Year 12 Knowledge organiser 1.7 Digital design & manufacture

A Level Design and Technology: Product Design

Digital Design and Manufacture

Computer Aided Design (CAD)

Computer-Aided Design (CAD) is software that is used by architects, engineers, drafters, artists, and others to create precision drawings or technical illustrations. CAD software can be used to create two-dimensional (2-D) drawings or three-dimensional (3-D) models.

Advantages
- Reduced storage space
- Corrections can be made easily
- Repetitive parts of the drawing can be saved and imported as part of a "CAD library"
- CAD systems can be linked with CAM machines to produce objects straight from the drawings•
- 3D CAD designs can be made to look realistic by using the material library for clients to see
- CAD designs can be easily shared between companies or department using email
- CAD can be used to create simulated environments to show the client

Disadvantages
- Work can be lost if the computer crashes
- Work could be corrupted by viruses
- Work could be stolen or "hacked"
- Time taken to learn how to use the software
- Initial costs of buying a computer system are high.
- Time and cost of training staff
- Continual need for updating software or operating systems
- CAD/CAM systems mean less people need to be employed

Maths/Science Link:
- Use of datum points and geometry when setting out design drawings.
- The use of tolerances in dimensioning.

CAD can be used to develop and present ideas for products, including:
- the use of 2D CAD for working drawings, packages such as 2D Design can be used to create working drawings such as third angle orthographic. Nowadays, orthographic and isometric drawings can be generated from models that have been created in 3D CAD packages.
- 3D CAD can be used to produce presentation drawings, these are often photo-realistic and can be shown to a potential client.

CAD is often used in industrial applications, for example for planning wiring and plumbing for a new building or by architects.

Computer Aided Manufacture (CAM)

You should be aware of, and be able to describe, how CAM is used in the manufacture of products.

Laser cutting (see paper and board processes)
Routing (see metal processes)
Milling (see metal processes)
Turning (see metal processes)

Maths/Science Link:
- Calculating speeds and times for machining.

Plotter cutting

Digitally controlled plotters evolved from earlier fully analogue XY-writers used as output devices for measurement instruments and analogue computers.
Pen plotters print by moving a pen or other instrument across the surface of a piece of paper. This means that plotters are vector graphics devices, rather than raster graphics as with other printers. Pen plotters can draw complex line art, including text, but do so slowly because of the mechanical movement of the pens. They are often incapable of efficiently creating a solid region of colour, but can hatch an area by drawing a number of close, regular lines.

Plotters offered the fastest way to efficiently produce very large drawings or colour high-resolution vector-based artwork when computer memory was very expensive and processor power was very limited, and other types of printers had limited graphic output capabilities.
Pen plotters have essentially become obsolete, and have been replaced by large-format inkjet printers and LED toner based printers. Such devices may still understand vector languages originally designed for plotter use, because in many uses, they offer a more efficient alternative to raster data.

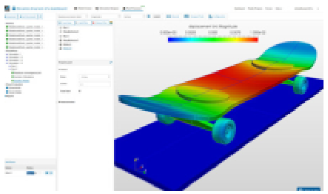
Cutting plotters use knives to cut into a piece of material (such as paper, mylar or vinyl) that is lying on the flat surface area of the plotter. It is achieved because the cutting plotter is connected to a computer, which is equipped with specialized cutting design or drawing computer software programs. Those computer software programs are responsible for sending the necessary cutting dimensions or designs in order to command the cutting knife to produce the correct project cutting needs.

Virtual Modelling

You should be aware of, and be able to describe, how virtual modelling/testing is used in industry prior to product production.

Simulation

Design and simulation software is becoming increasingly clever and accurate, with latest versions plugging holes and further automating design on an annual basis, making the design engineers' jobs easier and easier. If continued to its logical conclusion, the design rules and facilities included in the computer-aided design (CAD) package, allied with reliable and accurate simulation data, should mean first-time-right products every time. Prototypes would be a thing of the past and, as a consequence, it would obviate the need for the test function as part of the design loop.

