MANUFACTURING PROCESSES

Understanding which manufacturing process has been used to make an object can help you identify its material as different materials are manufactured with different process. Different manufacturing processes also mark the objects they make in different ways. These marks can help you identify the process.

Many plastics materials are produced in sheet form as an intermediate stage to producing the finished product by thermoforming of fabrication, described below. The process used to produce sheet varies from one material to another. Calendering uses rollers (like a mangle), extrusion (described below) and casting is carried out on large flat moulds.

You may find it useful to remove the pages from the binder and group objects made by particular processes by the description of the process. Further copies of these pages can be downloaded as a PDF from: https://www.modip.ac.uk/projects/identifying-plastics-toolkit/travelling-toolkit.

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Blow moulding

Process:	Hot air is blown into a pre-formed tube, a parison, of semi-molten plastic which expands to fill a cavity formed by a two part, usually metal, mould. The tube can be injection moulded allowing a thread for a lid or some other detail to be formed. It can also be extruded as a tube, pinched at one end, and again expanded to fill the cavity of a two part metal mould
Introduced:	1881 for use with cellulose nitrate
Plastics:	Commonly high density polythene and polyethylene terephthalate
Marks:	a line where the mould parts have met is often visible
Identification clues:	textures on one side only of artefact, formed from textures on the mould walls
Tooling cost:	relatively high
Production volume:	high
Uses:	hollow articles, usually with openings of smaller diameter than the body, such as bottles or containers

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Casting

Process:	plastic in liquid form is poured into an open mould itself often moulded from plastic
Introduced:	long history with traditional materials, like metals
Plastics:	commonly phenol formaldehyde as liquid resin, polymethyl methacrylate, and polyurethane
Marks:	frequently trapped air bubbles, or their remains on the surface
Identification clues:	base is often trimmed by hand or machine
Tooling cost:	low
Production volume:	low, essentially a craft process; objects can be placed in the liquid as it solidifies; the cast form can be carved; open casts allows manipulation of the finished result throughout the curing process
Uses:	preformed shapes: sheets, rods, tubes; jewellery; radio housings; designer furniture; paperweights

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Compression moulding

Process:	a measured amount of material is added to a two part mould and subjected to heat and pressure
Introduced:	before 1900
Plastics:	usually thermosets, especially melamine formaldehyde, phenol formaldehyde with filler and urea formaldehyde
Marks:	mould seams on complicated mouldings only
Identification clues:	capable of very fine detail
Tooling cost:	medium
Production volume:	relatively slow and labour intensive
Uses:	radio and telephone housings; plugs and sockets; tableware; ashtrays; bowls and boxes

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Extrusion

Process:	plastic pellets are fed into a heated cylinder and driven forward by a turning screw which compacts and melts them and forces the melt through a die at the end, creating continuous lengths of shapes with the desired profile. It is a system much like that of a mincing machine except for the addition of heat. Once the plastic shape is formed it is cooled by air or water
Introduced:	first experiments in the 1840s, widely used from late 1930s
Plastics:	any; all synthetic fibres
Marks:	none
Identification clues:	there may be continuous longitudinal surface marks
Tooling cost:	moderate
Production volume:	high but restricted to minimum order lengths
Uses:	anything with a constant cross section: fibres; tubing; pipes; sheets; films; cable sheathing; profiles e.g. curtain rails or window frames

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Fabrication

Process:	a catch-all term for a variety of processes, including bonding, carving, cutting, sticking, turning and welding
Introduced:	a traditional means of making developed initially for wood and other natural materials
Plastics:	cellulose acetate; cellulose nitrate; glass reinforced plastic; phenol formaldehyde as liquid resin; polymethyl methacrylate; polystyrene
Marks:	none
Identification clues:	seams and signs of adhesive residue
Tooling cost:	low
Production volume:	low
Uses:	varied; see materials concerned

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Foaming

Process:	There are a number of different processes but they share the release of air/gas into the plastic so that it fills with bubbles and foams within a two part metal mould of the desired shape
Introduced:	Post World War 1
Plastics:	Most, especially polystyrene, polyurethans, polyvinyl chloride.
Marks:	None
Identification clue:	Air holes can be visible. Light for its bulk.
Tooling cost	Medium
Production volume	High
Uses	Packaging; sponges; soles of shoes; steering wheels; vending cups, insulation; foam furniture

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Injection moulding

Process:	similar to extrusion except that the plastic is injected into a metal mould often with branching for multi-impression tools
Introduced:	first used successfully with cellulose acetate after 1928; since 1946 it has been the most widely used method of processing thermoplastics; since 1960 it has also been used for processing some thermosets
Plastics:	commonly all thermoplastics
Marks:	the plastic enters the mould through what is known as a gate which leaves a 'sprue' which is then broken off but leaves a slightly rough, often circular area; there are frequently also smooth circular marks left by the ejector pins used to help release the warm moulding from the mould; mould seams are sometime also visible.
Identification clues:	sprue and injector marks
Tooling cost:	high
Production volume:	high
Uses:	precision technique capable of complicated shapes: e.g. medical components; Airfix kits; cheap products produced in very large numbers: Lego; plastic cutlery; machine housings; washing-up bowls

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Rotational moulding

Process:	a measured amount of material is placed in a mould which is rotated on two axes at low speed within an oven. The molten plastic then covers and adheres to the inner surface of the mould. The mould is then cooled while still rotating and the product is released
Introduced:	1940s
Plastics:	most commonly low or medium density polythene; polypropylene can be used if end product needs to withstand high temperatures; polyamides may also be used but rarely because they are expensive
Marks:	none
Identification clues:	inside less finished than outer surface
Tooling costs:	relatively low
Production volume:	medium
Uses:	only for products with uniform wall thickness and where the inner surface of the product can be inferior to its outer surface which replicates the surface of the mould. Usually large simple forms: storage tanks; traffic bollards

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Slush moulding

Process:	a hollow mould is pre-heated and filled with liquid polymer. The curing process begins resulting in the desired wall thickness and the remaining liquid decanted. After final curing the tool is cooled and the moulding stripped from the mould. A relatively cheap way of obtaining a detailed finish on the outside of a moulding
Introduced:	1920s
Plastics:	a variety but most commonly polyvinyl chloride and polyurethane.
Identification clues:	hollow moulding with base attached by adhesive
Tooling costs:	inexpensive
Production volume:	small to medium
Uses:	toys, car dashboards

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Thermoforming

Process:	uses preformed sheets which are warmed and sucked (vacuum forming) or pushed into a mould. Neither high heat nor pressure is required so moulds can be made from cheap materials such as MDF or cast aluminium. Also used to shape rod and tube.
Introduced:	1890 for use with cellulose nitrate
Plastics:	most sheet thermoplastic materials
Marks:	may be variations in thickness where the material is stretched over sharp curves
Identification clues:	produces soft curves, no fine detail; variations in thickness if material is stretched over sharp curves
Tooling cost:	low
Production volume:	suitable for low quantities or even one offs, but can be mechanised to speed up process
Uses:	shallow forms: baths and boat hulls, bowls, yogurt pots