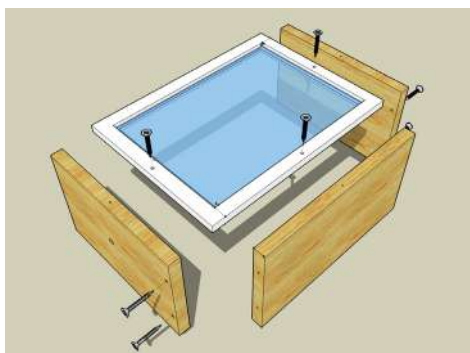
All models can contain some mathematical information to help a designer, but sometimes it is necessary to create a special model, for the purpose of gaining mathematical information about the intended product. This might include:

- calculating the amount of material required;
- researching joining solutions;
- using structural strength data;
- making calculations to do with the overall size and weight of the product.



## Exploded Drawings

These technical drawings can be useful in helping to explore how components and parts fit together. They can be drawn up more accurately and form a plan for the assembly of parts when producing a final prototype.



## Sketch Modelling

Sketch modelling can help a designer develop a design through looking at in in three dimensions. Different types of sketch model include:

- clay models;
- toiles (paper models of clothing);
- paper models;
- blue styrofoam models;
- CAD models;
- card models.



## Flow Charts

In design engineering, a flowchart can help explore the function and operation of a product. A designer can use the blocks to identify possible components that could be used in the system.



## User-Centered Design

Good design carefully considers the end user and the experience they will have with any product. A designer will seek to understand and involve the target user in all stages of the design process through exploration, creation, evaluation etc.

### Exploration:

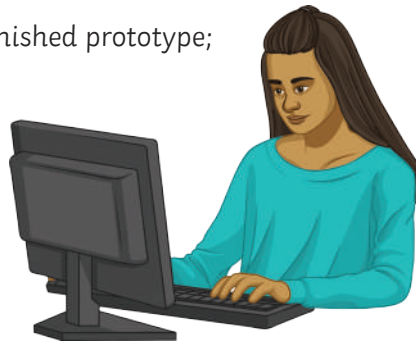
- creating mood-board to explore the user's lifestyle;
- conducting questionnaires and surveys;
- studying the design situation from the user's point of view.

### Creation:

- gaining the user's views on iterative models and drawings.

### Evaluation:

- carrying out user trials and evaluating the finished prototype;
- the designer conducting an evaluation of the user's experience with the product.



## Systems Thinking

When developing design engineering solutions, a systems approach can help to simplify the complex task of creating functioning solutions. By considering the primary function of the product, a designer can break the product's purpose down into blocks that, in turn, can be explored. This way, a designer can look at how different components can function in each of the blocks clearly.



## Collaboration

A designer needs to work with other professionals to gain specialist knowledge from across different subject areas in order to deliver effective design solutions and products. These may include:

### • Textiles Manufacturers

Manufacturers and suppliers of fabrics will provide designers with important specifications of a fabric, which will help the designer understand how the fabric will perform. Sometimes, the fabric manufacturer will develop a specially blended fabric, which is most suitable to the designer's requirements.

### • Plastics Moulding

In product design most plastic-cased products are manufactured using injection-moulding. Working alongside a specialist manufacture, a designer can modify their designs to make them suitable for manufacturing, without compromising on aesthetics.

### • Electronic Components Suppliers

Designers can liaise with specialist suppliers to determine whether the function of a component is suitable for the design engineering solution. Often, suppliers can source alternative components if required.

### • Packaging Manufacturers

When creating a radically new packaging design, for instance, using dramatically reduced amount of material, a manufacturer will be able to tell the designer if it is possible.

### • Scientists/Mechanical Engineers

When designing products that involve the manufacture of parts that will be placed under significant forces, such as sports equipment, specialists are consulted and their resources used to confirm the viability of a design solution (such as commercial wind tunnels).

# Influences in D&T Knowledge Organiser

How do developments in Design & Technology influence design decisions and practice?

The design decisions that a designer makes can have a significant impact on the end user and on society. The use of new and emerging technology in design needs to be critically evaluated, with careful consideration given to present and future use and scenarios.

## Learning from Existing Products and Practice

### Ethics

Ethics are a system of principles that help a person or society behave morally and covers the following:

- the way to live a good existence;
- our responsibilities and rights as humans;
- what is right and wrong;
- what is good and bad (moral decisions).

Designers have huge ethical responsibilities, as all design work ultimately influences human lives. The following is one simplified way of looking at a designer's role:

### Human Rights

**The work a designer does should be for the good of everybody, not just the few.**

Products are designed with precision for those who will use them, regardless of race, religion or culture. Designers fully understand the needs of those for whom they are designing and are engaged in addressing those needs.

### Human Effort

**The work of the designer should deliver on performance.**

Products are designed to be functional, convenient and reliable. Products should perform better than the previous iteration that the target market user owned and should not place demands on the user to provide anything extra to enable it to function.

### Human Experience

**The work of the designer should delight.**

The users who interact with the product should be delighted with their experience, not merely satisfied. The product does not impede on the users lifestyle, rather blending into the background. It is intuitive and empowering.

### The Environment

The life cycle of a product is important for a designer to evaluate critically to understand how existing products have contributed to environmental damage or conservation. The main stages to focus on are:

- raw materials;
- manufacturing;
- distribution;
- post-consumer use.

A designer can have a significant impact on each of these stages through critical analysis of their own work. A key feature of this is in the reduction of materials required in the manufacturing and packaging of a product.

New technologies, such as the use of drones for product distribution, could cut air pollution significantly. The reduction of weight of a product would also positively impact this form of distribution.



# Influences in D&T Knowledge Organiser

How do developments in Design & Technology influence design decisions and practice?

The design decisions that are made by a designer can have a significant impact on the end user and on society. The use of new and emerging technology in design needs to be critically evaluated, with careful consideration given to present and future use and scenarios.

## Learning from Existing Products and Practice

### Product Enhancement

A product enhancement is any change made to a product that gives it an increased capability beyond the original specification. In digital technology, this is a commonplace action by companies, as enhancements can be made through upgrading software. Hardware can also be changed to enhance a product; however, this requires changing the physical manufacturing process. Many phone manufacturers release upgraded versions of their products each year.

When similar products by competitors offer the enhanced feature on their products.



#### Lacking Features

When the first iPhone was introduced in 2007 it was considered to be a game-changing personal device. However, it lacked some key features that other smartphones offered as standard. Most significant of these was the capability to record video. Unsurprisingly, the iPhone released in 2009 incorporated video recording, bringing it in line with other smartphones. Can you imagine a smartphone that can't record video?