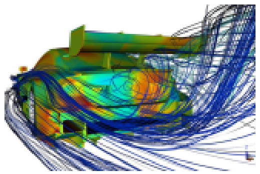


Simulation modelling is the process of creating and analysing a digital prototype of a physical model to predict its performance in the real world. Simulation modelling is used to help designers and engineers understand whether, under what conditions, and in which ways a part could fail and what loads it can withstand. Simulation modelling can also help to predict fluid flow and heat transfer patterns. It analyses the approximate working conditions by applying the simulation software.

Simulation modelling allows designers and engineers to avoid repeated building of multiple physical prototypes to analyse designs for new or existing parts. Before creating the physical prototype, users can investigate many digital prototypes.
Using the technique, they can:
- Optimise geometry for weight and strength
- Select materials that meet weight, strength, and budget requirements
- Simulate part failure and identify the loading conditions that cause them
- Assess extreme environmental conditions or loads not easily tested on physical prototypes, such as earthquake shock load
- Verify hand calculations
- Validate the likely safety and survival of a physical prototype before

Computational fluid dynamics (CFD)

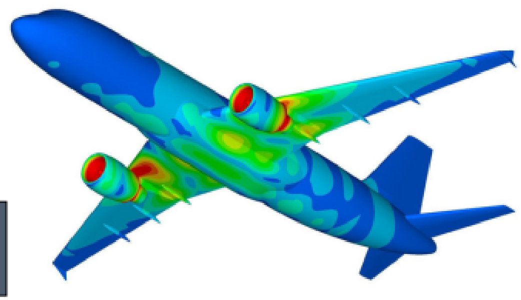
Computational fluid dynamics (CFD) is the use of applied mathematics, physics and computational software to visualize how a gas or liquid flows -- as well as how the gas or liquid affects objects as it flows past.
Computational fluid dynamics is based on the Navier-Stokes equations. These equations describe how the velocity, pressure, temperature, and density of a moving fluid are related.



CFD is used for testing aerodynamics and wind resistance, and flow of liquids within/around products

Finite element analysis (FEA)

Finite element analysis (FEA) is a computerised method for predicting how a product reacts to real-world forces, vibration, heat, fluid flow and other physical effects. Finite element analysis shows whether a product will break, wear out or work the way it was designed. FEA is used in component stress analysis.



Maths/Science Link:
- Interpretation of data from CFD or FEA testing.

Year 12 Knowledge organiser 2.6 Selecting appropriate tools and equipment

A Level Design and Technology: Product Design
Selecting Appropriate Tools, Equipment and Processes

You should be aware of, and able to discuss and demonstrate, good and safe working practices, including:
• the importance of using the correct tools and equipment for specific tasks
• the importance of ensuring their own safety and that of others when in a workshop situation
• how designs are developed from a single prototype into mass produced products
• the effect on the manufacturing process that is brought about by the need for batch and mass manufacture
• how to select the most appropriate manufacturing process to be able to realise their, or others', design proposals
• the importance of health and safety in a commercial setting including workforce training and national safety standards.

Successful manufacture is influenced by many factors such as the material and manufacture cost, product function, scale of production and proposed retail cost.

Example: yoghurt pots can be made in high volume via the thermoforming or vacuum forming process. Having multiple moulds on one sheet minimises waste, while providing the correct draft angles to enable the product to function. Vacuum forming is less suited to one-off production due to the time taken o produce a mould, as well as the amount of material wasted when producing the parts..

Selecting correct tools and equipment
Selecting the correct tooling involves knowledge of manufacturing processes as well as the materials used in the processes. E.g. if a games manufacturer were to produce a games console controller from a polymer, then only polymer processes would be considered. Blow moulding could be used to create the hollow shape, however this would not create the complex detailing that would be required. Vacuum forming may also be considered to make two halves of the product, however vacuum forming would produce too much waste, as well as a uniform wall thickness issue. Injection moulding would be the most suitable process due to the ability to create different wall thicknesses, as well as creating click fittings and circuit board holders within the mould. Injection moulding uses the same mould repeatedly, so each product wold be identical in quality and accuracy.

