A BRIEF INTRODUCTION TO PLASTICS

Plastics are materials that can be moulded into required shapes by the application of heat and /or pressure.

Most plastics are derived from organic material, that is substances made from things that have lived, including oil, cotton, sugar cane, coal, corn and many others.

At the point of manufacturing artefacts, plastics may be in the form of granules, pre-formed tablets, powders, syrups or pastes and sheet.

Plastics have been traditionally classified as:

- natural, a material that can be moulded in its natural form. Examples are amber, gutta percha, horn, rubber, and tortoiseshell.

- semi-synthetic, that means, made of a chemically altered natural material. Examples are Bois durci, casein, cellulosic plastics and Vulcanite (hard rubber).

- synthetic, that is entirely laboratory made, as for example is the case with phenol formaldehyde, polymethyl methacrylate and the many poly-plastics.

Only synthetic and semi-synthetic plastics are dealt with in this toolkit.

Plastics are based on polymers. That is a material made up of many smaller base units. The simplest plastic is polyethylene consisting of base units of carbon atoms with two hydrogen atoms to each carbon. The base unit is referred to as a monomer. Many monomer units linked together create a polymer, through a chemical process known as polymerization. Polymerization can be demonstrated by hooking together hundreds of paper clips (base units) to form chains. Chains in different configurations make plastics with different properties.

Plastics are divided into two distinct groups:

- thermosets, plastics that on being heated and moulded set permanently, and thus cannot be re-melted and re-formed.

- thermoplastics, plastics that can be re-melted after moulding again and again, and thus can be recycled by melting and reforming

Recognising whether plastics are thermosets or thermoplastics is relevant for the curator as certain production techniques, for example those that rely on reforming plastic sheet, can only be done with thermoplastics.

Increasingly plastics are copolymers, that is made up of two or more polymers, in order to increase the range of performance of the resulting material, e.g. carbon fibre.

It would be impossible to process most polymers into useful objects without additives. Additives can be added in different quantities and can affect the appearance, performance and long-term stability of the plastic. It is as likely to be the additive contributing to a plastic object's degradation as the plastic itself.

The principal manufacturing processes used with plastics are: blow moulding, casting, compression moulding, extrusion, fabrication, foaming, injection moulding, rotational moulding, slush moulding and thermoforming of sheet.

The clue to the manufacturing process can lie in the required number of the particular product. Some processes can be used at home and others involve high tooling investment. Low investment processes tend to be craft based and thus slower than high investment ones. Injection moulding is only economically viable if a very high output is required. For example an injection moulding machine can convert plastic granules to a safety helmet in 40 seconds, that is 2160 in 24 hours, 15,120 in a week and 786,240 in a year. The sharing of the tooling cost across so many units results in a relatively low unit price. It is not, however, cost efficient to injection mould small runs (e.g. 5000) of products. On the other hand, casting, fabrication and rotational moulding cost less to set up but are slower in the making.

Injection moulding was little used until after World War 2. Currently far more plastic objects are made by injection moulding than by any other process.

Compression moulded artefacts may have witness marks resulting from complications in the mould. Simple shapes such as plates or bowls are not likely to have any processing marks on them. Where products have protuberances such as handles the more complicated split mould is likely to leave processing marks. However in many cases post-moulding polishing may have removed this evidence.

The most frequently encountered marks on products are those left by injection moulding: the 'sprue', the tail of plastic that is broken off at the point it enters the mould, and the ejector pin marks, smooth and circular, which assist with the removal of the moulding from the mould.

Details of the characteristics of the materials and processes involved in the manufacture of the artefacts in this resource are given in Parts 3 & 4 respectively of the toolkit.