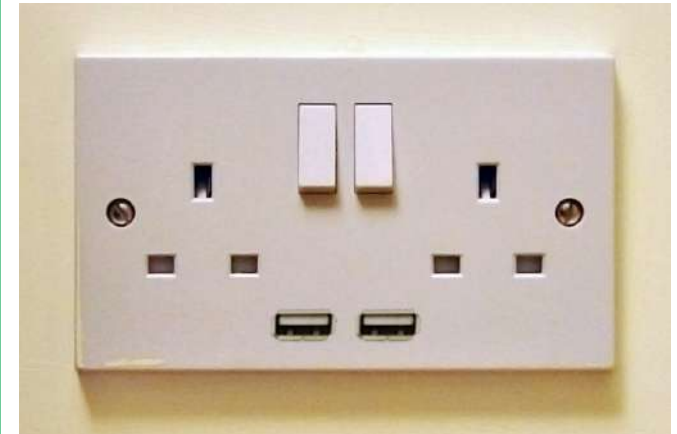
When consumers make the changes themselves and a manufacturer notices the opportunity to provide the enhancement.



#### Street Style

Trends in fashion can often come from the street, not the catwalk. Ripped denim jeans have been on sale in high street shops on and off for at least 30 years. Originally, all denim was dark blue and the washed out colours and rips happened through wear and tear. At some point in the late 1980s, one-by-one, all of the main jeans manufacturers began.

When new technology becomes available that was not present at the time of manufacture.



#### Plugging In

So many rechargeable devices use USB connectors to charge up. A few years ago, this would have meant powering up a computer to plug in, or taking a three-pin plug around with you in your pocket. Thankfully, manufacturers recognised that this new technology presented an opportunity for an enhancement of the existing plug socket fascia. Today, there are numerous versions of the socket available with two or more USB sockets in them.



## Fibres and Fabrics Knowledge Organiser

### Natural Fibre Products

#### Traditional fibres from plants and animals.

**Wool:** Fibres from sheep's wool are spun into yarn and can be woven and knitted. The fibres can also be spun into finer yarn which is turned into cloth. Absorbent, soft or coarse handle, not durable.

**Used in** yarn form in knitwear, scarves, gloves, bags, dresses and suits.

**Cotton:** Thread is spun from fibres from the cotton plant. Used widely due to its good durability and soft handle. Can be machine washed, but requires ironing as creases easily. Highly-absorbent.

**Used in** canvas, muslin, calico and denim, clothing, home furnishings

**Silk:** Natural fibre from silkworms, woven into fine fabric, which has a high sheen or lustre. Cool to wear.

**Used in** high-class clothing and home furnishings in Satin form.

**Linen** Made from fibres of the flax plant, linen is a traditional fabric. Does not cause allergies and is cool to wear. Highly absorbent.

**Used in** home furnishings, summer clothing.

**Leather:** Made from animal skins, leather is not strictly a fabric. Comfortable in both hot and cold conditions. Untreated, leather is absorbent but can be treated with a range of finishes to improve its effectiveness and durability. Tough and elastic.

**Used in** clothing, car upholstery, home furnishings.

### Manmade Fibre Products (synthetic)

#### Modern fibres manufactured using polymers.

**Nylon:** Strong and durable manmade polymer fibre. Has a wide range of applications, as a clothing fabric and in other uses where durability is important. Warm to wear, non-absorbent and good drape. Can be made with soft or coarse handle.

**Used in** wide range of clothing in pure and blended form. Waterproof coats, tents.

**Polyester:** Very durable polymer fibre, non-absorbent and cool to wear. Often blended with cotton to produce low cost, breathable fabrics and used widely in place of pure cotton.

**Used in** clothing and home furnishings, industrial polyester used for ropes, seat-belts.

**Organza:** A lightweight, sheer fabric traditionally made from silk, although more often now made from polyester. Its decorative properties make it popular for embellishments on clothing.

**Used in** home furnishings, hat decorations, wedding dresses.

**Lycra (brand name for spandex/elastane):** A 20th century 'wonder material', Lycra is commonly found in sportswear due to its breathable and elastic qualities. Excellent shape retention. When blended with natural fibres, clothing with the feel of natural fibre, and the elasticity of Lycra can be achieved.

**Used in** tight-fitting sports wear, stockings and leggings, blended in denim, woollen clothing.

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Photo courtesy of (@flickr) Those Who Affected Me - granted under creative commons licence - attribution

| Property               | Definition                                                                                                                                             | Found in                                                     |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>absorbent</b>       | A fabric's ability to hold moisture.                                                                                                                   | wool, cotton, linen, non-woven fabrics such as felt          |
| <b>blended</b>         | A fabric or yarn made from a mix of natural and manmade fibres, purposefully created to use the features of both.                                      |                                                              |
| <b>breathable</b>      | A fabric that uses specific fibres and weave that allows air to pass through the clothing, thereby preventing heat and moisture build-up.              | sportswear<br>blended fabrics, linen, cotton, wool           |
| <b>drape</b>           | The way a fabric looks when it is hanging down. Clothing designers must consider the drape of a fabric when choosing the material for a garment.       | all fabrics                                                  |
| <b>durable</b>         | Hard-wearing, stain resistant. Man-made fibres are mainly more durable, and are therefore blended with natural fibres to create more durable products. | nylon, polyester, denim, lycra                               |
| <b>handle</b>          | What a fabric feels like to the touch, for instance: smooth, rough, stiff.                                                                             | all fabrics                                                  |
| <b>sheen</b>           | A smooth and slightly reflective surface finish to a fabric.                                                                                           | silk and synthetic satins, polyester products, some leathers |
| <b>sheer</b>           | Fabrics that are flimsy and semi-transparent.                                                                                                          | organza, voile, muslin lingerie products                     |
| <b>shape retention</b> | A fabric's ability to keep its shape and not become deformed through use.                                                                              | lycra and lycra blends, leather, polyester, nylon            |
| <b>water-repellent</b> | Non-absorbent. A fabric's natural ability, or manufactured finish, allowing water to not penetrate through the weave.                                  | polyester, nylon, leather                                    |

### Smart Fabrics

Advancements in modern technology have implications for fabrics and design. **Wearable technology** and **performance enhancing textiles** are important strands of sports and fashion design in the modern age.



This acupuncture therapy shirt allows the wearer to receive specific therapy at the same time as getting on with their job.

