THE AGE OF PLASTIC

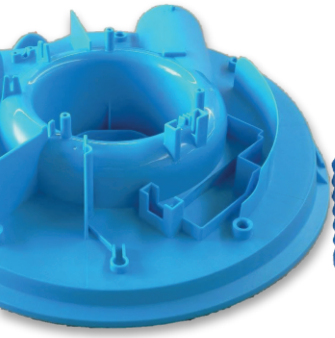
DESIGN & MANUFACTURE

Plastic is fantastic, right? It can be shaped and formed into almost any product we can think of.

There are a wide range of processes to transform thermo and thermoset plastics in to the designs we want.

In this pack, you will learn about some of the most common process you need to know...

INJECTION MOULDING



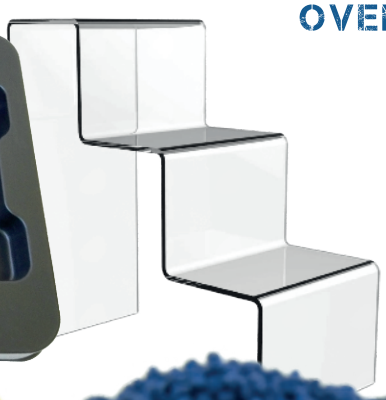
BLOW MOULDING

ROTATIONAL MOULDING

COMPRESSION MOULDING

VACUUM FORMING

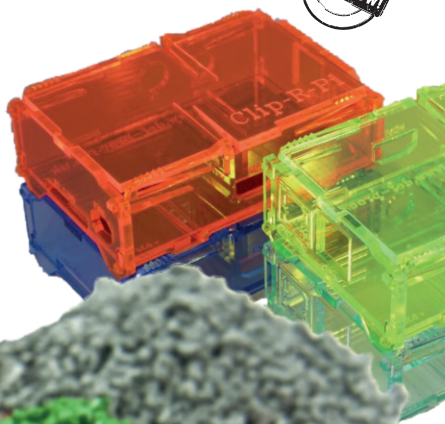
LINE BENDING



PLASTICS OVEN

PLASTIC EXTRUSION

PLASTIC FABRICATION



INJECTION MOULDING

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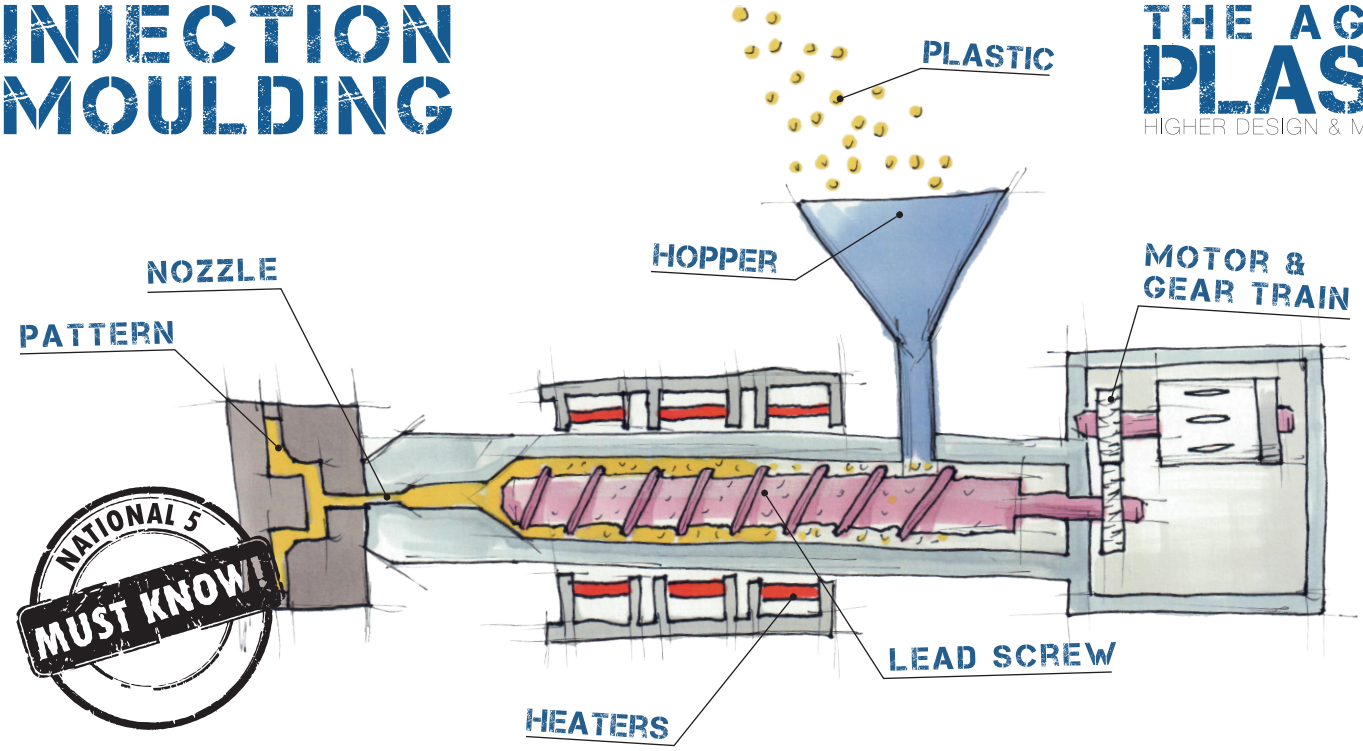