Maintaining safety in commercial manufacture
Commercial manufacture involves more staff than bespoke manufacturing, and employers must maintain safety standards across a wide variety of potential situations with a varying numbers of people with difference experience levels. The employer must comply with the **HSWA (Health and Safety at Work Act), COSHH (Control of Substances Hazardous to Health) and Personal Protective Clothing regulations.** Risk assessments for all processes are undertaken and should be carried out, and regularly reviewed and updated to protect those involves directly and indirectly in the manufacturing process.

The safe and appropriate selection of tooling is critical to ensure safe manufacture and safety for employees as well as suitability for the chosen materials. When selecting the right process or tools for the job, , the following factors could be considered:

- Duration of the job: could repeated action lead to a repetitive strain injury (RSI)? Will the works become bored?
- What hazards could be controlled before manufacture begins?
- What hazards has the process introduced to the workplace for both the manufacturer and others?
- Machinery and equipment: is there a safe place to load and unload materials, machinery and equipment? Are safe zones clearly marked?
- Is there a manual handling issue and has training been provided?
- Is machinery and tooling properly maintained in accordance with the manufacturer's specifications?
- Are the appropriate safety guards fitted and in good working order?
- Electrical safety: are power leads tested and tagged? Are circuit breakers used? Are power leads a trip hazard?
- PPE (personal protective equipment): is all the necessary PPE provided to protect working and others in the vicinity? Are there systems in place for maintenance and replacement of PPE as required? Is the necessary signage displayed?
- Emergency equipment: are there fire extinguishers, first aid kits and eye baths available? Has training been provided?

Development of designs from single prototypes to mass produced products
In commercial manufacture, prototype products are often the starting point for future productions of batch or mass-produced products. A prototype is the first generation of a product, which is used to fault find and evaluate prior to future production runs.

The car industry makes use of prototypes to test performance and aesthetics, and to gather market feedback prior to manufacturing a car for retail purposes. Prototypes usually take three main forms prior to production: visual, proof of concept and production.

Visual prototype: this is a sample or model that shows the overall shape and size of the product, but does not usually have any working parts. The materials will not be the materials that would be used if the product were to be mass produced. Often the visual prototype is made from traditional modelling materials such as Styrofoam, or it could be 3D printed. Visual prototypes provide an opportunity to test the visual impact that a product form may have, and enable designers and clients to suggest improvements.

Proof of concept prototype: this shows the key functionality and main technical aspects of the design. It is not intended to look like the final product, and will be a functional model, which may make use of existing off the shelf' components. A proof of concept prototype would not usually be made from production grade materials, but allows the design team to test the functions to see if they work as intended. There may be many proof of concept prototypes made and tested prior to a viable solution being found. Proof of concept prototypes can also be given out to trial or test groups to gain feedback of real world use rather than lab-based experimentation.

Production prototype: this gives a representation of how the mass- produced product would look and shows how the product would function. Off the shelf parts may still be used at this stage, but it is more likely that it will be built from bespoke parts. The materials used will be as close to production grade as possible, unless it is not economically viable, in which case a substitute material may be used. Manufacturers will make use of a presentation prototype to assess any alterations that may be required prior to mass production. These could be materials, positioning of components for a more economic manufacture layout as well as the most suitable manufacturing processes. Production prototypes will also generally be marketed in small user trials prior to a full production run.

In some instances, a company may produce an initial batch of products for testing, trialling and further refining prior to the final product being put into full production James Dyson, who invented the first bagless vacuum cleaner, made use of a huge number of prototypes prior to the first Dyson vacuum cleaners being launched in the retail sector. Over a five-year period, he made 5,12 prototypes before he was satisfied he had a successful and optimally functioning product

Batch or mass manufacture and the effect on the manufacturing process
The number of components or the complexity of the product and the volume of production will determine the type of machinery used to create a product. Before considering the machinery types, the designer must be familiar with the number of products expected from a manufacture process. If a one-off dining table were being made in a workshop, standard tooling such as bandsaws, pillar drills and mortice machines may be utilised. If the dining table were required to be manufactured in a batch of 50, the manufacturer would start to utilise jigs to ensure ease of repeatability and speed of production. Jigs could be used for many processes such as making a mortice and tenon joint for the legs, and the use of a gluing jig could ensure that all the frame joints were assembled quickly and 'square'.

