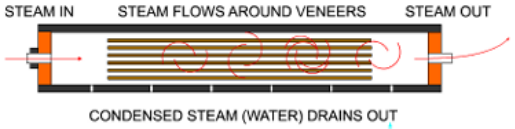
# Year 12 Knowledge organiser 1.3 Enhancement of materials

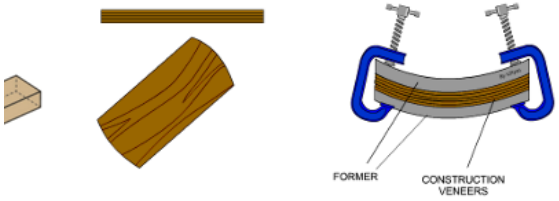
## Enhancement of Woods

Natural timber combined with resins and lamination can give enhanced properties, e.g. increased strength and stability. Timber products can also be enhanced with preservatives, finishes and coatings.

**Laminating/Steam Bending**

Thin layers of veneer are steam treated first. They are placed in steam chamber. Steam is introduced at one end and excess steam/pressure escapes at the opposite end. Condensed steam (water) drains away. As the steam flows from one end of the tube to the other end, moisture is absorbed by the veneer. After a period of time, the veneers are removed. They are now pliable and it is possible to bend them to the required shape, using a former.




This process enables curved products to be manufactured. **Lamination is the process of layering thin pieces of wood on top of each other with an adhesive between each layer.**

**Enhancement of Polymers**

Additives are added to plastics to alter and improve their properties.

FILLERS
- Reduce the bulk of the plastic (makes them cheaper, or can increase strength or hardness) examples are; sawdust and limestone.

FLAME RETARDANT
- Reduce risk of combustion, they create a chemical reaction which can stop combustion.

ANTI-STATIC
- Reduces the effects of static charge that can build up through use.

PLASTICISER
- Reduces the softening temperature and makes them flow easier.

STABILISERS
- Reduces the effect of UV light, stops the plastic degrading in sunlight.

**Enhancement of Metals**

**Case Hardening**

Case hardening is a technique in which the metal surface is reinforced by the adding of a fine layer at the top of another metal alloy that is generally more durable. Case hardening steel is normally used to increase the object life. This is particularly significant for the manufacture of machine parts, carbon steel forgings, and carbon steel pinions. Case hardening is also utilized for other applications. Case hardening is also called surface hardening. Case hardening has been in use for many centuries, and was frequently used for producing horseshoes and different kinds of cooking utensils that were subjected to substantial wear and tear. Case hardening is essentially a group of processes that are used to increase the surface hardness to an extent that is higher than that of the bulk material. Case hardening is performed normally locally on the top surface, and for a limited depth. Greater hardness is usually related with better wear and fatigue resistance.

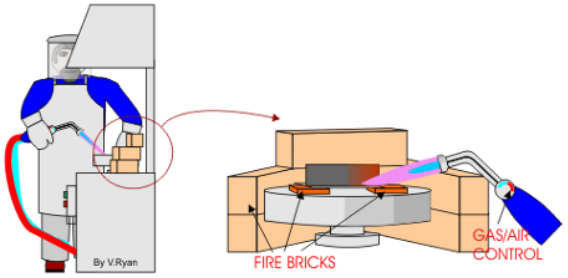
The addition of carbon to the iron surfaces is common. Case hardening involves the use of metal that has low carbon contents, and combining it with a metal that has more carbon content. The grouping of metals is likely to produce the product that is much harder. The adding of the low carbon metal creates a material that can be molded easily into the desired shapes. The surface improvement not only increases the product strength, but also assists to avoid the iron weakening. Consequently, items like fireplace equipment, cast iron wash pan, and frying utensils would continue to be serviceable for long periods of time. Case hardening is frequently utilized in the constructing industry for reinforcing girders, metal doors, and metal panels. Case hardening is generally performed after the formation of the component into its ultimate form.

**Carbon is penetrated into the metal skin to create mild steel that has an external covering with more carbon than the nucleus. The mild steel is subjected to heating at a particular temperature, till it is bright red. While the mild steel is soft, it is immersed into a carbon compound that covers the outer surface. One dipping may not be adequate, and several re-heating and dipping may be necessary. This procedure will produce a skin that is rich in carbon. Subsequently, the metal is reheated and dropped in water for hardening. Case hardening is useful for objects that need to be hardened externally to endure wear and tear, but soft internally to withstand shock.**

**Enhancement of Metals**

**Hardening and Tempering**

Steel can be treated by intense heat to give it different properties of hardness and softness. This depends on the amount of carbon in the steel (only high carbon steel can be hardened and tempered).




CARBON CONTENT OF COMMON STEELS: Mild steel: 0.4% carbon, Medium carbon steel approximately 0.8% carbon, High Carbon Steel approximately 1.2% carbon (this steel is also known as Tool Steel and includes Silver Steel and Gauge Plate).

Mild steel and medium carbon steel do not have enough carbon to change their crystalline structure and consequently cannot be hardened and tempered. Medium carbon steel may become slightly tougher although it cannot be harden to the point where it cannot be filed or cut with a hacksaw (the classic test of whether steel has been hardened).

If steel is heated until it glows red and is quenched in clean water immediately, it becomes very hard but also brittle. This means it is likely to break or snap if put under great pressure. On the other hand, if the red hot steel is allowed to cool slowly, the resulting steel will be easier to cut, shape and file as it will be relatively soft. However, the industrial heat treatment of steel is a very complex and precise science.

In a school workshop most heat treatment of metals takes place on a brazing hearth. A rotating table and fire bricks are essential. The fire bricks reflect the intense heat back on to the metal being heated. This is achieved by arranging the bricks in a semi-circle behind the metal being heated. Without the bricks, heat would escape and this would limit the temperature that could be reached.

HARDENING AND TEMPERING

Heat treatment of steel in a school workshop is normally a two stage process. For example, if a high carbon steel or silver steel screw driver blade has been manufactured, at some point it will have to be "hardened' to prevent it wearing down when used. On the other hand it will have to be 'tempered'. This second heating process reduces the hardness a little but toughens the steel. It also significantly reduces the brittleness of the steel so that it does not break easily. The whole process is called 'hardening and tempering'.

STAGE ONE:

The screw driver blade is heated, slowly at first, warming up the whole blade. Then the heat is concentrated on the area at the end of the blade. This gradually becomes 'red' hot.

STAGE TWO:

The screw driver blade is removed quickly from the brazing heart, with blacksmiths tongs and plunged into clean, cold water. Steam boils off from the water as the steel cools rapidly. At this stage the blade is very hard but brittle and will break easily.

STAGE THREE:

The screw driver blade is cleaned with emery cloth and heated again on the brazing hearth. Heat is concentrated at the end of the steel blade. The steel must be watched very carefully as it changes colour quite quickly. A blue line of heat will appear near the end of the blade and it travels towards the tip as the temperature rises along the blade. When the line of blue reaches the tip the brazing torch is turned off. The blue indicates the correct temperature of 'tempering'.

STAGE FOUR:

The screw driver blade is placed on a steel surface, such as an anvil face. This conducts the heat away and allows slow cooling of the screw driver blade. When cold, the blade should be tough and hard wearing and unlikely to break or snap. This is due to the tempering process.

# Year 12 Knowledge organiser 1.14 Design Communication

## A Level Design and Technology: Product Design

### Design Communication

You should be aware of, and able to explain and demonstrate the skills, in a range of communication and presentation techniques for conveying proposals and intentions to clients, potential users and manufacturers.

Maths/Science Link:

- Scaling drawings.
- Use of datum points and geometry when setting out design drawings.
- Representation of data used to inform design decisions and evaluation of outcomes.
- Presentation of market data, user preferences and outcomes of market research.

### Report Writing

A design report is the written record of the project and generally is the only record that lives once the design team disbands at the end of the project.

The report has three sections. The first section describes the problem that was being solved and provides the background to the design. The second section describes the design and the third section evaluates how well the design worked by comparing its performance to the design requirements. The report starts with a short executive summary that contains a synopsis of the three sections.

