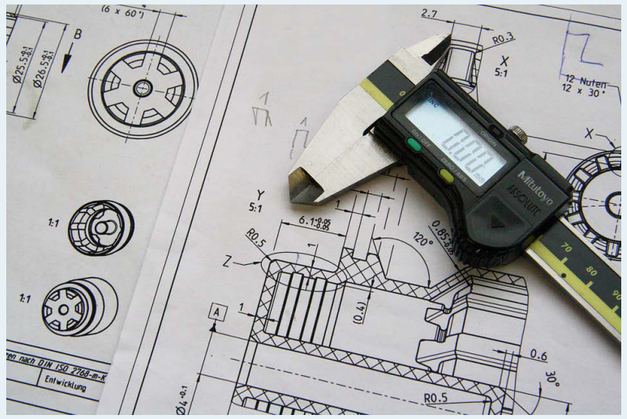
WJEC Level 1-2 Engineering Unit 1: Understanding engineering drawings

Interpreting engineering drawings

Designers and engineers use engineering drawings to convey information and details about the product to be manufactured or constructed.

Engineering drawings include details such as:

- sizes of parts or elements to be made
- details on materials
- information on finishes
- various views of the product
- tolerances
- scale
- details of complex parts.



Scale informs the engineer what scale should be used when using the drawing. A scale of 5:1 indicates that the drawings are five times smaller than the original product should be. This allows engineers to take dimensions (sizes) directly off the engineering drawings. Care must be taken when doing this to ensure the correct scale is applied.

Finishes information gives details on what the finish of the part or product would look like, for example, a knurled finish on a tightening clamp.

Detail views are sometimes used by engineers to explain the details of more complex parts in an engineering drawing.

Title blocks are used to display key sections of information about the drawing, i.e. scale, who made the drawing, the date it was drawn, the drawing number.

Orthographic views are the standard views used to lay out a set of engineering drawings. They must conform to British standards (BS8888) to allow a common format of presenting information to various people such as manufacturers.

Section views show a drawing of a part that may have been cut through to allow the reader to see further details.

Isometric views are often used by engineers and designers to produce a three-dimensional representation of the product or part.

Interpreting engineering information

Engineers need to interpret the information found on engineering drawings to assist them in manufacturing.

The information should be used to identify key areas in preparation for planning such as:

Equipment that will be required to manufacture the engineered product.

Tools that will also be required during the manufacturing should be identified.

Tolerances are the minimum and maximum limit that a part can be outside of the stated dimension (size) on a drawing. For example, a part that is 20mm long with a tolerance of ±0.3mm would be acceptable if it was 20.3mm or 19.7mm when finally tested.

Presenting engineering information

Engineers and manufacturers need to know specific information about the product before they can manufacture it.

The people who will undertake the manufacturing must also understand specific details about how processes are carried out i.e.

- which speed should be used to drill a particular size hole in a particular material
- what speed is needed to cut a slot in a piece of aluminium
- which size hole should be drilled in a material to create a given thread size
- what finished must be applied to a material when it is manufactured
- what component parts are required in production (nuts, washers etc.).

WJEC Level 1-2 Engineering Unit 1: Planning manufacture

Planning manufacture

Before any manufacturing can take place, a plan is needed to determine each stage or step of the process.

The plan should include:

- the materials to be used to produce the engineered product
- what equipment will need to be used
- what tools will be needed
- the sequence (order) that manufacturing needs to take place in.

The sequences need to consider in what order parts are manufactured, as some parts require others to be made to ensure they join correctly, etc. This is also known as prioritising.

Equipment selection

Equipment should be classed as any powered machinery that will be used in the production of an engineered outcome.

Equipment choices should give justifications for their selection and should refer to engineering drawings or other provided sources.

Typical equipment may include:

- centre lathe
- drills
- miller
- laser cutter
- bandsaw
- linisher
- brazing hearth
- buffer/polisher.

Tool selection

Tools should be classed as any hand tools that will be used in the production of an engineered outcome. These should also include marking and measuring tools.

