

# FACTFILE:

## ENGINEERING & MANUFACTURING

### QUALITY CONTROL

#### UNIT 3.2.2 – USING MATERIALS, PARTS, COMPONENTS, TOOLS, EQUIPMENT AND PROCESSES



## Moulding and Casting

### Introduction

Students should be able to apply knowledge and understanding of the following processes:

- vacuum forming;
- injection moulding;
- extrusion;
- blow moulding;
- composite layup;
- die casting or pressure die casting; and
- sand casting;

### Vacuum forming

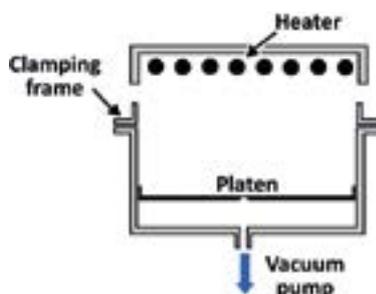
The vacuum forming process is used to form thermoplastic sheet around a mould to produce the shape of the mould. Vacuum forming uses atmospheric pressure to push the plastic sheet onto the mould. Most common thermoplastics are suited to this process and machines range in size to suit the manufacture of a wide range of products.

The mould for vacuum forming is simple in comparison to other moulding processes but the quality of the mould will be reproduced in the finished part. Complex moulds with internal recesses must have vent holes to allow the air to be evacuated from all parts of the mould.

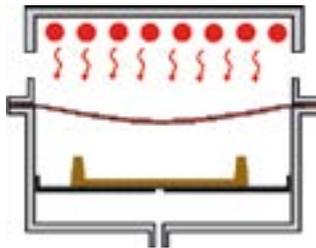
The stages in vacuum forming are as follows.

#### 1. Make a mould.

The mould should have tapered sides with an angle of around 5 degrees (draft angle). The draft angle enables the mould to release from the sheet. All edges should have a small radius and vent holes should be added to any internal recesses.



The vacuum forming machine consists of a heater, a frame to clamp and seal the plastic sheet in place, a platen that can be raised and lowered and a vacuum pump.

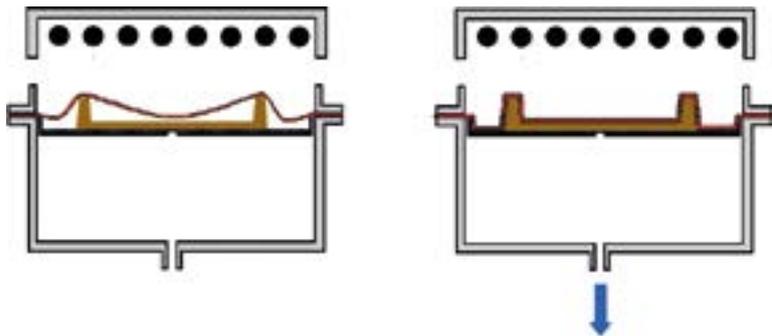


**2. Load the machine**

The mould should be located in the centre of the platen. The platen should be gently lowered and the thermoplastic sheet should be firmly clamped in position ensuring a good seal is achieved all around the edges. At this point the heaters can be switched on. The sheet is heated until it sags in the middle and it has become pliable.

**3. Draping**

The mould is raised and comes into contact with the heated plastic, at this point the vacuum pump is operated and the plastic sheet is pushed onto the mould surface by the pressure difference between the inside and outside of the machine.



**4. Trimming**

The sheet should be allowed to cool then it can be removed from the mould and trimmed from the sheet. Food packaging and blister packs are commonly mass produced using the vacuum forming process.



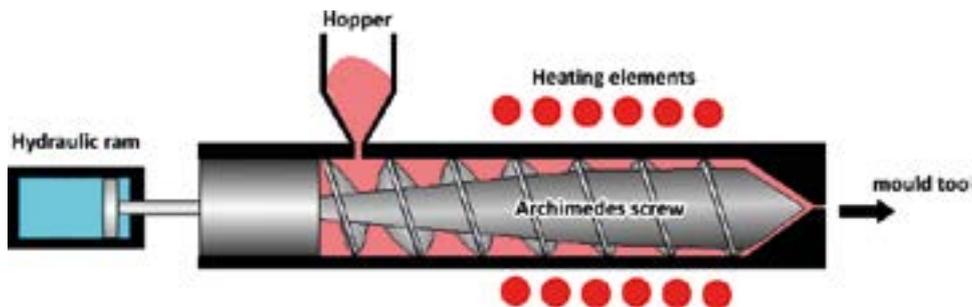
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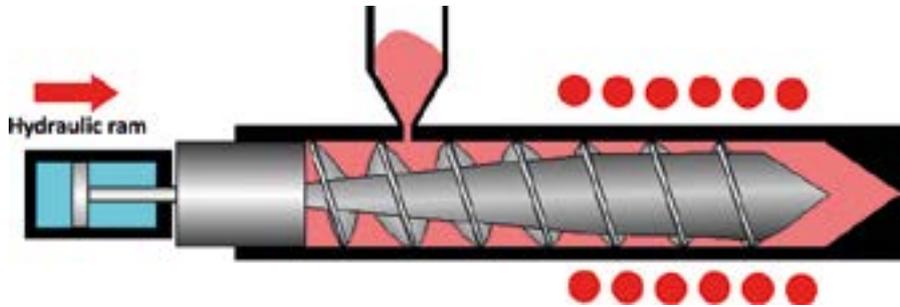
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**Injection moulding**