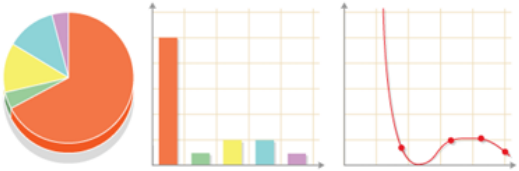
The body of the report is relatively short. Appendices to the report contain supporting information with the details needed by a reader who wishes to fully understand the design.

While this document describes the general content and organisation of a design report, some of the specifics (section headings, length, and format) may be determined by your project client.

### The use of graphs, tables and charts

Numerical data is often represented using graphs and charts.

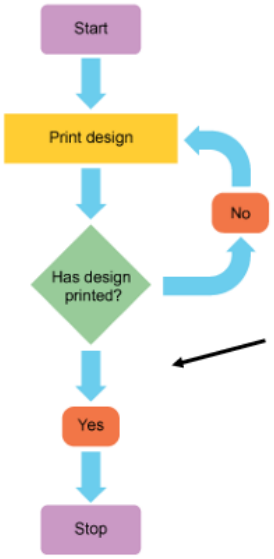
- Pie charts can show fractions of a whole number. 3D pie charts can be created.
- Bar graphs are useful for showing numbers, for example, colour choices. Different coloured bars can be used, and bar charts can be 3D.
- Line graphs are used to show change, for example results over a period of time of how well a product sells.



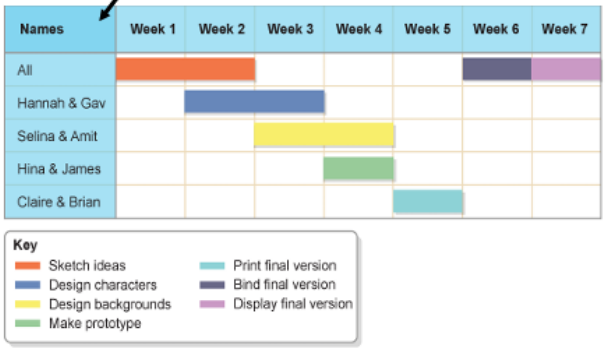
**Gantt charts** show the different tasks involved in making a product. They are used for complex planning where different tasks can be done at the same time, or where two or more people are working on the same product.

**Tables** can be used to display information.

| Class height (in cms) | Frequency | Cumulative Frequency |
|---|---|---|
| 150 - 155 | 12 | a |
| 155 - 160 | b | 25 |
| 160 - 165 | 10 | c |
| 165 - 170 | d | 43 |
| 170 - 175 | e | 48 |
| 175 - 180 | 2 | f |
| | | |
| Total | g | 50 |

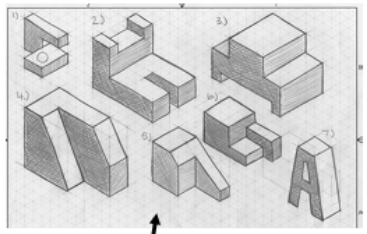



**Flow charts** describe in words the sequence of operations. Flow charts are useful for simple tasks. Arrows show direction and different shapes show stages:
Rounded rectangle = Start or finish
Diamond = Decision
Rectangle = Process

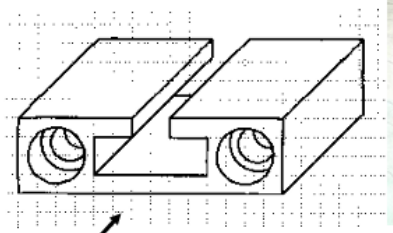



### 2D/3D sketching

Designers can use a wide range of sketching techniques to communicate design information. Some examples include:

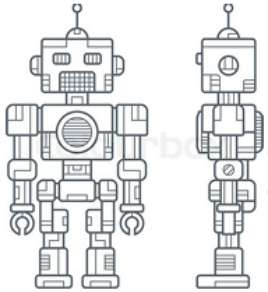


3D—Isometric



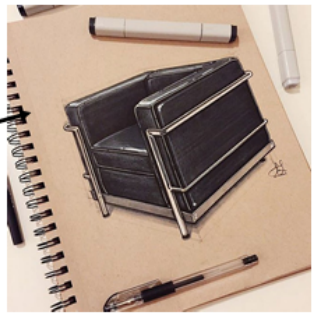
3D—Oblique

3D—Two Point Perspective



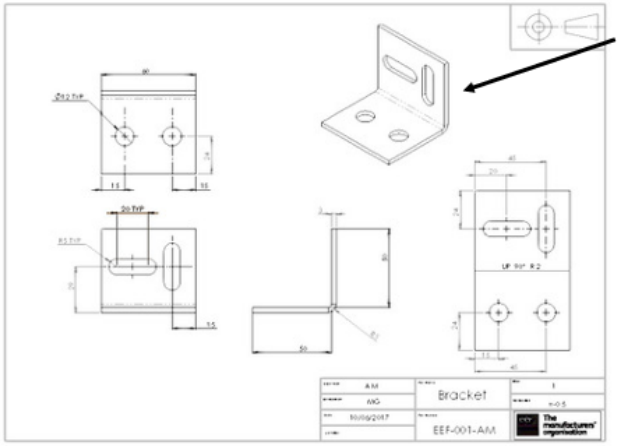
2D—Front and Side Views

Mixed media and marker rendering can be used to create more realistic drawings.



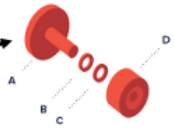
### Dimensioning and details for manufacture

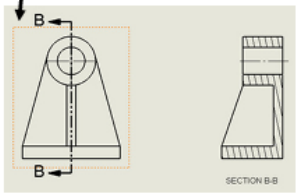
Details for manufacture are often communicated through orthographic drawings. In the UK, third-angle orthographic drawings are produced for manufacturers to work from.




The isometric view allows an engineer to visualise the part/product.

Exploded views and section views both aid in communicating manufacturing information.



# Year 12 Knowledge organiser 2.1 Design Theory

## A Level Design and Technology: Product Design

### Design Theory

You should be aware of, and able to discuss, how key historical design styles, design movements and influential designers that have helped to shape product design and manufacture.

### Design Styles and Movements

You should be aware of, and be able to discuss, key design styles and movements and their principles of design.

**Arts and craft movement** (see https://www.vam.ac.uk/articles/arts-and-crafts-an-introduction for more information)
The birth of the Arts and Crafts movement in Britain in the late 19th century marked the beginning of a change in the value society placed on how things were made. This was a reaction to not only the damaging effects of industrialisation but also the relatively low status of the decorative arts. Arts and Crafts reformed the design and manufacture of everything from buildings to jewellery.

Many of the people who became involved in the Movement were influenced by the work of the designer **William Morris**, who by the 1880s had become an internationally renowned and commercially successful designer and manufacturer.

Morris only became actively involved with the Arts and Crafts Exhibition Society a number of years after it was set up (between 1891 and his death in 1896), but his ideas were hugely influential to the generation of decorative artists whose work it helped publicise. Morris believed passionately in the importance of creating beautiful, well-made objects that could be used in everyday life, and that were produced in a way that allowed their makers to remain connected both with their product and with other people. Looking to the past, particularly the medieval period, for simpler and better models for both living and production, Morris argued for the return to a system of manufacture based on small-scale workshops.

Like many idealistic, educated men of his era, he was shocked by the social and environmental impact of the factory-based system of production that Victorian Britain had so energetically embraced. He wanted to free the working classes from the frustration of a working day focused solely on repetitive tasks, and allow them the pleasure of craft-based production in which they would engage directly with the creative process from beginning to end.

**Art Deco** (see https://www.vam.ac.uk/articles/an-introduction-to-art-deco for more information)
Arguably Art Deco – a term coined in the 1960s – isn't one style, but a pastiche of different styles, sources and influences. Art Deco designers borrowed from historic European movements, as well as contemporary Avant Garde art, the Russian ballets, folk art, exotic and ancient cultures, and the urban imagery of the machine age.

One of Art Deco's key sources was its forerunner, Art Nouveau, the fin de siècle style that fell out of fashion in the years before the First World War (1914 – 18). Key elements of Art Nouveau's visual language, such as plant and floral forms, were borrowed and adapted to create an updated vision, as seen in the stylised naturalistic fabric designs of the Atelier Martine.