Tool choices should be justified in the planning stages to explain why they were selected.

These include:

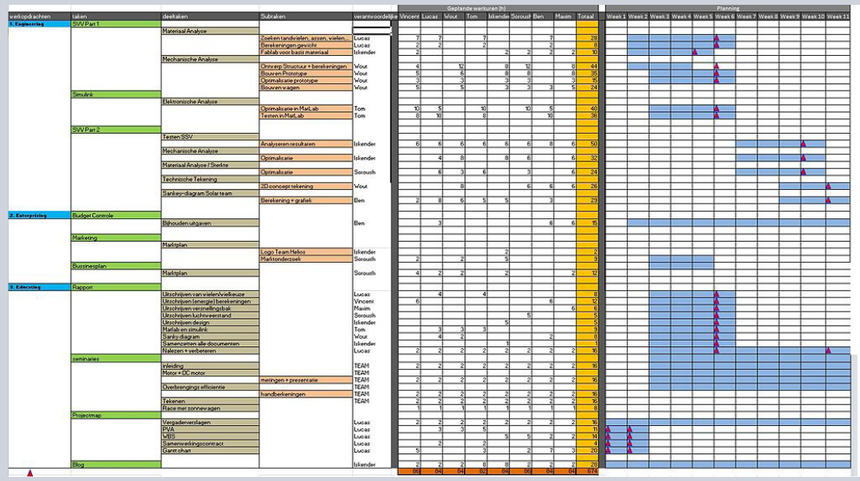
- scriber
- centre punch
- standard, internal, external and odd leg callipers
- soldering iron
- steel rule
- engineer's square
- file
- dividers
- micrometre
- vernier callipers
- rivet sets
- taps and dies
- hacksaw
- fretsaw
- pliers
- screwdriver.

Planning and sequencing

Plans for manufacture should be presented in a way which is easy to find key information at a glance. Planning information could include tables such as a GANTT chart or other lists or appropriate documents.

Manufacturers should be able to understand from the provided information, the sequence of manufacture and the time it should take to produce the part, which tools and equipment should be required for each stage and any processes such as the use of jigs or templates.

Planning and sequencing should also consider the use of CAM (where appropriate), including 3D printing and laser cutting.



Typical engineering GANTT chart

Contingency planning

Planning should also include contingencies to overcome problems that may arise during production. What happens if a machine breaks down or people become ill?

Contingency planning should include ways that problems can be overcome, giving examples of scenarios and possible contingencies.

WJEC Level 1-2 Engineering Unit 1: Using engineering tools and equipment

Using engineering tools

Using engineering tools

Files are used to remove material from stock form of metals and plastics. This is known as wastage.

Scribers are used to mark lines for cutting on materials such as metals and plastics.

Centre punch is a tool that is used to create a small depression in material prior to drilling. This helps locate the drill accurately on the material.

Tap and die sets are used to created threaded components. A tap used to thread a hole and a die to thread a bar (i.e. a bolt).

Hacksaws are a framed saw used mainly to cut metal.

Rivet guns are used to place rivets in areas that are often accessible from one side. Traditional rivets use 'sets' to form the rivet on both sides of a joint.

An engineer's square is used in marking out material. It is set at 90° and is also used for parallel marking.

Callipers are used to scribe and measure on metals and plastics. Odd leg callipers can be used to scribe lined parallel to an edge, whilst straight leg callipers can be used to both mark equal distance sizes and produce arcs and circles.

Vernier callipers are used to measure a range of sizes such as length of material, depth of holes, internal openings, etc.

Micrometres are highly accurate measuring tools used to measure sizes, i.e. material width/thickness.

Reamers enlarge, smooth, or contour an existing drilled hole in a work piece for a precise fit when installing fasteners or other parts in metalworking tasks.

Shears and snips are used to cut sheet metal. They may be straight or curved depending on the task.

Gauges are used in a variety of engineering manufacturing tasks such as centre gauges, which locate a centre on a metal bar, and thread gauges, which identify the size and pitch on a screw thread.