This light emitting fabric is an example of how designers can use fibre-optics to create high-impact visual clothing and accessories.

| Wasting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Addition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Deforming and Reforming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Fabrics are a compliant material and are relatively easy to cut and shape. They are, however, an unforgiving material, and an incorrect cut will be often difficult to undo or disguise.</p> <p>Cutting: Fabric is normally cut with textile shears. The blades are 150mm long and the lower handle is always bigger. This allows for a steadier, longer cut. Rotary cutters are used for cutting non-woven fabrics such as felt.</p> <p>Shearing: Although shearing and cutting are the same force and movement, pinking shears give a zig-zag edge to their cut. This prevents woven fabric from fraying</p> <p><b>Wasting Fabrics with CAD/CAM</b></p> <p>Sections of fabric can be wasted effectively using a laser cutter. A pattern can be created using CAD software such as 2D Design and used to control the laser cutter. Identical patterns can be created very quickly using this method with a high level of accuracy.</p> <p><b>Seam Allowance</b></p> <p>Fabrics require a seam allowance; the material where the stitch joins two pieces of fabric together. This means fabric must be cut larger than the size needed by approximately 10mm on all sides where a join is required.</p> | <p><b>Addition by hand-stitching</b></p> <p>All projects will require some degree of hand-stitching. This may be to add a button, join one piece of fabric over the top of another, such as in applique, or embroidering by hand. There are a range of stitches which can be done using a needle and thread:</p> <ul style="list-style-type: none"> <li>• <b>Running stitch:</b> Quickly joints two fabrics along a line</li> <li>• <b>Overstitch:</b> Loops over the edge of the fabric preventing fraying.</li> <li>• <b>Blanket-stitch:</b> Ornamental stitch effective on decorative work.</li> <li>• <b>Back stitch:</b> Stronger than a running stitch and good for seams.</li> </ul> <p>Zips, buttons, hook and eye, press-studs and Velcro can all be added to fabrics and used to add and fasten pieces together.</p> <p><b>Addition by machine-sewing</b></p> <p>The correct method for joining fabrics is dependent on the type of fabric being used, and the loads and stresses that will act upon the join. An overlock machine is good for professional looking products as it binds the seam inside the join. Sewing machines are required to add fasteners such as zips.</p> <p><b>Addition by computer sewing machine</b></p> <p>Many jobs can be completed by a programmable CAM sewing machine.</p> <p>Some schools have embroidery machines. A design is created on a computer, before being uploaded to the embroidery machine. Decoration, detail and personalised names can be added to a panel of a product this way.</p> | <p><b>Deforming by tailoring</b></p> <p>Once the pattern and fabric pieces have been cut, the main tool for shaping an item of clothing is a tailor's dummy. Re-forming, adjustment and fitting can be done whilst seeing the overall shape of the product. Because fabrics are compliant materials, they deform as part of their nature. Imagine wearing a pair of skinny jeans which didn't deform as you moved!</p> <p><b>Deforming by pleating and gathering</b></p> <p>Shape can be created and accentuated through the use of gathering. Pleating can create a strong visual effect and allow for movement in a garment.</p> <p><b>Pleat:</b> Repeated folds in a textiles product, usually stitched at the top.</p> <p><b>Gather:</b> To shorten a piece of fabric by drawing it together, like the top of some curtains.</p> <p><b>Deforming by heat and liquids</b></p> <p><b>Heat treatment:</b> Some specially laminated fabrics can be formed into shape using heat. This is useful where the designer needs parts of a design to hold a shape without support, such as collars.</p> <p><b>Blocking:</b> Traditionally, moulded hats, for both men and women have been created by deforming felt on wooden blocks. A felt hood or cone is placed on the block and a liquid stiffener is applied. A steam iron is then used to shape the felt around the block before shaping the brim and cutting off waste material.</p> |

# Identifying Requirements D&T Knowledge Organiser

## Why Is Usability a Consideration When Designing Prototypes?

### Anthropometrics

The use of human-size measurement in relation to our environment. For example, a cafe chair must be able to allow a range of people, short and tall, to sit down.

The human body has a basic set of measurements; there is a huge amount of variation of each of these based on the sizes of different people. Another factor is how these measurements change as the human body changes position – reaching up, sitting down, bending over. A designer must make use of this data in the iterations of design to ensure all potential users have access to good ergonomic design.

Clothing designers must consider the size variations that are needed for their products. This can vary due to age, lifestyle and culture.

### Ergonomics

How a product fits with its user – for example how comfortable a handle on a hairdryer is - depends on its ergonomics. Correct ergonomics not only make a product more comfortable to control or handle, but also allows the user to exert the correct force required to operate the device properly.

#### Hand-Held Devices

Hand comfort is perhaps the most crucial of all ergonomic considerations that affect usability. Some design is specific to particular anthropometrics:

- baby toys are specifically designed to be handled by tiny hands;
- most gym equipment is designed to fit a range of adult hands.

Video game controllers, however, must be useable for a much wider range of hand sizes.



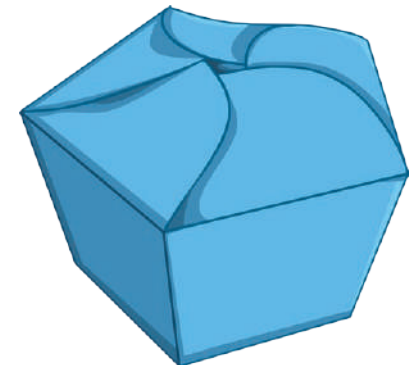
#### Seating

Seating comes in many forms and designers must take into account the range of anthropometric data that applies to the situation. They also need to consider the location of the seating and how long a user may use the seat for. Locations might include schools, cars, fast food restaurants, parks and playgrounds.



#### Packaging

Often overlooked, everything from fast food cartons to pet food tins require careful anthropometric consideration to get the ergonomics right. Have you ever wondered why drinks cartons from fast food restaurants are tapered? It helps them stack, but also it stops the ice-cold container slipping through your hands as the diameter increases as it drops.



A designer has to consider a number of factors relating to user interaction with possible design solutions if their designs are to be effective.

### The Impact on a User's Lifestyle

A designer has to be clear about what a product needs to be or do to successfully resolve the problem identified at the start of the project (often referred to as the Situation):

- good design should enrich the user's life and the experience of using the product should be positive;
- the product should look as good being used, as not;
- the product should offer more to the user than other products which may do the same thing;
- the product should appeal to the user on a moral level

### The Ease of Use and Inclusivity of Design Solutions

Good design takes into account the full range of users who will benefit from a product. Designers understand the principles of aesthetics, ergonomics and anthropometrics and can take these factors into account when considering all potential users, including:

- the young;
- the elderly;
- users with disability;
- users of different cultures.

Factors which may inhibit ease of use include:

- complex instructions;
- controls designed for one hand size only;
- non-intuitive controls or hard to access fasteners.

### Aesthetic Considerations

Good design of consumer products such as clothing and textiles, furniture and electronic products are composed of two things: **effective functionality** and **pleasing aesthetics**. A designer needs to investigate the intended user's preferences to fully understand the aesthetic style that will work best for a product. Aesthetics are basically made up of:

- shape;
- form;
- colour;
- texture;
- decoration/adornment.

- Trends in product aesthetics are driven by a range of factors, including:
- automotive design;
- cultural preferences;
- national events;
- new and emerging technology.

By creating a **mood board** that includes images of the intended user's world, a designer can begin to see a pattern in the aesthetic that the user prefers. Images should include everything that the user has, likes or wishes they had, as well as images of pop culture that may influence the user's decision to buy a product.