Injection moulding has a high rate of production and can produce components such as car body panels with high dimensional accuracy. The injection moulding machine is fed with small granules of plastic that are pushed along a heated chamber by a rotating Archimedes screw. A charge of molten plastic is built up at the front of the screw to be pushed into the mould cavity.



The extrusion barrel of an injection moulding machine is fed by a hopper, the barrel contains an Archimedes screw which drives the granules forward as it rotates. The barrel is heated externally and as the granules progress they become molten and build up pressure at the front of the screw. The design of the screw is such that it is driven back to form a void containing a pressurised reservoir of molten plastic which is called the charge.



When required the charge is injected into the mould by means of a hydraulic ram which drives the screw and the heated material forward. The moulds used have a space or cavity which is the shape of the part to be manufactured. The moulds usually have multiple cavities so that multiple parts can be moulded in one cycle. Mould tools are often water-cooled to speed up the mould cycle and have automated features built in to eject the moulded parts when the mould is opened.



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Above is a sample of the type and range of products manufactured by injection moulding.

## Extrusion



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The process of plastic extrusion uses a similar helical screw to that used in injection moulding but set up to produce a constant flow of molten material. Common extrusion products are sheet, rod tube and coated wire. When extruding tubular products, air is blown into the central cavity in the tube to prevent collapse of the profile. The molten plastic is forced through a die which has a hole the required shape, the extruded material is quickly cooled and checked for dimensional accuracy and surface finish.

In the extrusion process the temperature, pressure and flow rate of the molten material must be maintained within very tight limits.

Commonly extruded products include pipes, tubing, polycarbonate glazing sheets and uPVC window frame sections.



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## Blow moulding

Blow moulding is the process used to produce hollow objects from thermo plastic. Blow moulding uses a preformed "parison" in the moulding process.

The parison is extruded vertically as a tube which is then clamped while it is still hot in a mould and blown with air to fill a large mould cavity. This process is used to create milk cartons but can also produce larger containers such as plastic drums.

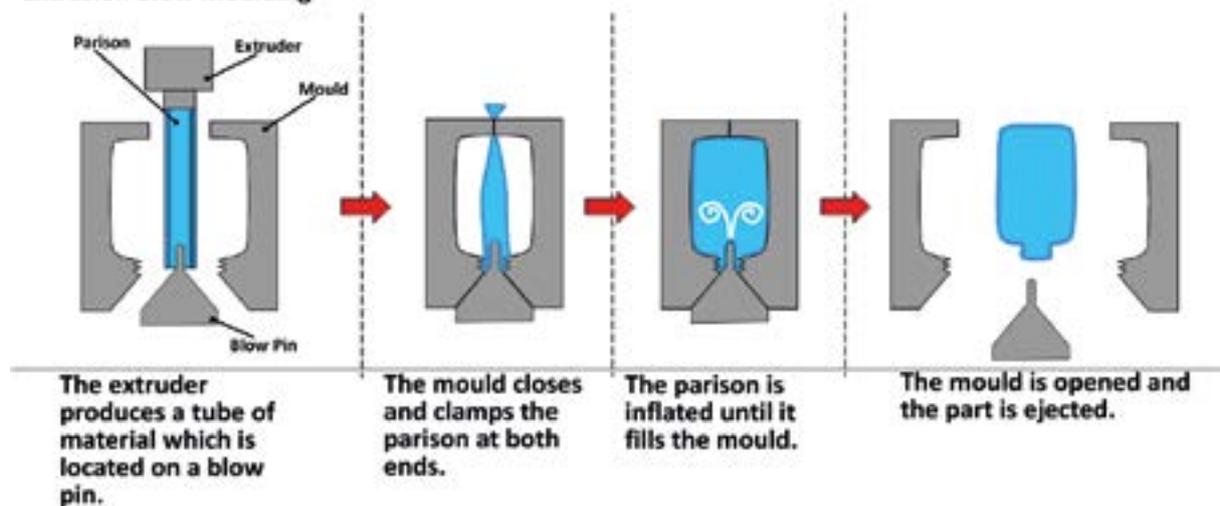


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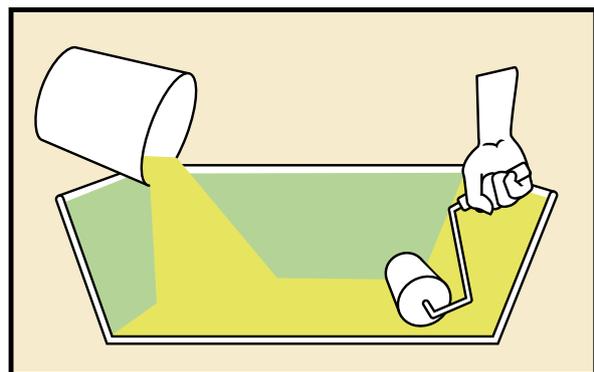
### Extrusion Blow Moulding