The plastic injection moulding process is a very quick way of producing high-quality, accurate parts.

Plastic material in the form of granules is melted until soft enough to be injected under pressure to fill a mould. The result is that the shape is exactly copied.

Once the plastic moulding has cooled sufficiently to harden the mould opens releasing the part.

The whole injection moulding process then repeats.

The injection unit takes plastic granules, heats them until molten, and injects them into the mould. Machines have a barrel that contains a screw and heater which raises the temperature to the correct level to melt the plastic.

The rotating screw forces the plastic along the barrel. This in turn forces the screw back as the molten material collects at the end of the screw.

When the right amount of material for the next shot has accumulated the screw stops rotating.

The screw then acts like a plunger moving forward and forcing the molten plastic into the mould tool.

ADVANTAGES

- Very detailed components.
- Ideal for mass-manufacture or batch-production of over 1000 parts.
- Quick to manufacture plastic components.
- Plastic components can have different surface finishes.

DISADVANTAGES

- Very, very expensive to make the metal moulds - so the design better be correct before manufacture...
- It can take quite some time to make a metal mould.
- Plastic components can be marked by the ejection pins and some parts like the sprue need to be cut off.

INJECTION MOULDING

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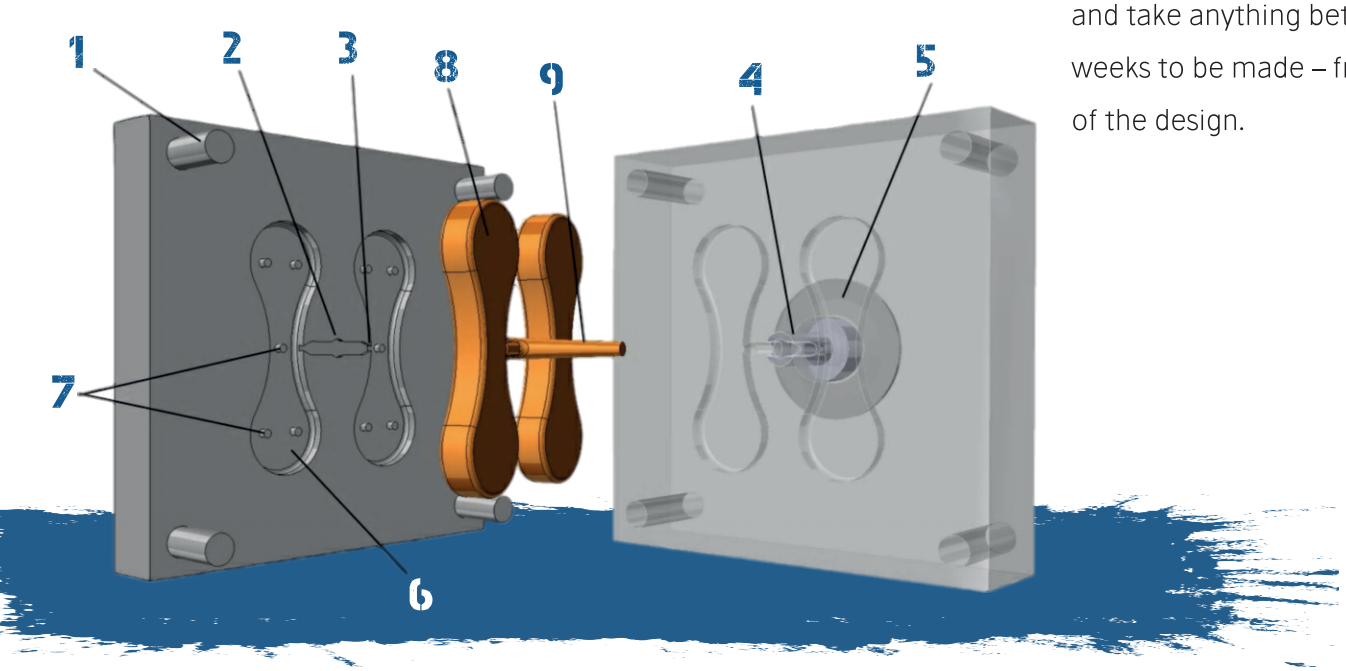
By their very nature, injection moulding 'moulds' have a high cost to make but a injection moulded plastic part has a very low production cost.