There are three key terms for volume of production: one-off, batch and mass. See scale of production sheet.

Key points:
One off—will use tools for specific processes, each machine would be adjusted for each task.
Batch—jigs would be used to speed up the process and ensure each product is identical. Templates and CNC could also be used. E.g. a depth stop could be used on a pillar drill to ensure each hole is the same depth. Often, workers rotate around different jobs during batch manufacture.
Mass—Uses automation, there is dedicated machinery and CNC such as laser cutters to manufacture the same product many times over. E.g. polymer milk bottles use the blow moulding process via mass production, nuts and bolts. Mass production tends to employ a less skilled workforce.

Process	One-off	Batch of 50
Drilling holes for a dowel joint	Mark out each individual hole. Set up pillar drill for a particular depth and drill each hole.	Use a drilling jig setup on a dedicated pillar drill. The component is placed in the jig and the drill is set to the correct depth. Each component is fed into the jig until all components for the batch have been drilled.

Year 12 Knowledge organiser 2.8 Responsible design

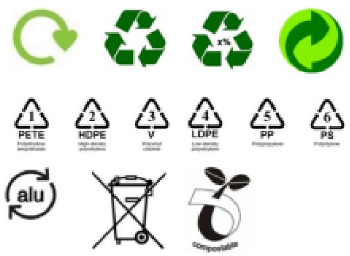
A Level Design and Technology: Product Design

Responsible Design

You should be aware of, and able to discuss, the importance environmental issues in design and manufacture, including:
• the responsibilities of designers and manufacturers in ensuring products are made from sustainable materials and components
• the environmental impact of packaging of products, e.g. the use of excessive packaging and plastics.

You should be aware of, and able to discuss, the concept of a circular economy, including:
• how products are designed to conserve energy, materials and components
• the design of products for minimum impact on the environment including raw material extraction, consumption, ease of repair, maintenance and end of life
• sustainable manufacturing including the use of alternative energy and methods to minimise waste
• the impact of waste, surplus and by-products created in the process of manufacture including reuse of material off-cuts, chemicals, heat and water
• cost implications of dealing with waste
• the impact of global manufacturing on product miles.

Environmental Issues
The starting point for many environmental decisions regarding product design is the **six R's of sustainability** (see earlier sheet).



Reduce - Cut down on the amount of material and energy used to make and package the product.
E.g. reducing polymers used in bottled water.
Reuse - At the end of a product's life, reuse the product for the same or another purpose.
E.g. using a used coffee jar again by using refill packs.
Recycle - Conversion of waste products into new materials for new products.
Recycling happens in three ways; primary, secondary and tertiary.
Primary recycling involves the use of functioning second-hand products such as those in charity shops, free-cycling or items found in local recycling centres. Secondary recycling involves recycling the materials of a product to make different products. Tertiary recycling involves completely breaking down a product and reformulating it via a chemical process. For example, making fleece from plastic bottles.

Products that can be recycled should have symbols printed onto or moulded into the product.

Repair - When a product or component fails, fix it rather than throwing it away.
Refuse - Exercise consumer choice as to whether to buy a product or not.
E.g. a consumer using a reusable bottle instead of multiple single-use water bottles.
Rethink - Rethink the way products are designed and manufactured so that they carry out the same function, but more efficiently.
E.g. Use of click fittings and reducing the number of parts.

How a designer could use the Six R's when designing a TV remote:
Reduce: Make walls as thin as possible, smaller, design only for essential buttons, use solar or human power rather than batteries, use renewable energy when manufacturing

Reuse: At the end of the products life, reuse the casing for another remote control, reuse the electrical components

Recycle: Use recycled polymers, ensure it is made from materials that can be recycled, use recycled and recyclable copper and solder, mould recycling codes into casing and provide instructions.