In addition to the examples above, tools can also include items used on items of equipment known as tooling:

Knurling tools are used to put a textured grip onto a metal bar using a lathe.

A **boring bar** is used to enlarge a drilled hole to a precise dimension. They are available for a lathe or a milling machine.

Parting tools are used on a lathes to form a narrow slot to assist in the removal of a work piece from the stock/waste material to remove.

Using engineering equipment

Commonly used items of equipment that you may find in a school workshop:

Centre lathe

- Facing off is the process of levelling off the end of the material
- Turning a taper causes a uniformed change in diameter over a set length on a bar
- Applying a knurled finish
- Boring a hole
- Drilling along the centre axis line
- Cutting a thread onto a bar or into a hole.

Drilling machine

- Drilling holes using a range of drill bits
- Trimming off using a trimming tool, i.e. vacuum forming.

Miller

- End milling is used to create a profile in the work piece, including square End mills, ball end mills, finishing mills and corner rounding mills
- Slot milling involves using a cutter, which cuts slots or groves into the material.

PCB tank

- Used to produce printed circuit boards for electronic circuits
- Uses a photographic and etching process and is used in combination with a UV light box to prepare the PCB artwork.

Vacuum forming:

- A process where a sheet of plastic is heated to a forming temperature, stretched onto a single-surface mould and forced against the mould by a vacuum.

WJEC Level 1-2 Engineering Unit 1: Health and safety, implementing engineering processes and evaluating quality

Health and safety

Assessing potential risks is a process that is undertaken prior starting manufacture. It should identify what potential hazards and risks may be present. This should include both the working environment and the actual items of equipment to be used.

Deciding on control measures should focus on stating how the identified risks and hazards can be mitigated (made safe). This should include detailing about guards on equipment and specific any hazards around the working environment.

Personal protective equipment should also be identified for manufacturing stages and should only include appropriate choices suitable for the individual task being undertaken.

Health and safety should also form a part of the overall planning stages.

Implementing engineering processes

This involves the physical making of an engineering product using a range of processes to produce a product or part. These can include:

Marking out is a process where the required shape is marked onto the stock material.

Cutting can occur using a hand tool like a hacksaw, sheers or snips saw or fretsaw, or using machinery such as a metal bandsaw.

Milling uses a milling machine to cult slots in blocks of metals, and to face off edges.

Finishing is applied at the end stage of production. It could include a range of finishes such as polishing, knurling, enamelling, electroplating or anodizing.

Shaping can involve the removal of materials, called wasting, using saws, files or grinding equipment.

Drilling is a process used when a hole is required in a material. Drilling can be done using a hand drill, or drill press/pillar drill.

Brazing typically involves a brazing hearth to braze metals together forming a permanent joint.

Turning uses a machine called a lathe that can be used to turn a piece of metal to create differently shaped round pieces. It can also be used to create threads and to apply different knurled finishes.

Joining metals can be done permanently using welding, brazing, epoxy resin adhesives and soldering. Temporary methods include nuts and bolts, hinges, screws and rivets.

Soldering is used to heat join softer metals such as silver in jewellery (silver solder) or to attach electronic components to printed circuit boards.

Forming is a process used to change the shape of the material, for example by bending, compressing or extruding.

Evaluating the quality of engineered products

Engineers, manufacturers and designers need to constantly evaluate stages of manufacture to ensure that outcomes are produced in line with the given criteria. Typical examples are:

Inspection techniques can combine a range of methods that can be undertaken to ensure that the product or part meets the set criteria. They could include visual inspection, looking for manufacturing defects or sophisticated digital scanning techniques, which assess accuracy to a minute detail.

Evaluating against a success criteria requires the end product or part to be reviewed against information that may have been included in a brief or manufacturing specification.

Evaluating against engineering information requires checking against information obtained from engineering drawings. This could include checking sizes and finish details but also checking that the tolerances of the final parts are within the allowed parameters.

Quality inspection can include inspection of individual parts as they are manufactured or as they are assembled on the completed engineered product.