Normally this is quite a shock to most people who haven't been involved with the industry before; Injection mould tools aren't cheap.

If you're going to be making more than 100 parts a month for several years, it may be worth it. A mould will cost you in the region of between £5,000-25,000 to make – and take anything between 5-12 weeks to be made – from finalisation of the design.



1. GUIDE PINS

Fixed to one half of the mould and aligns the two halves by entering the holes in the other half.

2. RUNNER

Passageways in the mould connecting the cavity to the sprue bush.

3. GATE

The runner narrows as it enters the mould cavity. This is called a gate and produces a weak point enabling the plastic moulding to be easily broken or cut from the runner.

4. SPRUE BUSH

Tapered hole in the centre of the mould into which the molten plastic is first injected.

5. LOCATING RING

Positions the mould on the injection moulding machine so that the injection nozzle lines up with the sprue bush.

6. MOULD CAVITY

The space in the mould shaped to produce the finished component(s).

7. EJECTOR PINS

These pins push the moulding and sprue/runner out of the mould. These can leave a circular mark on the plastic component.

8. THE SHOT

Total amount of plastic injected into mould.

9. SPRUE

Material which sets in the sprue bush and is broken or cut away when the part is ejected.

BLOW MOULDING

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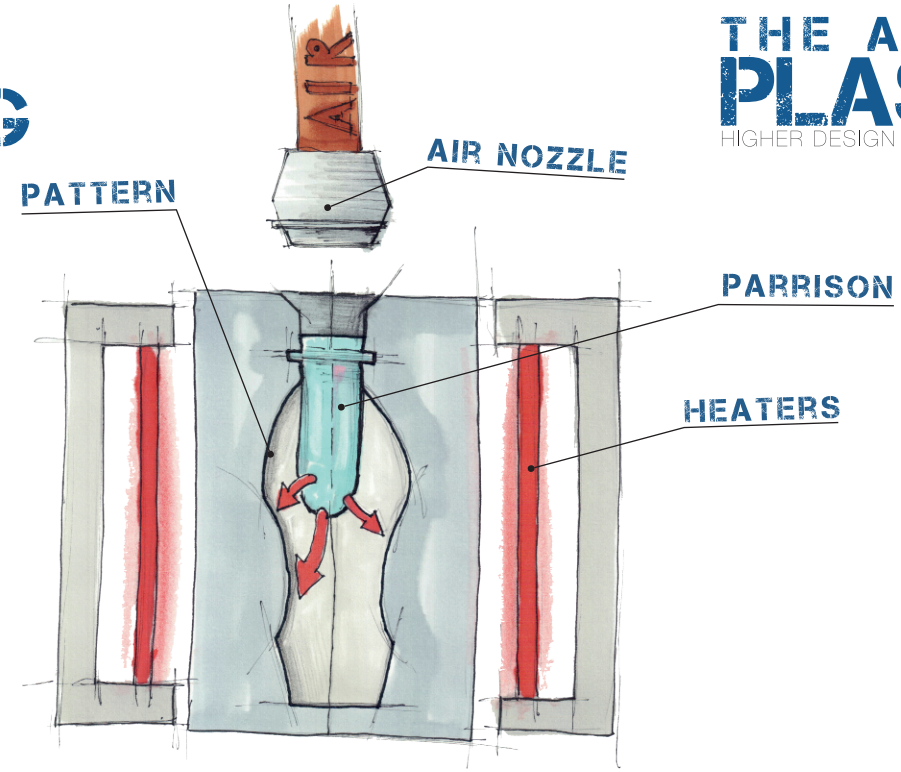

Blow molding is a manufacturing process that is used to create hollow plastic parts by inflating a heated plastic tube until it fills a mold and forms the desired shape.