Repair: Ensure the components can be fixed.

Refuse: Use recycled polymer to attract consumers and use substances that are not banned under RoHS directive.

Rethink: Make the product as simple to operate as possible, rethink the number of essential buttons, make the controller multi-purpose so that one product can operate all devices.

Using sustainable materials and components - The use of finite materials needs to stop. Many companies and individuals wish to reduce their **carbon footprint** and their subsequent impact on the environment. The carbon footprint is the total amount of CO_2 released as a result of the activities of an individual, community or organisation. **Primary carbon footprint** measures the direct emissions of CO_2 from burning fossil fuels. **Secondary carbon footprint** measures the CO_2 released as a result of the products we use.

The environmental impact of packaging - Packaging is important for making food last longer and keeping accessories with a product. Examples of how companies have reduced packaging is removing polymers, charging for carrier bags and offering bag-for-life schemes. A good example is M&S redesigning cardboard **pizza packaging** to become shrink wrapped with a thin cardboard sleeve. M&S also redesigned their **Easter egg packaging** to remove plastic, and instead created a card net that protected the chocolate egg. Using **concentrated liquids** instead of diluted, reduces the amount of packaging used. **Reusable cups** are also good examples, so less disposable cups are used. **Offering discounts** for reusing containers is a good way of encouraging consumers to reuse waste.

Conservation of energy and resources - Energy use is a major factor in both the manufacture and day-to-day running of products. A number of energy resources are **non-renewable** such as oil, coal and natural gas, and as such, alternative energy resources (**renewables**) must be found to provide enough energy to meet demands of the modern world. Examples include, wind, hydro, solar PV, wave, tidal, geothermal and biomass.

When designing products, designers must ensure the minimum amount of material is used to save resources and energy in production. **Nesting** and **tessellation** are good examples of minimising waste from sheet materials when laser cutting and routing.

Advantages of renewable energy:
- Sustainable and will never run out.
- Requires less maintenance than traditional generators.
- Fuel from natural resources reduces operational costs.
- Little or no waste, such as CO_2 or other chemical pollutants, is produced, meaning minimal environmental impact. Renewables are considered clean energy.
- Social and economic benefits - a renewable energy project can bring benefits through employment.

Disadvantages of renewable energy:
- Can be difficult to generate the large quantities of electricity that are produced by fossil fuels. More facilities may need to be built as a result.
- Renewable energy often relies on the weather for its source of power, and if the supply is unreliable or inconsistent, the energy production will be unreliable too. E.g. wind turbines need wind and solar panels need sun.
- Renewable energy cannot be stores in large quantities due to battery technology.
- Renewable energy is currently more expensive than traditional fossil fuel or nuclear energy, due to large capital costs.

Conserving energy, materials and components - Sprues can be included in injection moulding to mould a number of components at once. E.g. As a huge manufacturer, **Apple** has a big impact on the environment, as such, they use hydro-electric powered smelting facilities for aluminium. During manufacture, water cooling may be used, therefore **rain water** could be used.

Product Miles - Product miles are the total lifetime distance that a product is transported from its place of production to the place of use by the consumer. A typical product may travel as follows: raw material → processing plant → manufacturing facility → distribution → retail → user's home → recycling centre.

Companies can reduce emissions by sending products directly from the manufacturing facilities to retail. Electric trains can also be used to transport goods rather than by road, further reducing emissions. Using manufacturing facilities in the country of intended use also reduces emissions.

Circular economy - A **circular economy** aims to use materials in a way that ensures a continual cycle of reuse and remanufacture, without utilising wasteful resources or having products end their life in landfill. A circular economy approach anticipates and designs for biological and technical 'nutrients' to be continuously reused at the same quality, dramatically reducing the dependency on sourcing new materials. Good examples of initiatives are; **product leasing** and **take-back**.