Aesthetics are nearly always the first thing that a user notices about the product, and could lead them to buy it. Never underestimate the importance of producing products that are attractive to the potential





# Knowledge Organiser Timber

## Resistant Materials

| Hardwood                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Timber from a deciduous tree. They are slower growing and more expensive.                                                                                                                                                                                                                               |
| <b>ash:</b> a pale and attractive hardwood. Tough, flexible. Open grained.<br><b>Used in</b> furniture, steam bending, wood turning.                                                                                                                                                                    |
| <b>balsa:</b> soft and lightweight, the wood is actually from a deciduous flowering plant, not a tree. Very light in colour with a distinct, straight grain.<br><b>Used in</b> model making, prototypes, craft, model aeroplanes.                                                                       |
| <b>beech:</b> hard, tough, strong/close grained, white/pinkish brown. Prone to warping.<br><b>Used in</b> functional furniture, chairs, tables, tools, veneers.                                                                                                                                         |
| <b>Iroko:</b> African tropical hardwood. Deep reddish brown, is a less ecologically damaging alternative to mahogany. Also known as African Teak.<br><b>Used in</b> boat-building, decorative furniture, traditional musical instruments.                                                               |
| <b>mahogany:</b> fairly strong, medium weight, durable. Interlocking grain. Pink reddish brown. Prone to warping.<br><b>Used in</b> indoor furniture, panelling, veneers                                                                                                                                |
| <b>oak:</b> strong, heavy, durable, hard and tough. Open grained. Light brown. Finishes well. Expensive.<br><b>Used in</b> construction, high-class furniture, boat building, veneers.                                                                                                                  |
| <b>teak:</b> very strong, hard, durable. Natural oils make it resistant to moisture. Golden brown. Very expensive. Blunts tools easily.<br><b>Used in</b> quality furniture, outdoor furniture, boat building, veneers.                                                                                 |
| <b>walnut:</b> an extremely durable, tight-grained wood. Its hard, dense grain make it ideal for machining and joint making. Polishes to a high quality finish.<br><b>Used in</b> restaurant tabletops, cabinet making, decorative features such as handles, bannisters, veneers and layers in plywood. |

| Softwood                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Timber from an evergreen or coniferous tree. Fast growing.                                                                                                                                                     |
| <b>Douglas Fir:</b> pale to medium red/brown colour. Works well. Straight grained, dries quickly, fast growing.<br><b>Used in</b> construction, railway sleepers, joinery, flooring, decking.                  |
| <b>Paraná Pine:</b> fairly strong and durable. Straight grain. Pale yellow, red/brown streaks. Almost knot free. Tends to warp.<br><b>Used in</b> best quality indoor joinery, staircases, built-in furniture. |
| <b>Scots Pine:</b> pronounced straight grain. Light brown/yellow in colour. Polishes well.<br><b>Used in</b> general construction work and joinery.                                                            |
| <b>spruce:</b> fairly strong with small, hard knots. Creamy white, resistant to splitting. Not very durable.<br><b>Used in</b> general indoor work such as stud-walls, shelves.                                |
| <b>Western Red Cedar:</b> straight silky grain, dark reddish brown. Lightweight and not very strong. Natural oils make it durable against weather.                                                             |

| Properties of Timber and Sheet Materials |                                                                       |                                          |
|------------------------------------------|-----------------------------------------------------------------------|------------------------------------------|
| Property                                 | Definition                                                            | Found in                                 |
| hardwood                                 | Timber from a deciduous tree.                                         | oak, ash, mahogany, walnut, beech, balsa |
| softwood                                 | Timber from an evergreen or coniferous tree.                          | pine, red deal, cedar                    |
| tight-grained                            | Timber with a high ring count, slower growing and denser.             | oak, beech                               |
| loose-grained                            | Timber with a low ring count- faster growing.                         | scots pine, red deal                     |
| dense                                    | Can be deformed without losing toughness.                             | oak, beech                               |
| straight-grained                         | Timber which has grown straight, has a uniform grain.                 | oak, beech, red deal                     |
| knot                                     | Irregularity in wood grain, where a branch or offshoot existed.       | spruce, ash, some plywood                |
| weather resistant                        | A tight-grained timber has good water and heat resistance.            | oak, beech, ash, plywood                 |
| stiff                                    | A timber that does not bend easily.                                   | oak, ash, beech, plywood, MDF            |
| easy to work                             | A timber that is either low or medium density. Easy to cut and shape. | red deal, scots pine, balsa, MDF         |
| lightweight                              | A timber that is light in weight.                                     | balsa, plywood, MDF                      |
| attractive grain                         | When polished or varnished, a timber's grain is eye-catching.         | walnut, oak, ash, some plywood           |

| Timber products                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sheet materials manufactured from layers or particles of wood including MDF, plywood and hardboard.                                                                                                                                                                                                                                   |                                                                                                                                                                                                                          |
| <b>MDF:</b> mid-brown colour. Will swell if exposed to moisture. Sheets can be heavy. Smooth finish. No grain. Available in a wide range of sheet sizes and thicknesses.<br><b>Used in</b> flat-pack furniture, vacuum-form moulds, product modelling, architectural models. Often covered in veneer for a natural timber appearance. | <b>hardboard:</b> Made from wood chip and pulp, cheaper substitute to plywood. Used when space filling as opposed to requiring strength. No regular grain.<br><b>Used in</b> countertops, flooring, flat-pack furniture. |
| <b>veneer:</b> very strong, hard, durable. Natural oils make it resistant to moisture. Golden brown. Very expensive. Blunts tools easily.<br><b>Used in</b> table tops, flat pack furniture, plywood, cabinet-making.                                                                                                                 | <b>plywood:</b> Reddish brown or white in colour. Layered in odd numbered sheets. Strong. Susceptible to splintering<br><b>Used in</b> sheds and cladding, furniture, flooring, boats (marine ply).                      |



## Wasting

### Wasting timber by hand

Most solid woods can be easily wasted and shaped using a range of workshop tools.

- **Sawing:** tenon saw, bench saw, coping saw, jigsaw.
- **Filing:** rasp, bastard, second cut, half round, round.
- **Chiselling:** chisels are used along with vices and mallets to remove areas that have been pre-cut.
- **Planing:** shape and finish edges using a plane or spoke-shave. Edges require no further finishing after planing.

### Wasting timber using machinery

Using machinery to waste timber can speed up the manufacturing process and give accurate results.

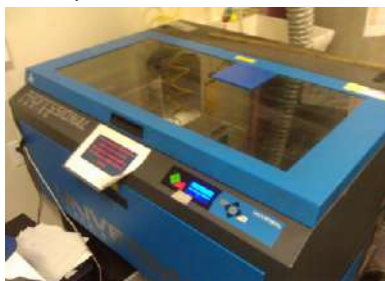
- **Turning:** lathes, used with special chisels, allow the shaping along the profile of a piece of solid wood, or laminated MDF as it is spun. Formers for vacuum forming can be made in this way.
- **Drilling:** chain drilling solid wood and sheet materials can speed up the wasting progress. A series of holes are drilled along a path, the waste is then removed using a coping saw or chisel.



### Wasting timber using CAD/CAM

Sheet timber lends itself to being wasted on flat-bed machinery. CAD files can be easily prepared to control these machines.