The test-tube shaped 'blank' is called a parison. This is created earlier by injection moulding.

Injection moulding the parison allows a detailed and high-tolerance part, such as a threaded top to be created.

Parts made from blow moulding are hollow and thin-walled, such as bottles and containers.

Blow moulded parts are available in a variety of shapes, sizes and colours and is a very quick and low cost manufacturing process.

ADVANTAGES

- Great for making hollow objects with an entrance or hole.
- Components can have quite detailed shapes and surface texture. However the inside cannot be changed.
- Blow moulded components use very little plastic - the wall thickness can be very thin.

DISADVANTAGES

- It is expensive to make the metal moulds - so the design better be correct before manufacture...
- It can take quite some time to make a metal mould.
- Plastic components will have a split line round the outside where the two patterns are joined.

ROTATIONAL MOULDING

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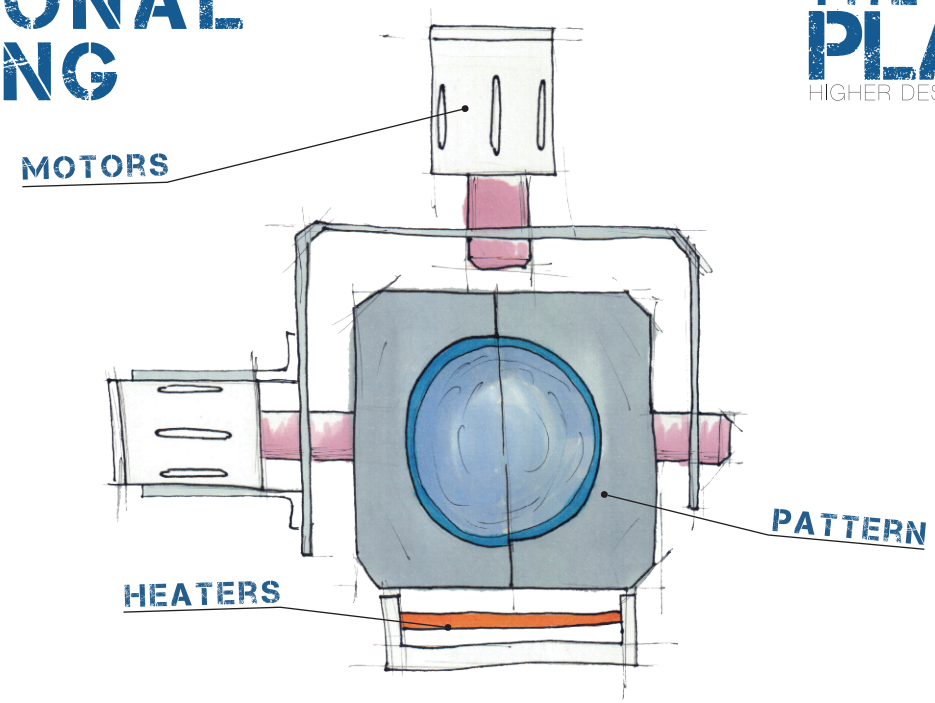

The concept of rotational moulding is very simple.

A plastic in powder form is placed into a hollow metal mould. The mould is closed and rotated slowly on two axis.

The mould is then heated in an oven whilst rotating and the plastic powder melts and 'lays-up' on the inside of the mould.

Once the plastic powder has fully melted the mould is moved to a cooling station and cooled usually with air and sometimes a fine mist of water.

As the mould cools the part solidifies. When the material has finally cooled sufficiently to release away from the mould surface the process is stopped and the product is taken out of the metal mould.

Moulds cannot be as detailed in the same way as injection moulding as there is no pressure forcing the plastic into small features and relies on gravity.

ADVANTAGES

- A great meathod for making large, hollow plastic components. These plastic components can be light weight and strong.
- Cost effective for making large plastic parts - injection moulding would cost many times more.

DISADVANTAGES

- It can take a long time to manufacture each component. Plastic needs to be put in the mould, heated, rotated and allowed to cool.
- Moulds can be huge and very expensive to manufacture.
- Only suitable for mass manufacture.