As the 1920s advanced, many designers turned to the new visual language, colour and iconography of the Avant Garde.
Movements such as Fauvism, Cubism, Futurism, De Stijl, Suprematism and Constructivism – frequently bundled together under the label of 'Cubism' – were eagerly absorbed by designers seeking to capture the dynamism of the modern world. British and American critics often used the terms 'Moderne', 'Jazz Moderne' or 'Zigzag Moderne' to characterise such work. Geometric forms worked their way into all aspects of life, including everyday small items such as vanity boxes, cigarette cases, and tableware.

The stock market crash of 1929 saw the optimism of the 1920s gradually decline. By the mid 1930s, Art Deco was being derided as a gaudy, false image of luxury. By the outbreak of the Second World War, this hostility had become intense. Despite its demise, however, Art Deco made a fundamental impact on subsequent design.

**Modernism, eg Bauhaus**

The built environment that we live in today was largely shaped by Modernism. The buildings we inhabit, the chairs we sit on, the graphic design that surrounds us have all been influenced by the aesthetics and the ideology of Modernist design.

Modernism was not conceived as a style but a loose collection of ideas. It was a term that covered a range of movements in art, architecture, design and literature, which largely rejected the styles that came before it. The methodology flourished in Germany and Holland, as well as in Moscow, Paris, Prague and New York and was prominent in the years between the World Wars.

At the core of Modernism lay the idea that the world had to be fundamentally rethought. The carnage of the First World War and the Russian Revolution led to widespread utopian fervour, a belief that the human condition could be healed by new approaches to art and design. Focusing on the most basic elements of daily life – housing and furniture, domestic goods and clothes – architects and designers set out to reinvent these forms for a new century.

There was a focus on *affordable housing* and *the use of new technologies*. There was also a focus on *rejecting ornamentation*.

**Bauhaus**
The Bauhaus was arguably the most influential architecture, art and design school of the 20th century. Founded in Weimar, Germany, in 1919 by architect Walter Gropius, it attracted some of the key figures in the evolution of Modernism.

At first the Bauhaus focused on individual handmade craft, but the school soon shifted to a more industrial focal point, merging art and technology and emphasising mass production. Furnishings created there, such as **Marcel Breuer**'s tubular-steel Club Chair (right) and **Marianne Brandt**'s light fittings (above), fit this ethos of standardisation and uniformity.

Despite its reputation for rigour and excellence, the school was closed by Nazi authorities in 1933. Many of its members went abroad, where they were to disseminate Bauhaus ideas through their work and teaching.

**Post modernism, e.g. Memphis** (see https://www.vam.ac.uk/articles/what-is-postmodernism for more information)
Postmodernism is one of the most controversial movements in art and design history. Over two decades, from about 1970 to 1990, Postmodernism shattered established ideas about art and design, bringing a new self-awareness about style itself. An unstable mix of the theatrical and theoretical, Postmoderism ranges from the ludicrous to the luxurious – a visually thrilling, multifaceted style.

Postmodernism was a drastic departure from the utopian visions of Modernism, which had been based on clarity and simplicity. The Modernists wanted to open a window onto a new world; Postmodernism's key principles were complexity and contradiction. If Modernist objects suggested utopia, progress and machine-like perfection, then the Postmodern object seemed to come from a dystopian and far-from-perfect future. Postmodern designers salvaged and distressed materials to produce an aesthetic of urban apocalypse.

The excitement and complexity of Postmodernism were enormously influential in the 1980s. As the 'designer decade' wore on and the world economy boomed, Postmodernism became the preferred style of consumerism and corporate culture. Ultimately this was the undoing of the movement. Postmodernism collapsed under the weight of its own success, along with the self-regard that came with it. Yet in the 21st century we are still feeling its affects. It gave us a new way of looking at the world that holds today, and a style that is resurgent.

**Memphis**
In a decade known for indulgence, the designs that emerged from the Memphis Group defined the boundary-pushing postmodernism of the '80s. The abstract and angular furniture and graphic patterns devised by this Italian-based collective were the antithesis of streamlined, midcentury style; one critic described a room of their work as a series of "flat disks, lozenges, and saw-toothed edges; some resemble slices of lemon, toothbrushes and imaginary animals."

# Year 12 Knowledge organiser 2.1 Design Theory

## A Level Design and Technology: Product Design
## Designers and their Work

Students should be aware of, and be able to discuss, the work of influential designers and **how their work represents the principles of different design movements**, including:

**Phillipe Starck (Postmodernism)**

One of the most widely known of artist-designer 'names' in the later 20th and early 21st centuries, Starck is one of France's most fêted designers who has worked across a wide range of media. His work epitomizes the intersection of art and design, its often fanciful qualities attracting both critical approbation and criticism, particularly in such commissions as pasta for Panzani (1987). His clients have included many leading international companies with a commitment to extending the visual syntax of design in Europe, the United States, and the Far East. These have included Alessi, Cassina, Driade, Flos, and Vitra. After attending the École Nissim de Camondo in Paris in the 1960s he established a company for the production of inflatable products in 1968. In the following decade he designed a series of nightclubs, establishing the Starck Product Company in 1979. Starck's celebrity status owed much to the design policies of the French State, following the establishment of the VIA (Valorisation pour l'Innovation dans l'Ameublement) in 1980 under the Ministry of Industry and its involvement with designers such as Martin Szekely, Garouste and Bonetti, and Starck himself. He designed a suite of rooms for President Mitterand at the Élysée Palace in Paris in 1982, a commission that led to considerable media attention. His interest in interior design continued during the rest of the decade with commissions in Japan, Spain, and France, the latter including the Café Costes in Paris in 1984 with a three-legged chair that was put into production by the Italian furniture manufacturer Driade. He also designed a number of hotel interiors, such as those of the Royalton (1988) and Paramount (1990) hotels for the entrepreneur Ian Schrager, and was also involved with the design of the Groningen Museum (1991) in the Netherlands.

His collaboration with Driade commenced in 1985 and, in addition to the Costes Chair, included the Ubik range (1985) and the Lord Yo chair (1994). Another significant collaboration with Italian manufacturing industry was with Alessi, commencing in 1986, and incorporated such iconic products as the Hot Bertaa kettle and Juicy Salif lemon squeezer (1990). Much of his work was highly individualistic, with strong artistic leanings. On occasion his work was literally experimental, as in his competition design of a plastic bottle for the mineral water company Vittel in 1986. On other occasions he paid homage to the fine arts, typified by his celebrated toothbrush (1990) for Fluocaril, a brand name of Goupil Laboratories, its sinuous form paying homage to the work of the sculptor Brancusi. Reference to other fields of creativity embraced film, acknowledging the work of a fashionable director in his design of the Wim Wenders stool (1992) for Vitra. Lighting designs ranged from the intimate to the large scale, such as the playful Miss Sissi table lamps (1991) and Romeo Babe pendant light (1996) for Flos and distinctive street lamps (1992) for Decaux. Industrial designs have also, since 1990, culminated in audio-visual products for Thomson such as the Rock 'n Role CD player, the Lux Lux television, and the Perso mobile phone, as well as the Moto 6.5 motorcycle for Aprilia. Amongst other notable commissions were an imaginary house for Les 3 Suisses and the Good Goods catalogue for La Radoute in which, in 1998, he presented over 200 product ideas.

**James Dyson (Postmodernism)**

British inventor, entrepreneur, and industrialist Dyson first came to notice with his design of the Ballbarrow, which won a Building Design Innovation Award (1977). Having sold his interests in this product, he developed the innovative G-Force vacuum cleaner. Unable to interest any European manufacturers to invest in its manufacture he worked with a Japanese company that launched it in 1986. His pink, Postmodern design soon attracted critical attention and was included in a number of significant exhibitions of British design. In 1993 Dyson opened a Research Centre and Factory in Chippenham, Wiltshire, producing the DC01 cleaner which became the best-selling cleaner in the market place. Dyson objects have become style icons, reflected in the 1996 launch of the colourful limited edition De Stijl DC02 vacuum cleaner, the standard edition of which was awarded Millenium Product status by the Design Council in 1998. Dyson products may be found in many design collections around the world including London's Design Museum and the Victoria and Albert Museum. They are also widely exhibited around the world, as at the Osaka Design Centre, Japan, in 2003. In 1997 Dyson became a member of the Design Council and a Trustee of the Design Museum. His interest in education is reflected in the establishment of the Design Museum's Dyson Centre for Design Education and Training and his membership of the Council of the Royal College of Art, his alma mater where he studied furniture and interior design in the late 1960s. His company has diversified into washing machines and has subsidiaries in Spain and Japan. More recently he has transferred his manufacturing capacity from Britain to South East Asia.