- **Laser cutters:** can quickly cut thin sheet timber such as MDF and plywood. Precision features such as joints can be cut accurately on a laser cutter.
- **Computer controlled routers and milling machines:** can effectively translate a computer design into a component. Double-sided tape is often used to secure the timber to the machine's



## Addition

### Addition using adhesives

- **White glue (PVA):** a strong and inexpensive glue to use with all timber.
- **Sheet material:** easily glued surface-to-surface as the large surface area gives a strong bond.
- **Some decorative detail:** can be added using white glue alone.
- **Cramps:** should be used to tighten the joint whilst the glue is drying.

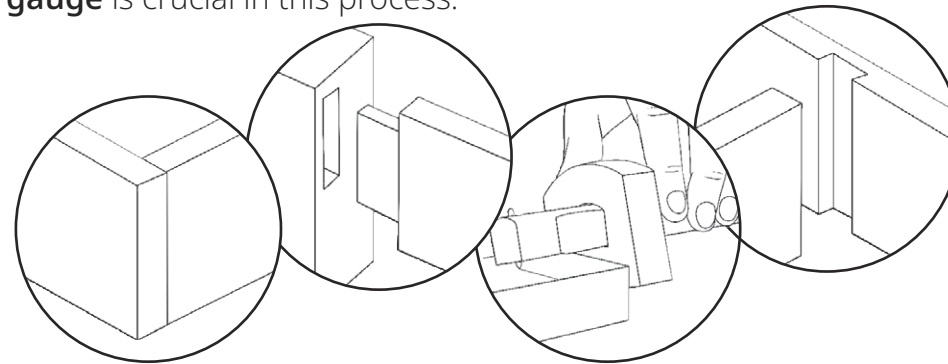
For most other joints, white glue is used in combination with other addition methods.



### Addition using joints

Solid wood can be precisely cut using chisels and a tenon saw to create tight-fitting joints which lock together. This can look attractive and give a strong join, especially when glued.

All joints require careful marking out and cutting. A **marking gauge** is crucial in this process.



### Addition using slotting

Sheet timber products can be joined using slots in the same way as sheet polymers. Slots can be cut by hand or cut using CAM machinery.



### Timber fastening hardware

The use of fasteners and joining hardware can be used in the addition of timber in combination with joints and adhesives. These include:

- **Woodscrews**
- **Coach bolts**
- **Dowel**

## Deforming and Reforming

- **Steaming:** soaking a thin length of solid wood or plywood in a special steamer box makes the timber flexible enough to twist and bend.
- **Laminating:** thin sheets of wood can be pressed together in a mould to form a three-dimensional structure. This technique requires plenty of space, glue and clamps!
- **Kerfing:** a technique which allows a strip or sheet of timber (either solid or man-made) to be deformed into curves and bends. Cuts are made along the inside of the material at regular intervals. The closer together, the tighter the bend. Once the cuts have been made, glue is applied to the cuts and the material is manipulated into shape and cramped to set.



### Reforming Timber

The term most commonly applies to the range of timber products that have been manufactured from solid wood. These include:

- **MDF (Medium Density Fibreboard):** this sheet material is reformed from material recycled from solid wood manufacturing. The tiny fibres are pressed together and bonded with a resin which gives the material its density. Easy to shape, but prone to causing dust.
- **Chipboard (Particleboard):** this sheet material is reformed from larger chips left over from solid wood manufacturing. Glue and sawdust is added and these are pressed together to create the sheet material Chipboard. This is a low-grade material and used most commonly in building projects such as barns, garages, flooring.
- **Hardboard:** this sheet material is reformed from pulped wood waste. The pulp is steamed under pressure before glue is added and the material is pressed flat with one smooth, hard side, and one textured surface. Low cost, this material can be used in a range of projects, but is not suitable for outdoor use.

Images courtesy of hackrva, kaktuslamp, nadya, pschlist1972, wwarby, unitedsoybean, via Flickr.com

## Polymers Knowledge Organiser Resist ant Materials

| Property                      | Definition                                                                                                                                                                        | Found in                                                                                                                                                                                      |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>polymer</b>                | The umbrella term for synthetic materials engineered from a string of monomers.                                                                                                   | plastics, paints, man-made fibres. DNA is an example of a natural polymer.                                                                                                                    |
| <b>plastic</b>                | A synthetic polymer available in many different types, widely used in packaging, product cases, toys and the car industry.                                                        | universal applications from toys to artificial limbs                                                                                                                                          |
| <b>thermoplastic</b>          | A polymer material which can be deformed and reformed using heat processes.                                                                                                       | acrylic, polystyrene, ABS, nylon                                                                                                                                                              |
| <b>thermoset plastic</b>      | A polymer that, once set, cannot be changed using heating processes, thereby making it more resistant to heat and fire.                                                           | urea formaldehyde (UF) is one of the most common types and is used in electrical fittings such as plugs and sockets. Bakelite, now rarely used, was an early plastic used commonly in the UK. |
| <b>memory plastic</b>         | Some thermoplastics can be deformed using heat and then reformed back to their original shape using heat again. The polymer chains return to their original state hence 'memory'. | high impact polystyrene (HIPS) can be reverted to its original state when vacuum forming                                                                                                      |
| <b>stiffness</b>              | A material that resists bending, remains rigid.                                                                                                                                   | acrylic, UF, polystyrene                                                                                                                                                                      |
| <b>tough (durable/strong)</b> | Able to withstand rough handling or treatment. Offers good weather resistance.                                                                                                    | polystyrene, PVC, ABS                                                                                                                                                                         |
| <b>transparent</b>            | A polymer that is clear-offering the same visual properties as glass, but with the safety benefits of often being shatterproof.                                                   | acrylic safety glass, moulded shapes such as jet-plane canopies, cellophane product packaging                                                                                                 |
| <b>brittle</b>                | A material which, through its stiffness and other properties, has less toughness and therefore may snap or crack in some situations.                                              | acrylic, UF, Bakelite                                                                                                                                                                         |