COMPRESSION MOULDING

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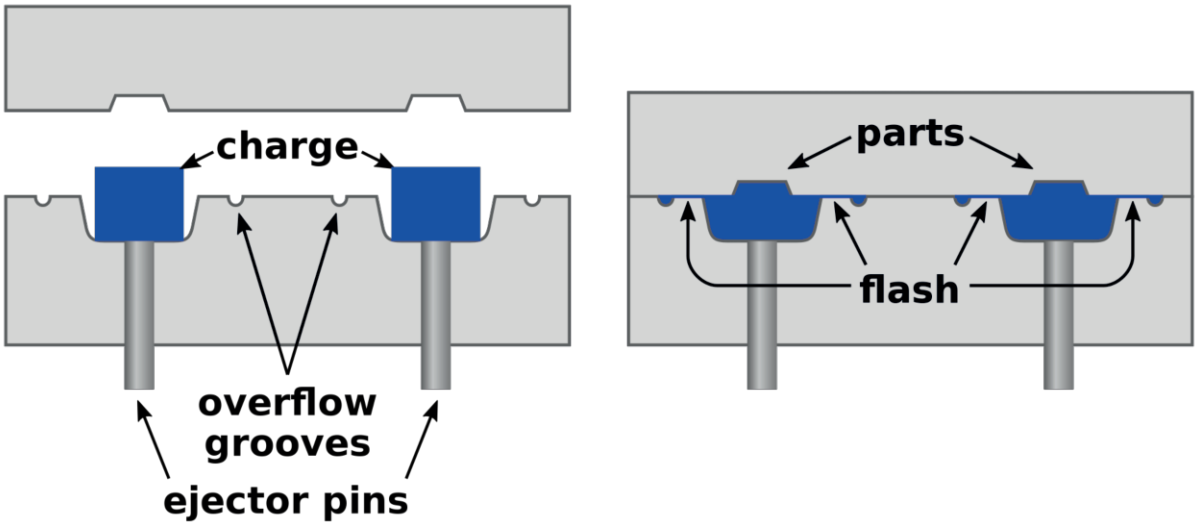

Compression moulding is a high-volume, high-pressure moulding method that is suitable for moulding complex, high-strength objects.

It is quick to make the metal moulds and once made the plastic parts can be produced rapidly. Many companies - especially in the car industry - have chosen compression moulding to produce parts.

The compression moulding process is a method of forming shapes in which a preheated plastic is placed into an open, heated mould cavity.

The mould is closed with a top plug and pressure is applied to force the material to contact all areas of the mould.

Throughout the process pressure is maintained until the plastic has set.

Ejector pins will help remove the plastic part from the mould once it has set. These pins can leave small circular marks in the part.

Moulds for compression moulding are generally simpler than their injection mould counterparts.

Because plastic is not injected into the mould the process itself is limited to simpler part shapes due to the plastic not flowing into the mould.

ADVANTAGES

- Great for making large sheet size objects.
- Components can have quite detailed shapes and surface texture on both the top and bottom.
- No sprues, gates or runners to be removed.
- Quite low cost to make moulds
- Great for batch production

DISADVANTAGES

- Lots of waste plastic
- Not suitable for mass-production of parts
- Higher labour costs
- It can take quite some time to make a metal mould.
- Plastic components will have a split line round the outside where the two patterns are joined.

VACUUM FORMING

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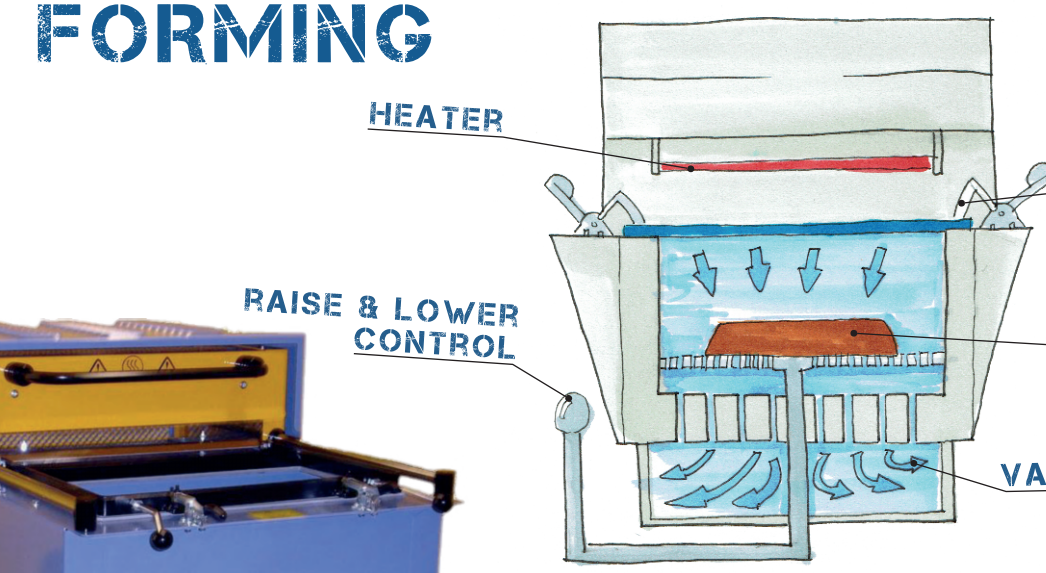