A circular economy considers two 'nutrient' types. Biological nutrients: organic non-toxic materials that can be composted e.g. shampoos and wood and technical nutrients: man-made materials including polymers and alloys, designed to be used repeatedly at the same high quality with minimal energy and no adverse environmental effects. They are designed to be used and then recycled.

Principles: Preserve and enhance natural capital, optimise resource yields and foster system effectiveness.

Importance: work against unsustainable 'take, make, dispose' culture, promote resource productivity, reduce finite resources, reduce waste, avoid pollution, deliver more competitive UK economy, reduce environmental impact.

Year 12 Knowledge organiser 2.9 Design for manufacture and project management

A Level Design and Technology: Product Design

Design for Manufacture and Project Management

Planning for Accuracy and Efficiency

You should be aware of, and able to discuss and demonstrate, the importance of planning for accuracy when making prototypes and making recommendations for small, medium and large scale production.

It is important to design against a specification and regularly review the specification throughout the design process. CAD and physical modelling can help check against this criteria.

Successful manufacture of a product on any scale of production requires a clear manufacturing plan, with deadlines and quality control inspections embedded into the schedule; the nature of the inspection will depend on the scale of production.

Ensuring accuracy of prototype designs

Pre-production: accuracy in prototype development relies heavily on a UCD process (see earlier), with client feedback playing a major part in the success of the prototype. QA procedures may include: **CAD simulations, working drawings with tolerances, mock up models, client feedback and peer review.**

Production: QC checks may include: **visual checks, dimension checks with flexible measuring equipment e.g. Vernier calipers, measuring individual parts or an overall product, machine tooling and alignment checks, assembly checks of multiple components and quality checks of the finish.**

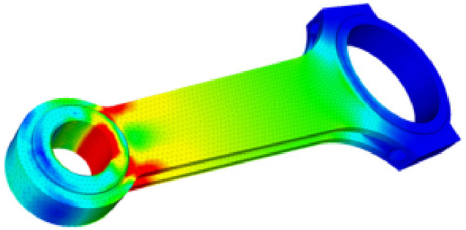
Ensuring accuracy during small, medium and large-scale production

Pre-production: It is cheaper to solve problems before production. Techniques such as **CAD simulations and costings, working drawings with tolerances, sample prototypes, templates, jigs and fixtures produced, focus groups and surveys and NDT (non destructive testing) and destructive testing.**

Quality Assurance (QA) - Quality Assurance (QA) refers to the procedures and policies put in place to reduce waste, and to ensure manufactured products are produced accurately within set acceptable tolerances. By using effective QA procedures, a manufacturer is aiming to produce products 'right first time, every time' which is ambitious. QA checks must be included.

E.g.

- Only sourcing materials and components from suppliers that hold the ISO 9001 Quality Management Standard.
- Setting specific temperature ranges for moulding to ensure effective filling of cavities and speeds of cooling.
- Setting rigid maintenance schedules for machinery to ensure cutters are machining within tolerances.



If QA is increased, then QC issues and waste is reduced.

Pre-production:

- Use CAD to model and check if components fit. This could also be done with exploded diagrams.
- FEA
- CFD

Project Management Systems - Effective project management is essential in all design and manufacture activities, to ensure that they are completed within budget and to agreed time scales. Management systems aim to improve efficiency and reduce waste within all the activities.

Total Quality Management - TQM is an approach to project management in use since the 1950s. The main aims of TQM stem from QA, with the ambition to remove waste and produce products right first time.

Companies that use TQM strive for continual improvement. They value the views of the workforce, and encourage the workforce to participate in teams where individuals can problem solve and contribute to the effectiveness of production.

Scrum - Scrum (agile manufacture) is a method of project management first used in software development. The main focus of Scrum is to work in a team to reach goals in short timescale 'sprints'. The team works on the goal and attends daily scrum updates where individuals feed back on their progress.

Six Sigma - Motorola introduced the Six Sigma system - a set of techniques and tools for process improvement which is designed to minimise defects. The aim is to reduce product failures to less than 3.4 in every million.