**Margaret Calvert (Modernism)**

South African-born British typographer and graphic designer Margaret Calvert designed many of the road signs used throughout the United Kingdom with colleague Jock Kinneir. She also designed the Transport font used on road signs and the Rail Alphabet font used on the British railway system. The typeface developed by Calvert and Kinneir was further developed into New Transport and used for the single domain GOV.UK website in the United Kingdom.

**Dieter Rams (Modernism)**

The clarity of form and minimalist design vocabulary associated with the German designer Dieter Rams is closely identified with the Braun company. Many of his designs for domestic appliances and audio equipment feature in the permanent collections of leading museums that collect and promote design, such as the Museum of Modern Art, New York, which began to collect Braun products in 1958. After studying architecture at the Wiesbaden Academy of Applied Arts from 1947 to 1953 he spent three years as an apprentice cabinetmaker. This was followed by a period in architectural offices until he joined Braun in 1955. The clean, austere appearance associated with a functional aesthetic was epitomized by Rams's and Hans Gugelot's design of the Phonosuper SK4 radiogram of 1956, sometimes dubbed 'Snow White's Coffin'. At this time he was also involved in furniture development with the designer, physicist, and entrepreneur Otto Zapf (born 1931). He became Braun's design director in 1960 and was responsible for establishing a cleanly stated and distinctive aesthetic for a wide range of products from kitchen appliances to alarm clocks, calculators, lighters, and electric razors. This aesthetic was also in tune with the outlook of the Hochschule für Gestaltung at Ulm, a progressive design academy with links to Braun that had been first established in 1954. Other companies with which Rams has been associated include the furniture manufacturer Vitsoe (established 1959), the door handle manufacturer FSB (established 1881), and the lighting producer Tecnolumen (established 1980). His clearly articulated and austere 606 shelf unit for Vitsoe (1960) remained in production for more than 40 years. He has held a number of academic posts including, from 1981, a professorship in industrial design in Hamburg. In 1987 he became president of the German Rat für Formgebung (Design Council), which for many years had promoted the values associated with ideas of 'Good Design'. By this time many of the design values espoused by Rams were increasingly challenged by the content-rich visual language associated with Postmodernism. Dieter Rams has received many international design awards throughout his career.

**Charles and Ray Eames (Modernism)**

Charles and Ray Eames practiced design at its most virtuous and its most expansive. From the 1940s to the 1970s, their furniture, toys, buildings, films, exhibitions, and books aimed to improve society—not only functionally, but culturally and intellectually as well. The Eameses' wholehearted belief that design could improve people's lives remains their greatest legacy. Even more remarkable is how they achieved their seriousness of purpose with elegance, wit, and beauty.

Challenges posed to them by clients or—as with most creative geniuses—posed by themselves, included:

- how to produce affordable, yet high-quality furniture
- how to build economical, yet well-designed space for living and working
- how to help people see beauty in the everyday
- how to help Americans and other cultures understand each other
- how to make fundamental scientific principles accessible to lay people.

The Eameses' vast body of work illustrates their solutions to these challenges. They also demonstrate the ambition and scope of the Eameses' agenda—from the utilitarian chair to complex issues of human perception, understanding, and knowledge.

**Marianne Brandt (Modernism)**

Marianne Brandt (1 October 1893 – 18 June 1983), German painter, sculptor, photographer and designer who studied at the Bauhaus school and became head of the metal workshop in 1928. Today, Brandt's designs for household objects such as lamps, ashtrays and teapots are considered the timeless examples of modern industrial design.

# Year 12 Knowledge organiser 2.3 Technology & cultural change

## A Level Design and Technology: Product Design

### How technology and cultural changes can impact on the work of designers

### Socio-economic Influences

You should be aware of, and able to discuss, how socio economic influences have helped to shape product design and manufacture.

**Post WW1: the Bauhaus and development of furniture for mass production**

Modernism is a philosophical movement that, along with cultural trends and changes, arose from wide-scale and far-reaching transformations in Western society during the late 19th and early 20th centuries. Among the factors that shaped modernism were the development of modern industrial societies and the rapid growth of cities, followed then by reactions of horror to World War I.

European and American artists turned their back on the old-world past after the mass slaughter of World War One. Not all Modernists found solace in the breakdown of the old order. Writers like T.S. Eliot found much reason to despair. But designers like **Eero Saarinen** and the husband and wife team **Charles and Ray Eames** embraced industrial techniques (like lamination) and mass production to create forward-looking, minimalist furniture and buildings that still define the way we live now.

The use of tubular steel by **Marcel Breuer** is an example of how new methods of designing and making furniture changed thinking.

**WW2: rationing, the development of 'utility' products**

Utility furniture refers to furniture produced in the United Kingdom during and just after World War II, under a Government scheme which was designed to cope with shortages of raw materials and rationing of consumption. Introduced in 1942, the Utility Furniture Scheme continued into post-war austerity and lasted until 1952.

By 1941 it had become apparent that the combination of a severe lack of timber suitable for furniture making (in which Britain was not self-sufficient) and the increased demand for new furniture due to the losses of housing caused by bombing and to the continuing establishment of new households after marriage, had created a severe furniture shortage.

New furniture was rationed and was restricted to newly-weds and people who had been bombed out, under the "Domestic Furniture (Control of Manufacture and Supply (No 2)) Order 1942" operative from 1 November 1942.

The Committee were genuine believers in the aesthetic qualities of their designs, however, popular hankering for ornament manifested itself almost immediately, and instances were apparently reported of black market utility furniture with added carvings and decoration. Design rules were relaxed in 1948 and the "Diversified" range was announced, drawing on contemporary Scandinavian designs, but the tide of public taste was against it and the Panel was wound down. The scheme was officially closed in 1952, the same year that furniture rationing ceased.

**Contemporary times:**

In the 1940s and 50s there was significant development in the field of polymers and their moulding techniques, this gave designers new opportunities. **Verner Panton** and **Robin Day** used these new techniques to design and manufacture iconic designs.

During yesteryears, furniture was crafted by hand. It took a long time. This obviously meant all pieces of furniture had a sense of craftsmanship and history to it, which was great, however, it also meant furniture had a price tag that quite simply wasn't attainable for most. And that wasn't the only caveat to what should be such a simple thing; back then, furniture was hard to transport due to fact you couldn't take it apart. If you decided you wanted a piece, it could be weeks before you received it.

Furniture was an outright nuisance, so one certain innovation in the field was welcomed with open arms: Flat Pack Furniture

As somewhat alluded to, in the past furniture was inaccessible; nice looking pieces were almost exclusively for the rich, unless it was an heirloom. That all changed when Swedish IKEA employee, Gillis Lundgren, had to screw his table's legs off to fit in his car. Supposedly when placing the legs in the car Gillis had the epiphany 'Why can't all furniture be like this?'. The rest was history. The fact he was employed by IKEA made the process very easy for him and them.

The innovation of flat pack furniture offered the world choice, suddenly it wasn't so hard to imagine all types of furniture in every one of rooms. You could have a certain aesthetic in one and a different in another. To say the innovation took the world by storm is an understatement; even students could afford a desk, dining room, their own bed, and whatever else their house needed.

# Year 12 Knowledge organiser 2.3 Technology & cultural change

## A Level Design and Technology: Product Design

### Major Developments in Technology

You should be aware of, and able to discuss, how major developments in technology are shaping product design and manufacture.

**Microelectronics**

Electronic components used to be very large, inefficient and unreliable. The first electronic-based products such as radios were very large and expensive.

Microelectronic devices, packaging designs, and materials have dramatically improved over the past decades. Integrated circuit (IC) chips are now much smaller and faster, and the packaging is more efficient, reliable, and cost-effective.

Microelectronics has touched every aspect of modern life. One cannot imagine a world without personal computers, cell phones, fax machines, camcorders, stereo players, televisions, microwave ovens, calculators, etc. In a way, microelectronics is becoming the central nerve of the modern world.