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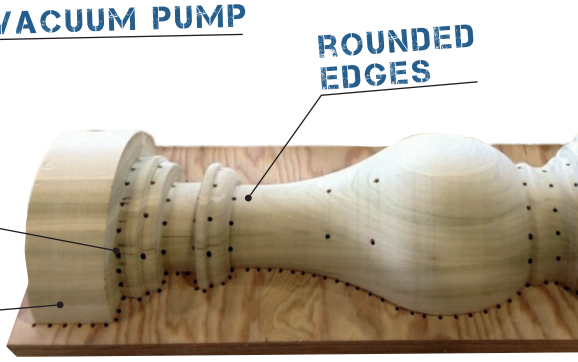

Vacuum forming is one of the oldest and most common methods of processing plastic materials.

The process involves heating a plastic sheet until soft and then draping it over a mould. A vacuum is applied, 'sucking' the sheet onto the mould. The sheet is then ejected from the mould.

In its advanced form, the vacuum forming process uses sophisticated pneumatic, hydraulic and heat controls enabling higher production speeds and more detailed vacuum formed shapes.

Vacuum forming can only be used with sheet plastics and it is important the mould does not have any sharp edges that can tear the plastic.

Similar to making a sand castles, moulds cannot have straight vertical edges - otherwise the pattern could not be removed from the plastic.

ADVANTAGES

- Great for create deep boxes or trays from sheet materials.
- Fantastic for one-off or small batch production of component parts.
- Simple to use process.
- Moulds do not take long to manufacture.
- Quick to make plastic parts once the mould has been made.

DISADVANTAGES

- Moulds must have tapered - angled - sides to remove the mould once the plastic part is formed.
- High staffing costs to remove the moulds from the plastic parts
- Great for create deep boxes or trays from sheet materials
- Cannot edit or change the surface finish of materials.

LINE BENDING

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Line or strip bending is used to form small curvature bends in sheet material.

The process is quite straight forward. An electric element similar to that in an electric fire, is enclosed in a channel which has an opening at the top.

When using machines which have a single heating element it is necessary to regularly turn over the thermoplastic sheet to ensure both sides of the plastic are heated evenly. This will help to avoid blisters appearing on the surface of the plastic.

Strip heaters are typically used manually to create component parts and you will use one during your Design & Manufacture course.

Heating times will vary due to thickness and colour of the thermoplastic.

PLASTICS OVEN

A plastics oven is used to give a consistent heat over sheet materials. This allows a sheet plastic to be placed over a mould or former to take a particular shape.

Plastics ovens are similar to ovens you will have at home. Heat is provided by an electrical element and a fan evenly distributes heat round the oven.

It is important to use gauntlets and tongs whilst using a plastics oven. Touching hot plastic can leave you with serious burns.

The time it takes to heat a plastic will depend on both the thickness and colour of the plastic.

Don't leave the plastic in the oven too long – it will bubble and blister the surface!

ADVANTAGES

- Great for making prototypes models that require plastic to take a particular shape or form.
- Great for making smooth, curved, natural-looking shapes.
- Useful was of changing the shape or form of sheet materials.

DISADVANTAGES

- Suitable for one-off or very limited batch production because it requires a person to do all the processes by hand.
- Handling hot plastics can be very dangerous, so personal protection equipment (PPE) is essential.