The five stages of Six Sigma:

- Define: what is the issue?
- Measure: measure the extent of the issue.
- Analyse: where do the issues occur?
- Improve: rectify the issues.
- Control: ensure the new procedures are implemented and maintained.

Lean Manufacture - Lean manufacture is an approach to production which aims to eliminate waste. Waste can come from many areas: transport, inventory, movement, waiting, over-production , over-processing and defects (TIMWOOD).

Critical Path Analysis

CPA is a project management method used to analyse all individual stages within a project, and to plan the effective and time efficient completion of each element within the desired schedule.

Analysing each task individually allows manufacturers to find out where time is wasted. See your booklet for more details on CPA.

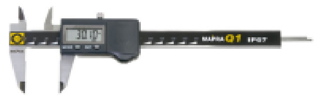
Quality Control

QC refers to the monitoring, checking and testing of materials, components, equipment and products throughout production to ensure they confirm to acceptable tolerances specified within the QA policies within the company.

QC checks take place throughout the production process, and are performed in conjunction with strict guidance documentations produced by the company and client, to ensure that the products fit the specified requirements of the client.

Material Checks

Materials must be checked before manufacture, compared to the company's specifications. **Simple visual checks, chemical analysis and colour matching** may be used.



Dimensional Accuracy Checks

Digital Measuring Devices

Dimensional accuracy checks may be carried out with flexible measuring equipment, such as **Vernier calipers or micrometers**, where a range of measurements can be checked and exact readings recorded. This tends to be done with **interval sample testing**, where a small sample are checked during production. **Vernier calipers** can be used to check external, internal and depth measurements. Micrometers are only normally used for diameters or thicknesses due to their shape.

Go/no go gauge

When checking dimensional accuracy on a production line, a specific measuring instrument is often used such as a go/no go gauge, which checks whether a single measurement fits between set tolerances. This is quicker than using Vernier calipers or micrometers. It never needs adjustment or recalibrating.

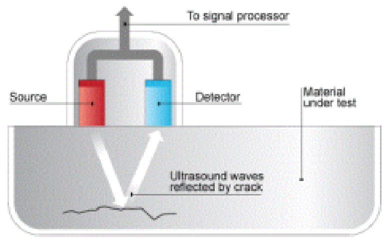
Co-ordinate measuring machinery

CMMs such as a probe scanner, allows manufacturers to check a range of predefined measurements on finished components. The accuracy of this technique is extremely high and the data is automatically compared against a 3D CAD model. Recently, manufacturers have started to use laser scanning to log lots of dimensions and compare them with a CAD model.

CMM can be used to check tooling for dimensional accuracy during maintenance, this may lead to tooling changes.

Non-destructive testing

NDT refers to methods used to check the internal structure of materials, often after joining through processes such as welding. Two main methods are **x-ray** and **ultrasound analysis.** They material is subjected to radiation or ultrasonic waves to check for refraction of the signals, which indicates faults.



Year 12 Knowledge organiser 2.10 national & international standards in product design

A Level Design and Technology: Product Design

National and International Standards

You should be aware of, and able to discuss, the importance of national and international standards in product design.

British Standards Institution

British Standards Institution (BSI) is a national organisation formed to devise agreed standard procedures for performing a wide range of tasks. The range of standards exceed 30,000. The kite symbol (pictured) can be displayed when a standard has been met.

If a British Standard has been accepted by a European standardisation organisation, it will carry the prefix "BS EN".

Examples of British Standards: BS EN 71-1:2014 Safety of toys. Mechanical and physical properties. BS EN 62115: Electric toys. Safety.

International Standards Organisation

BSI is one of 150 national standards bodies that are part of the **International Standards Organisation (ISO)**, where internationally recognised standards are agreed and put into place. With many companies increasingly trading internationally, it is essential that they conform to international standards.

Standards for management services such as ISO 9001, which deals with quality management, is applied worldwide, with many companies only dealing with those that have met the standard.