For example, automotive engines rely on electronic ignition and control systems to increase fuel efficiency and to reduce emissions; "smart" airbags rely on electronic sensing to adjust their inflation to provide collision protection without injuring the passengers; and drivers in unfamiliar streets can rely on global positioning systems to provide instantaneous driving directions. When electronic devices fail to perform these expected tasks, they are considered unreliable. Consumer books on automobiles publish reliability data about every automobile made, and the consumer depends on this information to decide which product to buy.

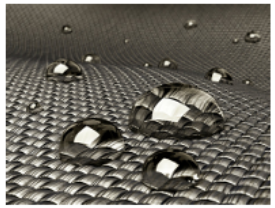
In addition to consumer products, microelectronic devices have also permeated many critical areas in medical, aerospace, and military applications. In such critical applications, reliable performance of electronic packages is extremely important. Failure of a desktop PC in the office may create inconvenience, but the failure of a pacemaker may be fatal. If the electronic navigation system on a jetliner fails to perform reliably, many lives may be endangered. Numerous military weapons systems, such as missiles, jet fighters, and nuclear bombs, are either guided or controlled by electronic devices. The reliability of these electronic devices and systems is so critical that a war between countries may break out if these systems malfunction.

Microelectronics have revolutionised how products are manufactured, they can be found in all CNC machines, including robots and moulding machinery, they can now be easily re-programmed.

**New materials**

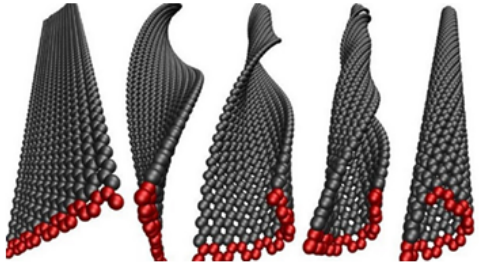
See modern materials/composites;

- Glulam
- Kevlar
- Precious Metal Clay (PMC)



Nanomaterials

Nanotechnology is the precise manipulation of nanomaterials, which are using particles in the size range 1 to 100nm (0.000001mm to 0.0001mm). It is currently used in the form of additives in suncream and cosmetrics. It is often used to coat products.



Graphene is a good example of a nanomaterial, it has very high tensile strength and hardness, combined with heat resistance and high electrical conductivity, making it perfect for many applications.

**New Methods of Manufacture**

The 20th century saw the introduction of massive improvements in our ability to manufacture products. One of the significant consequences of this has been to change the nature of the workforce; **we have moved from needing large numbers of high skilled machine operators, to a much smaller number of highly skilled technicians responsible for computer-based manufacture.**

Other new methods of manufacture, include;

- Electrohydraulic forming, which involves forming sheet metal into a complex form by using a spark in water, removing the need for a two-part mould.
- Direct metal laser sintering (DMLS), a laser is used to sinter (fuse) metal particles layer by layer, very similar to polymer 3D printing. The platform is lowered each time and a roller rolls on a new layer of powdered metal to be sintered. It can achieve undercuts and complex internal details which would be impossible using other manufacturing methods.
- Laser beam welding is now possible. A laser beam is used to join to pieces of metal together using heat. The process is fast and accurate. Advantages include; a wide range of metals can be welded, small heat area, smooth weld, more accurate, no filler rod needed. Disadvantages include; high cost, needs a clean environment and more health and safety concerns.

The internet of things (IoT) is changing the way we live our day-to-day lives. In the home, product such as Amazon Alexa can automate some daily tasks, smart fridges can automatically re-order items that need replenishing. In manufacture, it can be used to automatically order stock for JiT, automatically re-schedule due to breakdowns and automatically trigger maintenance on machines via sensors.

**Advancements in CAD/CAM**

CAD and CAM have developed significantly over the years, now 3D CAD can be used to design products, as well as generating the code required for CAM, such as 3D printing.

As the number of CAD packages increases, there is now a trend to use dissimilar file formats so that each software can read one another's file types.

FEA and CFD are now commonplace in commercial CAD packages, this allows the user to complete complex analyses on parts/assemblies, this saves money and time as there is less need for testing physical prototypes.

Cloud-based CAD such as OnShape allows users to access CAD files anywhere in the world, as well as collaborating with others anywhere in the world.

Virtual Reality (VR) is becoming more prominent in CAD, allowing the user to visualise the product in its intended environment. Sensory gloves can also be used to give potential consumers an idea of what the product will be like once manufactured.

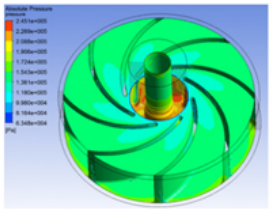


Figure 1 - Impeller CFD model

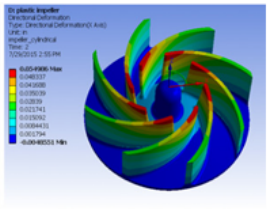


Figure 2 - Impeller FEA model

# Year 12 Knowledge organiser 2.3 Technology & cultural change

## A Level Design and Technology: Product Design

### Social, Moral and Ethical Issues

Students should be aware of, and able to discuss, the responsibilities of designers and manufacturers.

Social issues are those that affect environment, health, poverty, discrimination and unemployment that affect a significant number of people. Moral and ethical issues relate to people's beliefs, such as what they believe is right and wrong.

An example of issues of morality and ethics, is **William Morris** and his rejection of machine-based manufacture.

The need for designers to consider their responsibilities in relation to these issues and how they apply to various products and systems, will vary considerably for different societies and the groups within them. However they have a duty to ensure their practices and designs are appropriate.

Some companies are very aware of their social responsibilities, they often have a Corporate Social Responsibility policy. Lego and Disney are good examples of companies with effective Corporate Social Responsibility practices.

Companies are beginning to reduce the amount of virgin plastic they use and are now often using recycled plastics and using biodegradable alternatives, such as PLA. Many companies are also only using timber that comes from sustainable sources, such as those managed by the Forestry Stewardship Council (FSC).

Companies are now much more criticised for unethical treatment of employees, such as those working in mines.

Designers need to undertake extensive research into what is culturally acceptable around the world, so to avoid any embarrassment and damage to company reputation and sales.

### Inclusive Products

**Inclusive design** is 'the design of mainstream products/services that are accessible to, and usable by, as many people as reasonably possible...without the need for special adaptation or specialised design. The main feature of this is that designers should design products that accommodate a diverse range of people without them being stigmatised in some way.

Good examples of inclusive design are:

- Updated standards for wider doors for wheelchairs in new houses.
- Good Grips by OXO can be used by a wide range of people.
- Many improvements on public transport, including buses with floors that lower for pushchairs and wheelchairs, and bright yellow handrails that can be seen easily.
- Road crossings; bumps on pavement, ramps, audible and tactile feedback.
- Hearing induction loops in public places.
- Large buttons on remote controls

**Products that could assist with social problems**

Social problems cover a wide range of issues, from what might seem quite trivial to serious issues that affect the lives and wellbeing on lots of people.

An example of a trivial issue is **litter**. A number of bins have been developed that encourage children to throw litter in bins, thus changing habits earlier.

Another issue is that on vehicle accidents involving young people, therefore **black box** recorders are now often installed by insurance companies., which offer discounts, thus encouraging safe driving.

### Poverty, Health and Wellbeing

Some designers have worked towards ensuring the declaration of human rights, set out by the UN in 1948, is met.

**Trevor Baylis** became aware of the unaffordability and unavailability of batteries to power radios in parts of Africa. He developed a wind-up radio that did not require batteries. He sold millions around the world and became an inspiration for other wind-up products.

**Yanko Design**, a design blog, ran a competition for products aimed at reducing poverty, a number of products were produced as a result:

- Rainwater harvesting system made from plastic bottles
- Homeless shelters
- Mobile storage units for schools in developing countries.

In the field of **Health**, a number of developments have transformed modern medicine:

- Prostheses have become much more sophisticated due t new materials, products and technology.
- Minimally invasive surgery robots have been developed.
- Telehealth allows healthcare professionals to monitor a patient's health remotely.
- MRI and CT scanning allows healthcare professionals to diagnose conditions much more accurately.
- Artificial organs allow a patient to lead an almost normal life.
- 3D printing is now used in health, including, skin, scaffolds to support bone growth, medical equipment e.g. umbilical cord clamps in developing countries and skull repair implants.