PLASTIC EXTRUSION

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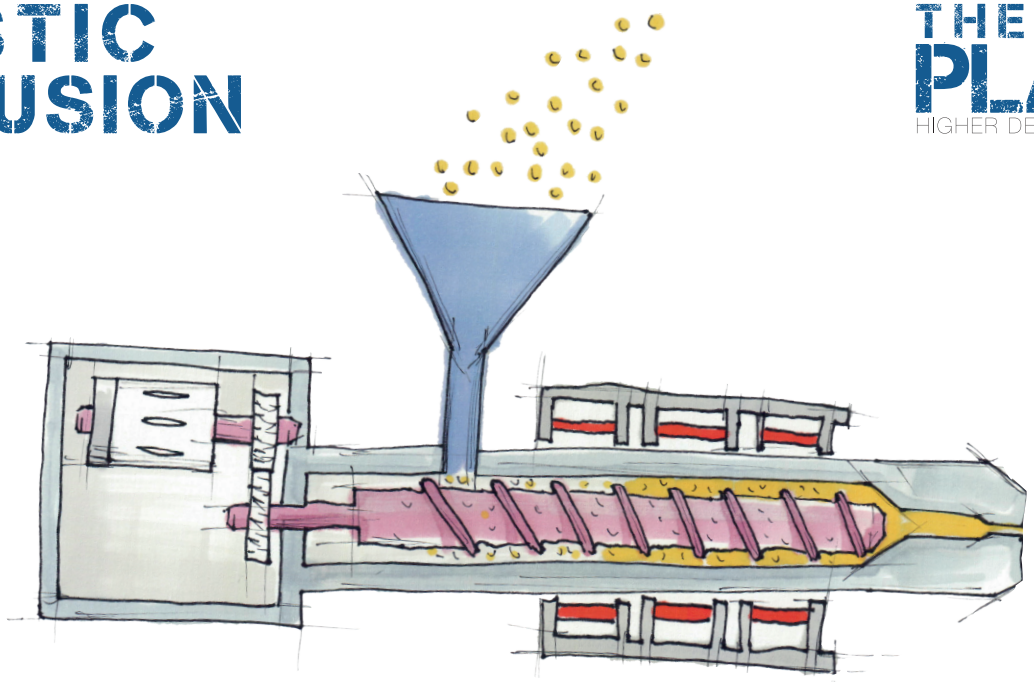

Along with Injection moulding, extrusion is a widely used method of forming plastics parts.

The plastic granules are melted and pushed along by the action of a heated lead-screw. It is a continuous process and is able to manufacture long lengths of a product.

This is ideal for such applications as pipes and trunking. It is common to cut continuous extrusion into suitable lengths.

Unlike injection moulding where the process makes individual identical components, the extrusion process makes a continuous length of plastic with a constant 'cross-section' shape.

This cross section is called the profile. A good example would be a hosepipe, curtain tracks or water guttering round a building.

An electric motor continuously turns a screw, which is contained in the machine barrel. Plastic granules are fed into the hopper of the extruder and are drawn down into the screw.

The barrel and screw are heated by external heating elements. As the plastic granules move along the screw they melt and are forced through a die which is located at the end of the barrel. The die contains the cross section of the profile of the extrusion required.

The plastic is quickly cooled, often with a spay of water and cut to the required length.

ADVANTAGES

- Great for making long parts that are the same shape
- Manufacturing the mould (or 'die') is less expensive than other plastics process.
- It is quick to manufacture the plastic parts.

DISADVANTAGES

- The plastic needs to be cooled quickly and this can damage the extruded parts.
- Extrusion does not make particularly accurate products - the plastic can swell or shrink as it exits the die and is cooled. It all depends on the temperature.