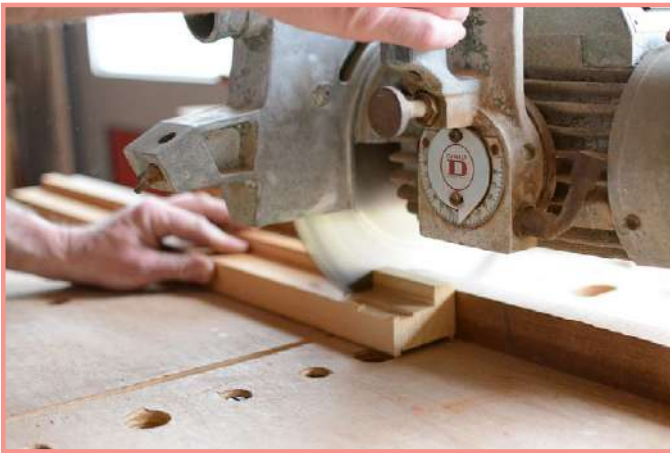
| Thermoplastics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Thermosetting Plastics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Acrylic:</b> A hard, tough thermoplastic available in sheet form and as granules for moulding. In its clear form, it makes a safe alternative to glass. Stiff, hard, durable, self-finishing, scratches easily.</p> <p><b>Used in</b> bicycle reflectors, car lights, safety glass, clothing.</p> <p><b>Polyethylene Terephthalate (PET):</b> One of the most common day-to-day thermoplastic polymers, widely used in food packaging and (in fibre form) clothing. Chemical-resistant, hard, stiff, strong.</p> <p><b>Used in</b> drinks bottles, food packaging, cosmetic packaging.</p> <p><b>High Impact Polystyrene (HIPS):</b> Inexpensive and widely used in many products as it is easily moulded. Suitable for food packaging. Flammable and not widely recycled. Expanded polystyrene is used in product packaging. High-impact, easy to shape, lightweight.</p> <p><b>Used in</b> low strength structural applications, vacuum formed packages and casings.</p> <p><b>Polyvinyl Chloride (PVC):</b> Good chemical and weather resistance, stiff, hard, tough, good insulator.</p> <p><b>Used in</b> construction-window frames, drain pipes, guttering. Widely used in the fashion industry in the flexible form of PVC.</p> <p><b>Polypropylene (PP):</b> Lightweight, hard, impact resistant, chemical resistant. Waxy finish.</p> <p><b>Used in</b> medical equipment, syringes, chair shells, kitchenware, crates.</p> | <p><b>Silicone:</b> Heat-resistant and rubber-like, this thermoset plastic is available in liquid form in many products. It is waterproof and mouldable. It is also heatproof and non-stick.</p> <p><b>Used in</b> food preparation, cake moulds, medicine, prosthetic body parts, baby toys.</p> <p><b>Epoxy Resin (ER):</b> High strength, good chemical and wear resistance, resists heat to 250°C.</p> <p><b>Used in</b> castings, adhesive, laminating paper, printed circuit boards.</p> <p><b>Melamine Formaldehyde (MF):</b> Stiff, hard, scratch resistant, brittle and dulls easily.</p> <p><b>Used in</b> decorative laminates for work surfaces and flooring, tableware, electrical insulation.</p> <p><b>Phenol Formaldehyde (PF):</b> Retains properties at low temperature, heat-resistant, easy to shape by casting.</p> <p><b>Used in</b> Bakelite products, coatings, adhesives, laboratory tops.</p> |



## Wasting

Sheet plastics that are readily available in schools can be wasted by using the following resistant materials processes and tools:

- **Sawing:** coping saw; abra file,
- **Drilling:** hand drill and pillar drill.
- **Filing:** Most wood files.



### Wasting Using CAD/CAM

Sheet plastic can also be wasted effectively using CAM, such as laser cutters and routers.



## Addition

Thermoplastics can be joined using specialised adhesives, which must be handled responsibly.

### Adhesives

Solvent glues (superglues) can be used to join some thermoplastics. Heat Welding  
A specialised 'gun' is used to heat both edges to be joined.



### Solvent Welding

This is the most common method used in schools. A syringe is used to place a small amount of solvent on the two faces to be joined. A clean, permanent join can be created.



### Fasteners

Many polymers can be joined using different fastening techniques, which may require drilling or machining. Sheet plastics such as acrylic can be laser cut with finger joints or slots to allow simple joins.

## Deforming and Reforming

Thermoplastics are a resistant material but with the correct equipment, effective use of its properties can be realised.

### • Line Bender

A thin wire is heated red hot. It is enclosed in the machine so only an exact line has heat applied to it, allowing you to make a clean bend.



### • Plastics Oven

Allows you to heat an entire piece of plastic and then bend it by hand, or in a press, using leather gloves.



## Early Modelling Knowledge Organiser

### Graphic Packaging

Working with paper and boards naturally lends itself to the use of modelling materials.

Designers use early modelling to:

- check how graphics 'wrap' around the package;
- check the contents are contained securely;
- check storage/stacking issues;
- check structural strength;
- calculate the amount of material required.

### Furniture Design

Working with natural wood and timber products for the finished product, a designer will often use paper and board to produce scale models which are quick and comparatively inexpensive to create.

Designers use early modelling to:

- ensure the product is suitable for use (anthropometrics);
- calculate the amount of material required;
- research joining solutions;
- check structural strength;
- check the overall style.

### Engineering Design

Creating a full size mock-up helps the designer to understand more about how the technology works and fits together.

- Designers use early modelling to:
- check the overall function of the product;
- investigate how components function together;
- research the size requirements of the product;
- investigate the use of different materials;
- research joining and fastening methods;
- electronics designers use simulations in specialist cad packages, as well as vero-board, to create a functioning circuit.
- modelling products such as Lego and Meccano are used for early engineering design.

### Automotive Design

Many individual components make up a large product, such as a car – but the overall shape of a vehicle is sculpted in clay, which is called a 'maquette'.

Designers use early modelling to:

- check the aerodynamics of the product in a wind tunnel;
- make calculations to do with the overall size of the product;
- develop and modify the aesthetic style of the product (clay can be wasted and re-formed).

### Product Design

Product designers use paper, card and foam to create models, as well as using CAD software to develop designs without the need for a workshop. Using CAD can also support the use of 3D printers, or rapid prototyping machinery to create three-dimensional models.

Designers use early modelling to:

- check the ergonomics of a product;
- make calculations to do with the overall size and weight of the product;
- check structural strength;
- develop and modify the aesthetic style of the product.

### Fashion Design

Designers of clothing often use paper toiles to realise and develop their ideas on a tailor's dummy.

- Designers use early modelling to:
- check the fit of a product;
- make calculations for the overall size and weight of the product;
- research how different panels are joined or fastened;
- make calculations for the amount of fabric or other material required;
- develop and modify the aesthetic style of the product.

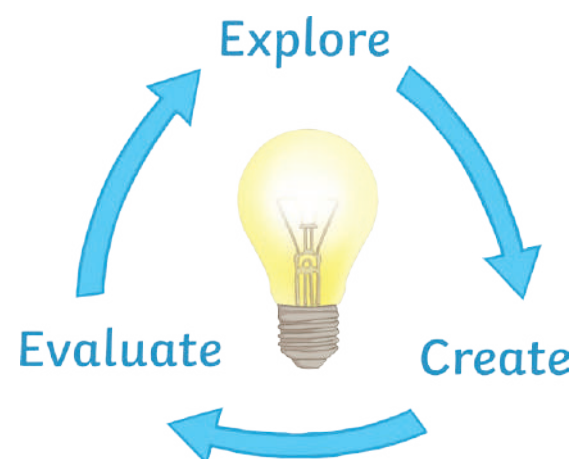
**Early modelling- Why it is important to iterative design.**

At all stages of designing, designers use paper models, toiles or maquettes to test the feasibility of their work. It is part of the cycle of iterative design.