**Migration**

Some products that have been borne out of migration issues, for example mass refugee camps:

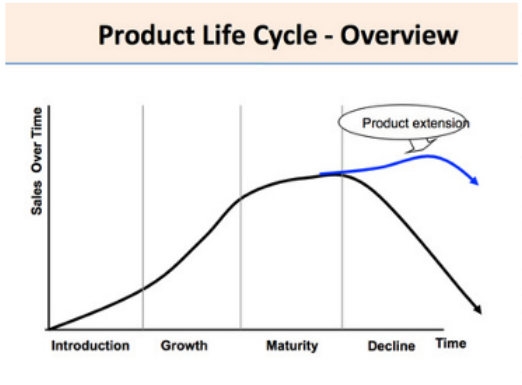
- Trough-style solar cokers.
- Solar based water purification products.
- Used clothes donated to refugees.
- Flat packed shelters for refugees, including solar panels for charging phones and lighting.
- Shipping containers that have been converted into mini hospitals and mini maternity wards.

### Fairtrade

Consumers are becoming more aware of the way growers and handicraft products in developing countries are often exploited and dealt with unfairly when trading. The Fairtrade movement seeks to give a better deal to such people. Supermarkets have enormous buying power, this can lead to producers being treated unfairly.

The Fairtrade organisations enters into negotiations with supermarkets and other buyers to ensure a fair, minimum price is set for prodicts and also agrees on a premium which is used to make investments to support developmental projects. The Fairtrade mark is displayed on products that meet its standards.

### Product Lifecycle




The product life cycle is an important concept in marketing. It describes the stages a product goes through from when it was first thought of until it finally is removed from the market. Not all products reach this final stage. Some continue to grow and others rise and fall.

What are the main stages of the product life cycle?
The main stages of the product life cycle are:
Research & development - researching and developing a product before it is made available for sale in the market
Introduction – launching the product into the market
Growth – when sales are increasing at their fastest rate
Maturity – sales are near their highest, but the rate of growth is slowing down, e.g. new competitors in market or saturation
Decline – final stage of the cycle, when sales begin to fall
This can be illustrated by looking at the sales during the time period of the product.

**Extending the Product Life Cycle**

For successful products, a business will want to do all it can to extend the growth and maturity phases of the life cycle, and to delay the decline phase.
What can businesses do to extend the product life cycle?
To do so, it may decide to implement extension strategies - which are intended to extend the life of the product before it goes into decline.
Examples of extension strategies are:
Advertising – try to gain a new audience or remind the current audience
Price reduction – more attractive to customers
Adding value – add new features to the current product, e.g. improving the specifications on a smartphone
Explore new markets – selling the product into new geographical areas or creating a version targeted at different segments
New packaging – brightening up old packaging or subtle changes

# Year 12 Knowledge organiser Design processes

## A Level Design and Technology: Product Design

### Design Processes

You should be aware of, and able to discuss and implement, the stages of a range of design processes in order to apply personal judgement and relevant criteria in the appraisal of products and systems.

**Design Brief**

A design brief can contain the following:

- A description of the problem or need (often called the situation).
- Images and details of the context, situation or problem.
- An explanation of why existing products are not suitable or do not meet the needs of the user.
- Details of the client or user group.
- An outline or description of the type of product that is to be developed.
- A description of the product's key functions.
- A list of the key areas of focus for the product to be a success.

### Investigations and Analysis

**Primary Research**

Designers carry out investigations (research) using a wide range of techniques; many of these involve **primary research**. Designers often observe people in similar environments using similar products. This can be useful in identifying the weaknesses of existing products and potential areas for improvement. They will also seek the opinion of potential users by using **focus groups** or **questionnaires.**

**Analysis of Existing Products**

When analysing products, you should use them and then take them apart.

- How does the product function?
- What are the vital components that allow the product to work?
- What are the materials and how has it been manufactured?
- Are there any ergonomic features that make the product easier to use?

You should try to identify what consumer needs are met by the product and what key criteria were used when the product was developed. You can also critically analyse the product by considering its aesthetics and cost. Where possible, you should compare the product with others and comment on function, suitability of materials and manufacturing method, ergonomics, aesthetics and cost.

**Investigation and Analysis of Materials**

Sometimes designers may need to carry out research into materials, construction methods and finishes so that they can select the most appropriate ones to use in a project. In the commercial world, designers are not likely to be experts in all materials, components and technologies, so it is vital that they carry out practical investigations. This type of testing may be carried out by specialists who make the results available to the designer.

Example tests could be for hardness or brittleness.

**Other forms of investigation**

- Meeting with the client
- Using internet forums to gauge opinion
- Talking to experts
- Investigating the work of other designers
- Investigating historical influences
- Looking at current trends and styles
- Identifying design constraints such as size, the environment the product will be used in and how it is to be used
- Using British Standards
- Investigating the safe use of materials and components, ensuring COSHH regulations are adhered to
- Analysis of anthropometric data
- Consideration of relevant social, moral, cultural and environmental issues.

### Using Inspirational Materials

Designers often collect materials to inspire them, including:

- Mood boards - a collage of images relating to the product.
- Inspiration boxes - swatches, colour samples and existing products.
- Job bags - A collection of cuttings from newspapers, magazines, sketches, material samples, components and products.

**Idea Generation** Designers can generate ideas in many ways.

Mind maps are often used by designers to help them think about factors that influence the design, and what might be considered when developing the product. These could form a checklist that is worked through when developing designs.

**SCAMPER** The SCAMPER technique can be used to develop/generate ideas. It involves substituting, combining, adding, multiplying, putting to other uses, eliminating or reversing.

Ideas can be **discussed** with others to get feedback and develop ideas further.

**Illustration** Methods of illustration can be found on the Design Communication sheet.

### Development of a Specification

After carrying out an investigation and analysing research, a design specification can be development.

Typical elements of a specification are:
Function, User, Environment, Sustainability, Maintenance, Size, Weight, Ergonomics, Aesthetics, Cost, Quality and Safety

**Modelling** Modelling is an important tool used in developing ideas. Modelling is often completed using paper, card, Styrofoam, clay, wire, modelling clay, foam board and balsa. Cardboard and paper are good for creating quick models.

Models can be made to scale, which is helpful in communicating the aesthetics of a product. They can also be used to demonstrate the function of a product. Full size models can be used to check sizes and proportions, for example to test ergonomics.

### Evaluation and Testing

Evaluation and testing should be seen as an ongoing activity throughout the design process. For example:

- After completing investigation work, such as disassembly and analysis of products, the designer would evaluate their findings and summarise key points.
- After completing initial design drawings, the designer would evaluate them with the client/potential users.
- When a design proposal is produced, good quality 3D CAD drawings might be shown,. Their comments would be used for further development of the product.
- When models and prototypes are produced, they can be tested with potential users and their feedback used for further development.
- Before making a product, it is good practice to experiment with materials and manufacturing methods, testing construction methods and evaluating their suitability.

When a prototype is completed, it could be evaluated by:

- A detailed comparison of the product against the specification.
- Testing the product in its environment.
- Obtaining third party feedback.
- Obtaining expert opinion.
- Using all findings from testing and evaluation to suggest how the prototype could be developed further.

### Iterative Process in Industrial and Commercial Contexts

**Collaborative Working** Designing and making products often requires the expertise, skills and knowledge of a number of people. In industry, design teams consist of people with different areas of expertise and specialist knowledge. For example, one designer may have particular strengths in product styling or aesthetics, while another may have more expertise in engineering components and be able to focus on the functional aspects. Ergonomists may be involved in the development of the product to ensure that it is usable by the target market. Production designers will also be closely involved because they develop the tooling required to manufacture the product. Design teams work alongside product marketing teams who are responsible for promoting the product, and have a clear idea of the need and wants of potential users of the product When producing your own project, you should try to make use of a range of people who might be able to give you specialist advice and practical help For example, you might be able to contact people who make or sell similar items to the product you are developing. They may offer to give you some guidance or even be involved in evaluating your designs and prototype. You can also use your friends to bounce ideas off and to obtain feedback about your designs.