PLASTIC FABRICATION

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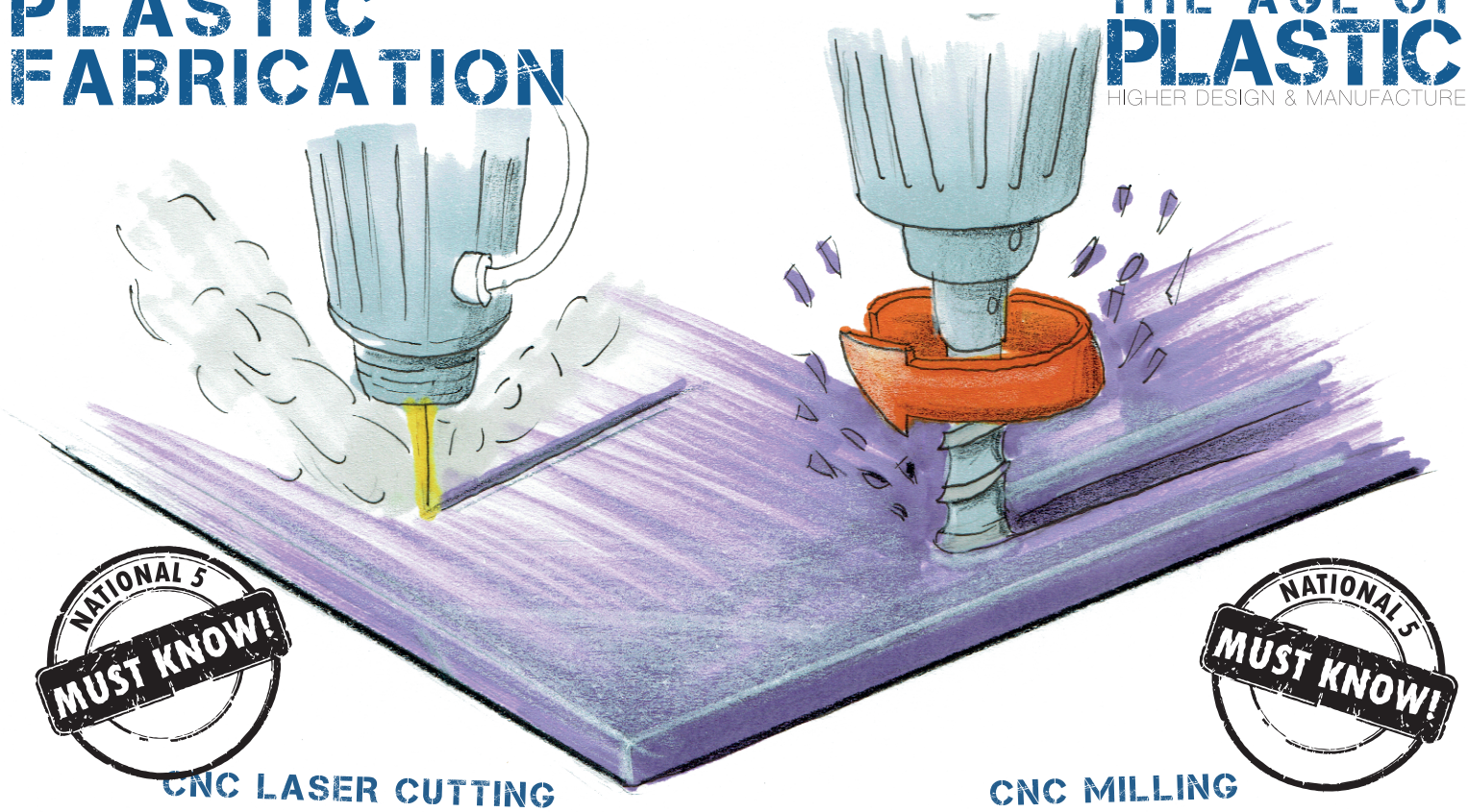

CNC LASER CUTTING

CNC (computer numeric control) is a machine that is controlled by computers sending co-ordinate positions for a tool to move to.

The tool used with a laser cutter is a focused beam of light, capable of marking or even cutting a sheet of plastic.

Laser cutters have a beam less that 0.2mm wide and leave plastic with a polished edge.

Materials do not need to be clamped down as the laser does not have any force to it.

The thickness of material that can be cut depends on the strength of laser beam.

CNC MILLING

A CNC milling machine is similar to a laser cutter, but uses a cutting tool rather than a beam of light.

A CNC milling machine can cut or engrave a 3D profile into a block of plastic.

Special tools have to be used to cut plastic without shattering it and particular tools have to be used to ensure a polished edge.

Materials need to be clamped to the machine as the tool moves incredibly quickly and provides a lot of force.

The thickness of material that can be cut depends on the length of the cutting tool and the size of machine.

ADVANTAGES

- Fantastic for one-off or batch production of component parts.
- Quick and very accurate production of plastic parts.
- Changes of the cutting program is all that is required - no expensive moulds.
- Engraving and cutting both possible.

DISADVANTAGES

- CADCAM (computer aided design, computer aided manufacture) machines can be very expensive to buy.
- Specialist training is required to use the machines.
- A cut process has a lot of waste material