This is different to prototype manufacturing, where a designer or modelmaker will produce a functioning version of the final design.

Early modelling allows the designer to:

- design in three dimensions;
- better understand their own design thinking;
- communicate their ideas to others;
- explore construction considerations;
- explore technical considerations;
- make modifications to their ideas.

**Design Dictionary**

**aesthetics:** the look or style of a product.

**anthropometrics:** the use of human measurements in relation to our environment - for example, a café chair must be able to allow a range of people, short and tall, to sit down.

**compliant material:** can be shaped, wasted and deformed easily.

**ergonomics:** how a product fits with its user – for example, how comfortable a handle on a hairdryer is depends on its ergonomics.

**fastening:** a temporary or non-bonded way of joining two parts of a product – for example, buttons, nuts and bolts and cable ties.

**maquette:** a scale model made from clay, built with the purpose of examining and developing the form and aesthetics of the product.

**scale model:** a model or prototype which is proportionally identical to the full-sized product, but scaled down to a practical size for initial making.

**toile:** an early version of an item of clothing, made from paper or inexpensive cloth.

# Green Energy Sources in D&T Knowledge Organiser

How do designers choose appropriate sources about energy to make product and power systems?

## Hydroelectric Power

This form of energy production relies on creating or using a pre-existing water body. The flow of water is restricted by damming, which creates potential kinetic energy. The water is released through channels within the dam and powers a turbine. This movement energy is transferred to a generator, where it is turned into electrical energy. The national grid then carries it off.



### Advantages

Hydroelectric power is the most established sustainable energy production methods, and seen as the most dependable due to the fact that it is not dependant on the weather. Other advantages include:

- no dangerous pollutants produced;
- can be turned on quickly to provide on demand power;
- no fuel required.

### Disadvantages

When hydroelectric power stations are built, the surrounding landscape has to change dramatically. A river has to be dammed to create a lake, or a large piece of land has to be quarried and flooded to create the lake. Local species of animals, insects, plants and trees are all threatened when their environment changes so rapidly. Other disadvantages include:

- the need for new roads to be built;
- expensive to build;
- a drought could render the power station useless.



## Wind Power

Wind power has seen considerable investment over the past ten years in Europe. As the UK is surrounded by sea, offshore wind farms have been established all around the island. Elsewhere in Europe, it is common to see huge arrays of the tall windmills throughout the countryside. Wind turbines produce electricity when the wind turns the three huge rotor blades. This kinetic energy is transferred through a shaft to a gearbox and then to a generator where electricity is produced. It is then fed into the national grid.



### Advantages

Wind power is considered one of the main forms of sustainable energy for the future and it is likely that more and more wind farms will be made. Advantages include:

- no dangerous pollutants produced;
- no dangerous pollutants released in energy production;
- no fuel required.

### Disadvantages

Many people consider that wind farms cannot compete with the demand for energy that continues to rise as the world's population grows. Others consider that the landscape views are spoiled by the introduction of wind farm turbines. Other disadvantages include:

- noisy if built near homes;
- expensive to build;
- when there is no wind, there is no energy produced.



# Green Energy Sources in D&T Knowledge Organiser

How do designers choose appropriate sources about energy to make product and power systems?

## Tidal Power

More dependable than the wind, the ocean's tides flood in and out of rivers and estuaries twice a day. There are two ways that the movement of sea water is being used to create sustainable energy.

### Tidal Barrages

These barriers are built across a river, and as the water moves with the tide, turbines are powered, transferring kinetic energy to generators.



#### Advantages:

- no dangerous pollutants produced;
- no fuel required;
- has the potential to provide the UK with up to 20% of its energy requirements.

#### Disadvantages

- very expensive to build;
- only operational for around 10 hours a day (as the tides go in and out).

### Wave Energy

Scientists believe that of all the green energy sources, waves are the most constant and predictable. Long-wave energy convertors float in the sea and the movement between the sections moves hydraulic links that then power a generator.

Wave energy convertors are still at a research and developmet stage and whilst they prove to harness the sea's potential energy, the costs are too high to warrant the level of investment by governments seen elsewhere.

## Solar Power

Huge arrays of solar cells are now commonplace in some parts of the UK. Unlike all other forms of energy production, solar farms do not require turbines to transfer movement energy to generators. Solar cells create electromotive force that is converted into alternating current and supplied to the national grid.



#### Advantages

Solar power can work on many different scales – a pocket calculator uses a small number of cells to power itself; a domestic house has its roof covered to provide what it needs; and commercial solar farms can exist over hundreds of hectares. Other advantages include:

- no dangerous pollutants produced;
- no fuel required.

#### Disadvantages

Like wind farms, solar farms are only productive under certain conditions – solar cells need daylight. In the UK, this means that solar cells only convert energy for around 8 hours per day in the winter.

Other disadvantages include:

- very expensive to build;
- changes the landscape and agricultural land is lost.



## How can exploring the context a design solution is intended for inform decisions and outcomes?

### Where and How the System or Product Is Going to Be Used

The **environment** that a product is going to be used in has to be explored by the designer to ensure the product operates as intended.

|                             |                                                                                                     |
|-----------------------------|-----------------------------------------------------------------------------------------------------|
| Is it sandy?                | Moving parts could become clogged with sand particles. Polished plastic finishes may get scratched. |
| Is it in direct sunlight?   | Thermoplastics can relax and deform. Metals can reflect.                                            |
| Is it really cold?          | Metals can be uncomfortable to touch in freezing temperatures.                                      |
| Is there water or moisture? | Ferrous metals rust, while untreated wood can warp and rot. Plastic can be slippery.                |
| Is it dark?                 | Poor visibility may heavily affect the use of the product.                                          |
| Is it really hot?           | Some fabrics perform badly in hot climates.                                                         |

The **way** a product is going to be used is crucial for the designer to understand if they are to design a product which is fit for purpose.

|                                                |                                                                                          |
|------------------------------------------------|------------------------------------------------------------------------------------------|
| How often will it be used?                     | Products designed for public use need to be much more durable than domestic products.    |
| How many people will use it?                   | The ergonomics should suit the intended user, even if this is multiple groups.           |
| How will it be handled?                        | In activities such as sports, products experience heavy impacts.                         |
| Will the user access the product on their own? | If it is designed for young children, the product must be intuitive and easily accessed. |

### Identifying the Primary User and Wider Stakeholder: Requirements

The **primary user** is the target user group that a product is intended for at the design and marketing stage. Iterative design identifies the needs of the user to begin to develop the product. The function, style and price are all determined by who the product is aimed at.

|                              |                                                                                                                    |
|------------------------------|--------------------------------------------------------------------------------------------------------------------|
| How much will they pay?      | Every market group has an upper limit to what they can pay for a product.                                          |
| Where will they use it?      | Studying the user's habits will tell you a lot about the locations that the product might get used in or taken to. |
| What styles would they like? | Look at the intended user's lifestyle. What other products do they own? What brands influence them?                |
| How will they use it?        | Will the intended user make typical use of the product, or do they require something with different features?      |

**Wider stakeholders** are other groups of people who may be directly or indirectly affected by a product.

|                                   |                                                                                        |
|-----------------------------------|----------------------------------------------------------------------------------------|
| Who else sees the product?        | The physical appearance of the product may be offensive to viewers in some way.        |
| Will lots of people use it?       | A medical tool may be primarily used by a doctor, but may also be handled by patients. |
| Who changes the batteries?        | Products such as fire extinguishers need to be serviced by qualified professionals.    |
| Who is responsible for buying it? | Most toys are not bought by children themselves.                                       |



## How can exploring the context a design solution is intended for inform decisions and outcomes?

The more investigation a designer can do into the wider context of the needs and usage of a product, the more accurate they can be in the development of an effective solution.