**The cyclic nature of commercial design and manufacture** In commercial design and manufacture, designers constantly evaluate their designs with clients and potential users. Using the feedback from clients and people from the target market, designers create new iterations of their designs and again obtain feedback. Similarly, when prototypes are used, designers can test their designs with potential users and obtain feedback. his might be done with a focus group or selected individuals. In addition to this, prototypes are shown to production engineers, to gain feedback about any design changes that would be required for the prototype to be put into production. Finally, when the product goes to market and consumers start to use the product, designers will already be working on new 'improved versions of the product, using feedback from customers and data from sales. Designers working in large businesses and industry are usually involved in a cyclic design process as opposed to a linear model. Working alongside sales and marketing teams, designers will be aware of market trends an will know when their product or product range needs to be refreshed to improve sales.

# Year 12 Knowledge organiser 2.5 Critical analysis

## A Level Design and Technology: Product Design

### Critical Analysis and Evaluation

You should be aware of, and able to discuss, your own and commercial products leading to possible improvements/modifications of the original idea.

When designing and making your products, you can compare them to your **specification** throughout the process, leading to a more successful solution.

You are encouraged to study commercial products as part of your primary research.

**Testing and Evaluating in Industrial or Commercial Contexts**

You should be aware of, and able to discuss, how products are required to undergo rigorous testing, and the testing methods used, before they become commercially available for sale.

Evaluation throughout the design process ensures the product is of a good quality in terms of its design, however it is subject to rigorous testing to ensure it is safe to use. **Product recalls** can be implemented to withdraw faulty products from service, however these are very expensive. The cost of rectifying issues during the design/ manufacture stages are cheap in comparison to recalling products.

**Example:** one of the most expensive recalls was due to the issue with lithium-ion batteries catching fire on the Boeing 787 Dreamliner. It cost Boeing hundreds of millions of dollars to rectify the issue and a poor standard of testing was blamed.

**Use of Third Party Feedback**

You should be aware of, and able to discuss, how the use of feedback and testing informs the evaluation process, including:

- informing future modification and development
- the importance of ensuring the views of other interested parties in order to have objective and unbiased feedback.

Third party feedback consists of **objective views** about products that are not involved in the product's design or manufacture.

A number of international organisations exist to monitor the standards of products and services. In the UK, the United Kingdom Accreditation Service (UKAS) is responsible for checking and monitoring the work of the many agencies that certificate testing and inspection of the products, and their manufacture, along with many other sectors. The BSI is the UK's most significant UKAS **accredited** organisation, since it publishes a range of **standards** that are used in the design and manufacture of products. Some examples from BSI are:

- BS 8887 Product manufacture, assembly, disassembly and end-of-life processing.
- BS EN ISO 6506 Brinell hardness testing of metals
- BS 1363 13-amp plugs, sockets and related equipment
- BS 1362 Cartridge fuses for domestic plugs
- BS EN 62031 LED lighting safety specifications.
- ASTM F3078 lead content in paint used for toys and other products.

Each of these standards specifies exactly how manufacture and/or testing must be carried out. For example within ASTM F3078, samples are scraped off products and subjected to x-rays, which facilitate the accurate analysis of all elements present in the sample, thus enabling the calculation of the amount of lead present.

A number of organisations are accredited by UKAS to enable them to carry out the testing necessary to award certification for compliance within standards. The award of appropriate certification enabled manufacturers to display the **CE Mark or BSI Kitemark**.

The UCD (User Centred Design) approach, as explained in Design Methods, is employed to ensure that products are appealing for consumers to buy and use. An important part of this approach is to obtain information from **market research** organisations. Market research organisations are used because they are totally independent of the client companies that use their services. They obtain information relevant to the proposed new product from a number of sources: targeted questionnaires and independent research into a variety of factors such as competitors' products, the state of the market, retailing constraints and brand identity.

One of their key services is to host **focus groups** in which members of the public, from appropriate **demographic groups**, are invited and paid to attend a meeting where they can express their views on existing and proposed products.

Members of focus groups may participate in a variety of activities, which will be recorded in some way. They could even be observed in a one-way mirror.

Typical focus group activities include:

- answering direct questions
- physical interaction with products
- Watching videos/presentations
- Sketching ideas and logos
- Making suggestions for product improvements and desirable features
- Role playing
- Creating mood boards
- Group discussions.

Examples of what might be learned from a focus group include:

- Their attitude towards colours for product finishes
- The level of comfort experiences while holding products
- How easily they can change the batteries in electronic products
- How easy they find it to navigate control panels or screens
- Their level of enjoyment when playing a computer game
- What they feel is an appropriate pricing level for a particular product
- The strength of a brand identity that they recognise

# Year 12 Knowledge organiser 1.6 Modern & Industrial scales of practice

## A Level Design and Technology: Product Design

### Scales of Production

You should be aware of, and be able to describe, the different scales of production giving example products and specific manufacturing methods.

**One-off, bespoke**

One off production is the manufacture of a single product/item.
This can include large scale projects, such as a bridge, ship, stadium, multi-storey building or tower, Other examples of one offs are - specialist jewellery, made to measure clothing, bespoke furniture and many more.
Specialist companies manufacturing 'one offs', usually employ skilled staff.

Characteristics of one-off production

- Small specialist companies.
- A skilled workforce - eg. engineering / cabinet making.
- Specialist materials often used. eg. specialist modelling materials.
- High quality products manufactured.
- Products expensive, due to the level of skill required to manufacture them and cost of specialist materials.
- A high standard of quality control.
- Products manufactured for a specialist market / clientele.

**Batch production**

When tens, hundreds or even thousands of the same product, are manufactured on a production line, this is called Batch Production.

Batch production takes place on a production line. A production line is one stage of manufactured followed by another stage. A production line can be made up of several or hundreds of different stages.

Companies tend to order batches of products. Customers usually order one.

Characteristics of batch production

- Production line is set up.
- One task for each stage of manufacture.
- Semi skilled or unskilled workers - Flexible workforce.
- Production line can manufacture different products.
- Production line runs for a limited time.

**Mass/line production**

Mass production is the industrial-scale manufacture of large quantities of products, usually on a production line. Standardised production methods mean it is suitable for products that rarely need to be redesigned. Mass production is used for products that are needed in very large numbers, eg socks or jeans. Often, products are made overseas where labour costs are lower.

Mass production, if stringently monitored, typically results in the high-accuracy assembly as production line machines have fixed parameters. Labour costs are often lower for mass-produced products; assembly line production with automated processes requires fewer workers.

Products that are mass-produced are assembled at a quicker rate due to increased automation and efficiency. This helps with prompt distribution and marketing of an organization's products with the potential to create a competitive advantage and higher profits. For example, McDonald's has a competitive advantage due to the speed at which it can produce a meal for the time-conscious customer.

Mass production may result in wasted resources. Establishing an automated assembly line is typically capital-intensive; if there is a production design error, extensive costs may be required to redesign and rebuild mass production processes. Additionally, if one area of mass production is interrupted, the entire production process may be affected.

Employees that are part of a mass production assembly line may lack motivation because tasks are repetitive. This may lead to low employee morale and increased levels of turnover. Mass production may stifle flexibility; production processes can be cumbersome and expensive to change.

**Unit production systems (UPS)**

The unit production system (UPS) for clothing industries is a flexible material handling system that requires a computerised overhead transportation system to move the garment components automatically from one workstation to the next according to a pre-determined sequence. It replaces the traditional garment production system of handing, bundling, tying and untying, and manually moving garment parts. It provides uninterrupted workflow to the workers and helps to improve work efficiency and product quality. In the fast-moving fashion and apparel industry, this is highly essential.

**Quick response manufacturing (QRM)**

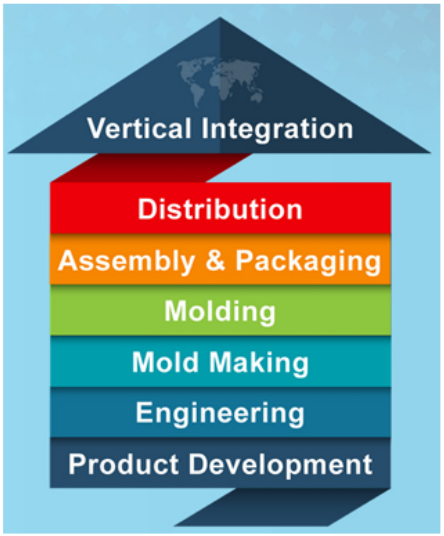

Quick Response Manufacturing (QRM) is a companywide strategy to cut lead times in all phases of manufacturing and office operations. It can bring your products to the market more quickly and help you compete in a rapidly changing manufacturing arena. It will increase profitability by reducing cost, enhance delivery performance and improve quality.