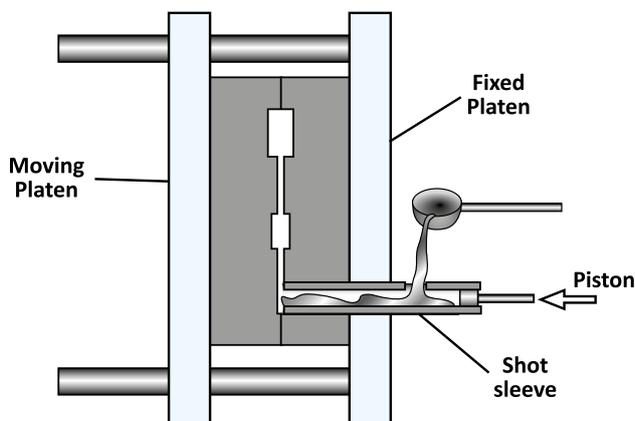
## Composite lay up

Hand layup is the oldest and simplest form of open moulding used in composite fabrication. Hand layup is a low volume and labour intensive method used to manufacture large components such as boat hulls and truck fairings/panels.

The mould is coated in a pigmented gel coat which gives the moulded part a smooth finish. Glass fibre matting is trimmed manually and placed in position in the mould and a two part resin is brushed on to soak the matting, air bubbles are removed using a roller. The polyester resin contains a resin and a hardening compound that cures at room temperature.



## Pressure die casting



Pressure die casting is a process that uses low melting point alloys to manufacture items such as casings for transmissions and components for domestic appliances.

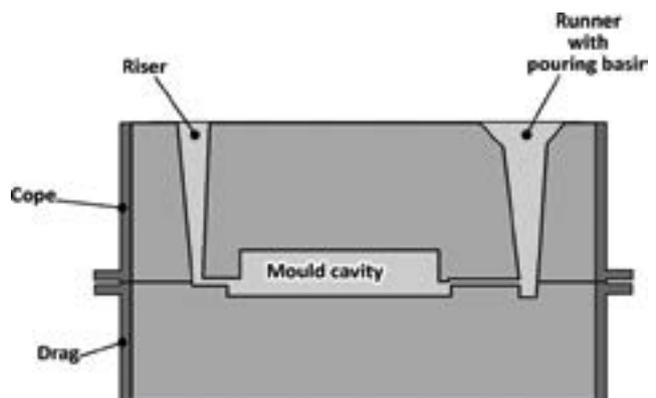
A measured amount of molten metal is poured into the shot sleeve and is forced under high pressure into the mould cavity by a piston driven by a pneumatic cylinder. The pressure is maintained until the mould has solidified. To reduce the cycle time moulds are often water cooled via internal cooling channels in the die.

## Sand casting

Sand casting has been used for thousands of years and is still the most common form of casting.

Typical applications of sand casting include machine frames, propellers and a wide variety of other products.

Sand casting typically involves making a mould pattern and using it to create an imprint in the sand. Then a gating system is added to the mould so that it can be filled with molten metal and to allow gasses and impurities to escape. When the metal has solidified and cooled it is broken out of the mould. The mould is made in two halves in metal boxes, the bottom half is called the drag and the top half is called the cope.



## Revision Questions

1. Explain what is meant by the term draft angle and why is it important when making a mould for a vacuum form?

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2. Explain how a charge of molten plastic is gathered inside the barrel of an injection moulding machine.

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3. How are hollow sections such as tubing prevented from collapsing during the extrusion process?

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4. Name **three** products that are produced using the blow moulding process?

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5. What is the function of the gel coat in the composite layup process?

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6. Produce a labelled diagram of a sand casting mould, include the cope, drag, runner, riser and mould cavity.

## Additional resources

### How Its Made Hot Tubs

<https://www.youtube.com/watch?v=N402QNZHfou>

### Injection Moulding Animation

<https://www.youtube.com/watch?v=b1U9W4iNDiQ>

### How Plastic Bottles Are Made (Injection blow moulding)

<https://www.youtube.com/watch?v=ed7XJeXl3b4>

### Extrusion Blow Moulding

[https://www.youtube.com/watch?v=8Ql4H40TX\\_c](https://www.youtube.com/watch?v=8Ql4H40TX_c)

### PVC Pipes Extrusion Line

[https://www.youtube.com/watch?v=zcBv\\_JvFDBI](https://www.youtube.com/watch?v=zcBv_JvFDBI)

### Sand Casting Foundry

<https://www.youtube.com/watch?v=eTr8cscmx-M>