### Social Factors

A designer must work to understand the needs of the user of their product, including wider social factors such as religion, gender, family members, wealth and multiculturalism.

These factors can influence:

- cost of the product;
- where the product can be used;
- who can use the product;
- how the product will be looked after.

### Cultural Factors

It is important to an ethical designer to consider the different conventions of the cultures in which the product may be used, which may include:

- colours that may be associated with nationalism;
- the use of icons that may have multiple meanings;
- the use of materials, including animal products;
- people's perception of the product or its use.

### Moral Factors

Designers have to consider how a product or its use may affect the moral values of the user, or the society in which it will be used. This might include:

- potential misuse of the product;
- sustainability issues;
- environmental impact of manufacturing and use;
- knowledge of pressure groups associated with the above factors.

### Economic Factors

Every stage of a product's lifecycle has a cost attached to it. The more the designer understands about this, the better informed their designing will be. Factors may include:

- material costs and availability;
- manufacturing costs, including outsourcing;
- employment/unemployment data in area of intended use;
- poverty data in area of intended use.



## Manufacturing Processes and Techniques Knowledge Organiser

How can materials and processes be used to make iterative models?

### Graphic Packaging

The creation of graphic packaging models can follow the same procedure that final prototype models take.

Very early models are often no more than adaptations of existing product packages, with variations created by adding or wasting the material.

Plain card or paper is favoured by some packaging designers, using joining materials such as masking tape or magic tape.

Other tools and materials include:

- cutting mat;
- scalpel or craft knife;
- safety rule and flat steel rule;
- hot glue gun;
- clear sheet material, such as acetate, for creating windows;
- pins or pegs for holding joints together;
- double-sided tape;
- liquid glue;
- spray mount;
- adhesive vinyl (for graphics);
- colour printer.

Iterations of nets can be quickly turned into 3D iterative models using a CAM cutter/plotter.

This iterative model of a graphic logo for a water bottle has been created using vinyl on a CAM cutter/plotter. The designer has used a real bottle with the label removed to apply the graphics- helping them get an idea of what their design will look like.

### Furniture Design

A designer will work with scale models throughout the process of designing, but will also make full-sized iterative models, or part models, at key points to explore a range of factors, such as ergonomics. Very early models may be made from basic forms in card or paper.

Other tools and materials include:

- modelling clay;
- modelling foam;
- thick, recycled corrugated cardboard;
- found materials such as crates and planks;
- zip-ties;
- hole punch;
- modelling timbers (balsa, plywood)
- thermoplastics.



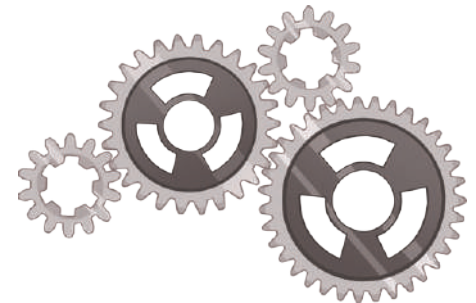
### Engineering Design

The complex nature of some design engineering projects means the designer has to go through numerous iterations of a design in order to explore, develop and finalise the function and performance of a solution.

Using desktop modelling in the early stages, a designer can begin to understand the solution, before creating actual models. In its simplest form, a control model will help the designer. The use of flowchart modelling then determines components required.

Other tools and materials include:

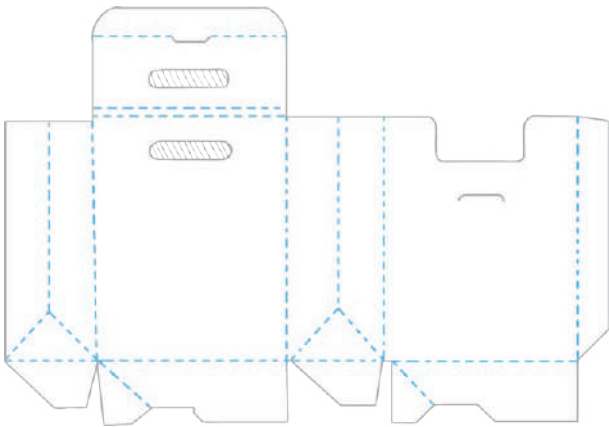
- modelling kits, such as meccano;
- stiff card;
- hole punch;
- zip-ties;
- a range of components to substitute and test;
- simulation software;
- 3D printer (for specific parts).



Iterative models are an essential part of the design process, allowing the designer to gain three-dimensional insight into their work, allowing for rapid development of ideas and the ability to share thinking with other stakeholders. A wide range of materials are available to designers with which to model their ideas and it is important that they know which are most suitable for which purpose.

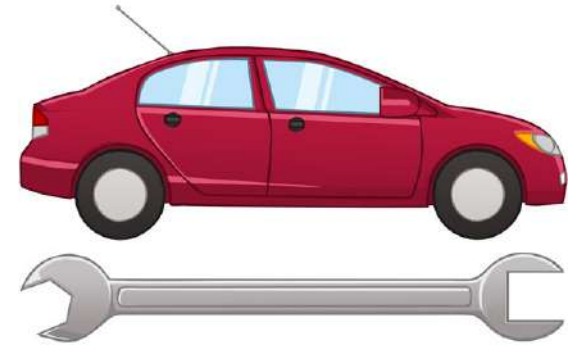
### Product Design

Most product design involves the design of products that are mass-manufactured out of moulded polymers. The shapes are often smooth, rounded or organic in appearance and this element is a key element of a Product Designer's role. Creating iterative models that help explore the aesthetics of a product can be done using a range of tools and processes:



### Automotive Design

Similar to product design, the aesthetic of a motor vehicle is often organic and sculptural. Clay is used in industry to make small iterative models as well as full-scale models that can be tested in wind tunnels.



### Fashion/Textiles Design

When designing clothing, a designer will quickly move from sketched design ideas to full-scale paper modelling. These iterative models, called 'toiles', are often created from large sheets of newsprint cut in panels. Through continual resizing and replacement, a designer can develop a design through a series of iterations, eventually using the paper panels to create cutting patterns.