QRM's overarching focus on time as the guiding management strategy is ideally suited for companies offering high-mix, low-volume and custom-engineered products. In fact, many companies making highly customized products and/or a high variability in their product mix have used QRM as an addition to existing Lean, Six Sigma, and other improvement efforts.

Long lead times come with many hidden costs – much more than most managers realize. For almost 20 years, QRM has helped companies of all sizes and industries uncover the causes for long lead times and provided tools to eliminate them.

**Vertical in-house production**

One of the key challenges that every manufacturing business faces is structuring its value chain. The value chain consists of all businesses and individuals that play a part in the production process, from raw materials suppliers to end customers who buy finished products. Manufacturers typically occupy a space in the middle of this chain, but through vertical integration, they can extend their reach, and profits, within the value chain.




Vertical manufacturing refers to vertical integration of a value chain that a manufacturer undertakes to gain a strategic advantage. Manufacturers achieve vertical integration when they control or own elements within a value chain beyond the central manufacturing component. They can do this by buying other entities or entering into contractual agreements with them to provide goods and services that are part of the manufacturing and distribution process at fixed rates. For example, a manufacturer could buy one of its key suppliers to guarantee access to the raw materials it needs to produce goods. It might also sign a contract with a retailer to guarantee a certain level of sales in the future. Each of these acts is an example of vertical integration in manufacturing.

Advantages

Vertical manufacturing has several distinct advantages over manufacturing without any form of vertical integration. It allows manufacturers to take control of their supply chains, ensuring steady access to components and raw materials. It can also ensure that distribution networks are ready to move products, especially during periods of high demand. Manufacturers that practice vertical integration also stand to earn profits from each step in the process. They save on costs by running their own supply chain instead of paying other independent businesses to fill its various roles.

Disadvantages

Vertical manufacturing can have some drawbacks for businesses that manage it poorly or lock themselves into inflexible arrangements. For example, a manufacturer that signs a contract with a supplier is committed to paying a set price for necessary materials, perhaps several years into the future. If a new supplier emerges with lower prices, competitors will be able to pay less for the same materials and reduce their costs. This leaves the vertically integrated manufacturer at a disadvantage until the contract expires or can be renegotiated.

# Year 12 Knowledge organiser 1.6 Modern & Industrial scales of practice

## A Level Design and Technology: Product Design

### Modern Manufacturing Systems

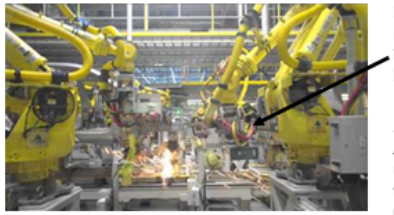
The use of computer systems to plan and control manufacturing, reduce waste and respond quickly to changes in consumer demand.

You should be able to describe how computers are used in modern manufacturing.

Computers have made a massive impact on the speed and accuracy in which products can be made. It is now possible to manufacture high-quality outcomes in a short period of time when previously people would have taken a number of days to make the same products with no guarantee that they would all be of the same standard.

**Computer Aided Design (CAD)**
CAD is a system that allows designers to create solutions to problems within a computer program through the use of illustrations. Designs can be modelled in 3D and manipulated time and again from all angles. There are many CAD packages available.

**Computer Aided Manufacture (CAM)**
CAM is a term used to describe any activity where a machine is programmed with several instructions to produce a component from a raw material. CAD packages are commonly used through an interface software to drive the special machine codes that in turn tell the machine what to do and where to cut and shape the material.



A car has many thousands of components that all need to behave in specific ways. Cars have become increasingly complicated, yet each small piece of the engine or controls is relatively simple to make. This is because machines assemble and shape the raw materials or assist people in assembling them.

Imagine how difficult it would be for one or two very skilled people to make these cars without the assistance of machines, computers, robots and diagnostic systems.

It is easy to imagine how a craftsman, equipped with hand tools, can manipulate hardwood into a well- made table or use metals to create some fine jewellery. In these cases, human touch and sensitivity toward the aesthetics of the pieces is easy to appreciate. However, computers are needed when manufacturing to consistently satisfy high demand and reproducible quality.

Sophisticated computer systems can be integrated together to monitor every aspect of a manufacturing process. Designs can be modified time and again without the need to repeat all the drawings and computers can hold vast amounts of technical data with great accuracy. This information can be fed into a manufacturing cell where several robots or machines can carry out the precise tasks time and again precisely and with accuracy.

**Computer Numerical Control (CNC)**
This is the control of machines using numbers or digital information. This can be provided manually or through a computer. Generally this is used for milling and drilling procedures. CNC makes use of the machine axes and the tools move along these axes according the programme.

**Flexible Manufacturing Systems (FMS)**
A flexible manufacturing system involves the use of pre-programmed machines and computers to carry out a series of tasks and operations. They can be programmed so that a different set of operations can be carried out as the designs change.

**Automatic Guided Vehicles (AGVs)**
This is an unmanned vehicle that follows a pre-programmed route around a factory floor or warehouse.

**Modular/Cell Production**
See the use of computer systems

**Just In Time (JIT)**
See the use of computer systems

**Master Production Schedule (MPS)**
A master production schedule (MPS) is a plan for individual commodities to be produced in each time period such as production, staffing, inventory, etc. It is usually linked to manufacturing where the plan indicates when and how much of each product will be demanded.

**You should also be familiar with the use of standardised and bought-in components made by specialists.**

### Examples of Modern Manufacturing Systems

#### Computer Aided Design (CAD)

- 2D Design
- OnShape
- Solidworks
- Autodesk Inventor

Many modern CAD systems allow users to complete analyses, including CFD and FEA.

#### Computer Aided Manufacture (CAM)

- Laser Cutting
- CNC Milling
- CNC Routing

#### Flexible Manufacturing System (FMS)

Robots are often used in FMS, this is due to the fact it can be reprogrammed in response to re-designed products. A good example of this is in the automotive industry. Welding/painting robots can be used to weld parts together; the locations of these can be reprogrammed.

#### Automatic Guided Vehicles (AGVs)

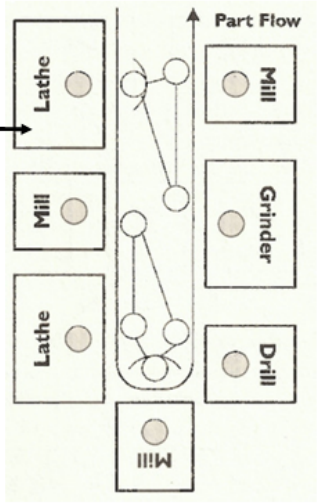
An automated guided vehicle or automatic guided vehicle (AGV) is a portable robot that follows markers or wires in the floor, or uses vision, magnets, or lasers for navigation. They are most often used in industrial applications to move materials around a manufacturing facility or warehouse. Application of the automatic guided vehicle broadened during the late 20th century.

Example: Moving finished goods from manufacturing to storage or shipping is the final movement of materials before they are delivered to customers. These movements often require the gentlest material handling because the products are complete and subject to damage from rough handling. Because AGVs operate with precisely controlled navigation and acceleration and deceleration this minimizes the potential for damage making them an excellent choice for this type of application

#### Modular/Cell Production

A good example of modular/cell production is in the manufacture of Toyota cars, they often arrange different machines in a U shape to reduce travel times.

The parts travel between each cell, often using AGVs.




#### Just in Time (JIT)

Fast food restaurants like McDonald's usually have everything they need to assemble and don't do so until the order has been taken, except for a few finished products. This makes the process so standardized that every time a customer goes they get the same experience.

In this case there was a dramatic change after World War II, when after showing a less than efficient process they turned to JIT and by having inventory on hand they lead to shorter lead times and a much more efficient service for customers. After implementing JIT at Harley Davidson the inventory levels declined in 75 percent, but at the same time productivity rose. By doing so, they were able to identify and solve the inefficiencies of the process because it could no longer hide under a large amount of costly inventory.

#### Master Production Schedule (MPS)

The majority of large manufacturers use a form of MPS, it takes into account a wide range of information in order to produce products quicker and more economically.