The presence of the CE Mark means a product conforms to all relevant European safety standards. It is mandatory to display the CE mark when a product is sold within the EU.

Restriction of Hazardous Substances Directive

The **Restriction of Hazardous Substances (RoHS)** directive (2002/95/EC) is a European directive that restricts the use of specific materials found in electronic and electrical products. As of July 2006, all relevant producrs sold in the EU were required to be RoHS complaint. This directive aims to prevent hazardous substances from entering the production process in order to prevent damage to human health and the environment.

Four restricted substances are: lead, mercury, cadmium and chromium.

Battery Directive

The **battery directive** (2013/56/EU) is an amendment of the directive (2006/66/EC) which, in combination with the RoHS and **Waste from Electrical and Electronic Equipment (WEEE)** directives, deals specifically with the restriction of hazardous substances and safe disposal of batteries and accumulators (such as capacitors). The directive states that a limit of 0.0005% mercury is allowed in batteries and accumulators, including button cells like watch batteries. It also restricts the volume of cadmium in portable batteries and accumulators to 0.002%. This also includes power tools.

The directive states that the symbol (pictured) is included on the product. Clear instructions for safe removal and disposal must be provided with the product.

Polymer Codes for Identifying and Recycling

PETE

The Mobius Loop is an internationally recognised symbol of three arrows, which shows a product can be recycled. The loop may include a percentage, or on a polymer product, an SPI (Society of Plastics Industry) code to state the polymer resin used in the product, so that during recycling, the polymers can be separated.

Packaging Directives

The EU packaging and packaging waste directive (94/62/EC) aims to limit the production of, and prompt the recycling and reuse of, packaging materials. The directive covers all areas of packaging from commercial to household.

At least 60% of packaging waste must be recovered or incinerated at waste incinerators with energy recovery. All packaging must be marked with the specific materials used to assist in identification and classification.

WEEE Directive

The **Waste from Electrical and Electronic Equipment (WEEE)** directive (2002/96/EC) is a mandatory European directive that covers the end of life of electric and electronic equipment, whereas RoHS details the materials that can be used in the product. The directive came into force in August 2006, and all relevant products must also carry the wheelie bin sticker.

EC Energy Label

The EC energy label is a compulsory system required on a wide range of household appliances. The label must be displayed by manufacturers and retailers to assist customers in making purchasing decisions. The use of coloured scale from A (most efficient) to G (least efficient) gives consumers an easy method of comparison. Due to the compulsory rules, this has forced manufacturers to make their products more efficient.

Eco-labelling

Eco-labels are a wide range of **voluntary** environmental certifications given to companies/products that are seen to meet specific environmental targets set for a product category.

The EU Ecolabel is a label of environmental excellence that is awarded to products and services meeting high environmental standards throughout their life-cycle, from raw material extraction to production, distribution and disposal.

The energy efficiency label and logo

The energy efficiency label is a certification mark issued by the energy saving trust as a recommendation for only the most energy efficient products within specific categories. The certification is available for appliances such as washing machines and fridges, light bulbs, central heating boilers and insulation products.

Forest Stewardship Council®

The **Forest Stewardship Council (FSC)** logo can be found on products made from timber, paper or other forest products which are sourced from well-managed forests and/or recycled materials. FSC certified forests are managed in an environmentally appropriate, socially beneficial, and economically viable manner, protecting the wildlife and people who live there and rely on the forest for their way of life. The workers within the forest must be local, and FSC guarantee that they are trained and work in a safe environment for a fair wage. Most importantly, when trees are harvested, they are replaced or allowed to regenerate, preventing deforestation.

EU ENERGY STAR®

The EU ENERGY STAR® program was developed from an agreement between the EU and US to standardise how IT equipment was labelled to show the energy used. Products are assessed on their power usage when idle and in sleep mode, and these figures are collated in a database to allow customers to make informed decisions on product choices.

The scheme covers the following types of equipment:

- Computers: including desktops, laptops and tablets
- Displays: including monitors and signage displays
- Imaging equipment: including printers, scanners and copiers.